Encyclopedia of Information Technology Curriculum Integration

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Preface

INTRODUCTION

Information technology continues to be one of the most rapidly changing disciplines, and nowhere is that reflected more than in the classroom. New technologies and concepts are introduced daily, and new ways of utilizing technologies for teaching and learning are constantly unveiled. In such an ever-evolving environment, teachers, researchers, and professionals of the discipline need access to the most current information about the concepts, issues, trends, and technologies in this emerging field. Towards that end, the Encyclopedia of Information Technology Curriculum Integration provides comprehensive classification, coverage, and definition of the most important issues, concepts, trends, and applications of technologies for the classroom.

This important new publication is distributed worldwide among academic and professional institutions, and will become instrumental in providing researchers, scholars, students, and professionals with access to the latest “best practices” with respect to the integration of information science and technology curricula.

The Encyclopedia of Information Technology Curriculum Integration provides a compendium of terms, definitions, and explanations of concepts, processes, and acronyms. This volume features a host of highly selective articles authored by leading experts in the field of information technology education, and offers in-depth descriptions of key terms and concepts related to worldwide issues and trends in teaching and learning with technology. It employs an organizational structure grounded in a classification system introduced by the editor in his 2005 publication, The Taxonomy for the Technology Domain.

The taxonomy offers a methodology for using technology to enhance student learning. Research shows that a classification scheme is an excellent tool for categorizing learning outcomes. For our purposes here, the Taxonomy for the Technology Domain is employed to stratify the encyclopedia and organize its 150-plus manuscripts by literacy, collaboration, decision making, infusion, integration, and technology (Tomei, 2005). As with most taxonomies, each step offers educators a wealth of practical applications of increasingly multifaceted student learning outcomes at each level of activity.

LITERACY

Literacy Defined

The encyclopedia entries subsumed under Literacy reflect the lowest level of technology-based learning. At this level of the taxonomy, literacy is defined as “the minimum degree of competency expected of teachers and students with respect to technology, computers, educational programs, office productivity software, the Internet, and their synergistic effectiveness as a learning strategy” (Tomei, 2005). Literacy entries found here discuss basic technology skills necessary for the technological learner.

Technological literacy is a foundation for learning now as commonplace as the historically traditional skills of reading, writing, and arithmetic. As society responds to this technological revolution, it also faces major challenges. Society has changed rapidly in recent years and international economic competition is booming. Success depends on the ability to acquire new skills quickly in response to new technologies. Realization of corporate goals demands the attainment of innovative knowledge in order to become a contributing member of our high-technology educated citizenry.
Contributions of the Encyclopedia

Literacy demands a level of skill and competency in the use of technology for personal application. At the outset, the list of required abilities appears daunting. It involves an understanding of technology at its most basic roots; an appreciation of a growing inventory of technological hardware media; and, the operation and application of complex operating system, office productivity software, and basic software utilities (e.g., paint and draw, virus protection, communications, and entertainment).

The encyclopedia offers a host of contemporary manuscripts that deal with research projects and practical applications. From the demands placed on education by the No Child Left Behind legislation to the magic of wireless technology, literacy presupposes that the learner is able to communicate with instructors, fellow students, and peers using state-of-the-art technology and terminology.

The articles classified under Literacy represent the gamut of technologies and offer the reader reviews of topics including, but not limited to, wireless, local- and wide-area networks; technology literacies, competencies, and skills; computer security, copyright, and fair use laws; discussion groups, chat rooms, and e-mail for teaching; and, primers on database, spreadsheet, and electronic textbook software.

Assistive Technology for Individuals with Disabilities (also called “adaptive technology”) explains the delicate balance between the weak and strong areas of learning for students with disabilities. Cognitive Informatics discusses the emerging discipline that studies the natural intelligence and internal information processing mechanisms of the brain, as well as the processes involved in perception and cognition. Critical Literacy and Technology employs text, images, voice, and video to enhance learning and social equity. Cyber Academy introduces the APEC Cyber Academy, a networked learning environment originally designed for K-12 students to address specific characteristics in pedagogy essential for supporting international collaboration among primary and secondary school learners. Cyber Charter Schools presents the alternative school model for delivering curriculum and instruction while minimizing the use of personnel and physical facilities.

Database in Computing Systems offers readers a primer on database models and the terms “table,” “record,” “field,” “entities,” and “attributes.” Desktop Publishing in Education explores the creation of digital files for desktop or commercial printing such as newsletters, brochures, posters, flyers, name cards, and other projects that use page-layout software. Digital Literacy Research examines the ability to distinguish between content and presentation; evaluate a wide variety of content from different sources; demonstrate search skills; filter messages and use Internet agents; create a personal information strategy; operate in a community of practice; define problems and develop questions; judge the completeness of information; plus, much more.

Discussion Groups introduces techniques in facilitating discussion groups based on common issues, challenges, and the principles of instructional design that encourage meaningful discussion leading to student critical reflection. Distance Learning Specialists defines many of the roles of these instructional professionals as designer of the educational experience, facilitator and cocreator of a social environment and subject matter expert. Providing access to instructional materials and resources is important for any type of learning to occur.

Educational Accessibility to Technology investigates students who may not have access to the resources necessary for them to complete projects, perform research, retrieve data information, and communicate with others, and the resulting impact on learning. Electronic Textbook Technology in the Classroom looks at e-books, devices approximately the size of a traditional paperback that hold digital forms of printed material that can be downloaded and read at will, and sport advantages and uses that are seemingly endless in a school setting.

Ergonomics is defined as the science of designing working environments for maximum health and safety and maximum work efficiency, as well as the study of human physical characteristics and needs. This article describes major considerations when integrating technologies into the classroom or the workplace.

Fair Use and the Digital Age provides a close-up look at key elements of both copyright and fair use laws, as well as critical factors in assessing personal adherence to these laws and recommendations and cautions for operating in a technology environment. Information Literacy is integral to the development of many of the capabilities important to survive in the 21st Century. Nine standards, developed by the American Library Association and the Association for Educational Communications and Technology, are highlighted in this article for consideration.

Internet Citizenship presents the design of an actual course that focused on how the Internet may be used as a medium for discovering information about citizenship, in general, and for advocating and practicing citizenly conduct, in particular. Keyboarding and When to Teach It argues that typing can be exciting and rewarding when approached as a content area to be taught, learned, and mastered as a skill set necessary to raise computer use to its fullest potential. Local Area Networks provides a primer for one of the most popular technologies in both the consumer and enterprise markets. LANs have be-
come a ubiquitous resource as the Internet and personal computers matured in size, speed, capabilities and features, and use, making this an important contribution to the encyclopedia. **Neural Informatics** chronicles the development of classical and contemporary informatics as the cross fertilization of knowledge between computer science, systems science, cybernetics, computer/software engineering, cognitive science, neuropsychology, knowledge engineering, and life science.

President George W. Bush signed the *No Child Left Behind Act of 2001* (NCLB) on January 8, 2002. The article, *No Child Left Behind*, discusses the main ideas and key features of accountability, flexibility, proven education results, and school choices for parents, and shares some initial results of how information technology has contributed to its success so far. **Online Mentoring in Education** considers the importance of using technology-enhanced communication to form mentoring relationships between educators and their students. When distance and time are factors impeding effective mentorship, online tools often help improve the teaching and learning processes.

**Podcasts** introduces the latest “voice of the people” in the form of audio files stored and uploaded to the Internet and published for targeted subscribers. **Spreadsheets** are multidimensional, addressable, ordered arrays of cells whose contents may be text, values, formulas, or functions, able to display and store data and evaluate expressions. For many, the spreadsheet was the first software application that made personal computers a fixed tool in the business office and a literacy of paramount importance to information technology educators.

**Students with Disabilities and Technology** examines how America’s schools are required to meet federal laws and regulations for special education covered by the *Individuals with Disabilities Education Act*. More and more, teachers of students with disabilities are utilizing techniques, such as universal design, to make adaptations to the regular education curriculum to help them garner access and understanding. **Teaching and Learning with Personal Digital Assistants** relates the latest in classroom-targeted technologies in the form of small handheld devices that store documents, spreadsheets, calendar entries, games, databases, and other resources. Their relative cost and portability have endeared them to faculty and students, and have opened avenues for instruction once relegated to desktop computers and textbooks. **Thinkquest** introduces the worldwide competition focusing student efforts on project-based learning, and the technology that supports this style of learning. The article summarizes the accomplishments and benefits of the program’s impressive array of efforts and resources, and the interactive tools that facilitate learner-instructor and learner-learner collaboration.

**Understanding Computer Security** considers the measures and controls that ensure confidentiality, integrity, and availability of information system assets including hardware, software, firmware, and information being processed, stored, and communicated. This article reviews many of the hardware, firmware, and software security features available to protect against, or prevent, the unauthorized disclosure, manipulation, deletion of information, or denial of service. A bibliography is a well-known apparatus provided by authors to document the litany of printed resources (e.g., books, articles, reports) on a given subject or topic for further study or reference purpose.

In *Webliography*, the citation discusses ways to search, evaluate, organize, update, and reference Web-based resources. Closely aligned are WebQuests, which have become popular tools for integrating Internet resources into existing curriculum content. Their application has expanded rapidly with the advent of multimedia-rich technology, to the point where they are presently one of the most common tools used for the integration of technology into the classroom.

**Wide Area Networks** examines network services distributed over large geographic areas and provides a prologue to a much broader understanding of telecommunication systems on which such distribution depends, and the growing reliance on general dependency on third-party carriers to provide these transmission services. In the encyclopedia citation, *Wireless*, the author looks at many implications of using wireless technology on campus or in corporate buildings, providing its users greater flexibility in movement and increased elasticity in addressing mobile job requirements. Finally, as a literacy technology, *Wireless Computer Labs* discusses issues of instructors and faculty, formal and informal curriculum, and funding, staffing support, and training needs associated with the introduction of wireless labs for teaching and learning.

### Summary

Technological literacy involves using technology hardware and, at the same time, understanding word processing, spreadsheets, and Internet access, to the point where terminology barriers are eradicated. Lifelong learning implies the use of these powerful tools for success. The first classification of articles for the *Encyclopedia of Information Technology Curriculum Integration* promotes continued awareness and individualized consideration of the many technologies that make up information technology curriculum integration.
COLLABORATION

Collaboration Defined

Collaboration is defined as “the ability to employ technology for effective interpersonal interaction” (Tomei, 2005). Effective uses of interactive technologies include appropriate written and oral communication, the professional exchange of information, and interpersonal collaboration. Collaboration involves the use of telecommunications media to network with peers, instructors, content area experts, and others. Skills at this level of the taxonomy are evidenced by sharing information in written form (word processing, desktop publishing), responding to directed personal interchange (electronic mail), and participating in and interpreting interpersonal dialog (via list servers, chat rooms, and online bulletin boards).

After literacy, collaboration moves quickly to the forefront of any list of necessary competencies. Collaboration is paramount in order to work cooperatively, gather information, express knowledge held within, communicate with others in support of direct and independent learning, and pursue personal and professional interests.

Contributions of the Encyclopedia

Perhaps no other level of the taxonomy is as important to educational, personal, and professional success as collaboration. As a result, a host of important citations have been added to the Encyclopedia of Information Technology Curriculum Integration at the collaboration level.

Advancing Professional Learning with Collaborative Technologies explores the use of collaborative technologies with preservice teachers, and how the effective integration of technology into teacher education courses positively impacts school technology practices. Active Learning Online purports a widespread agreement on the definition of learning as a recognizable change in behavior as the result of experience. This article attempts to examine the relationship between active learning online and the intellectual growth and development of learners as a result of technology infusion into the collaborative component of online instruction.

In a world that is increasingly mobile and connected, the nature of information resources is constantly changing in terms of how new information is networked, the modalities in which it is delivered, and the overwhelming quantity of data. Anywhere, Anytime Learning Using Highly Mobile Devices describes how mobile devices for teaching and learning are pushing users closer to a ubiquitous computing environment. It explores the issues relevant to making a commitment to replace more cumbersome technologies with such devices. To successfully implement mobile devices takes rethinking on the part of administration and faculty regarding the role of technology in schools, and the fundamental impact this changing role is going to have on teaching and learning. Asynchronous Online Networking has been at the forefront of foreign language education at least since the early 1990s, with the goal to promote intercultural communication, and assist students in developing the construct of the intercultural communicative competence. This article presents arguments based on data gathered from the implementation of asynchronous online networking across native language and culture, the language and way of life of the target culture, and the necessary skills to mediate across them.

Blogs (short for Web log) are online journal entries, usually displayed on a Web site, that contain entries listed in reverse chronological order. These tools combine text, images, hyperlinks, and in some cases, audio, to provide information on a specific topic. This article describes a host of blog characteristics including page title, main content (or body of the post), post date, and a link that provides future access when placed in the archives. Chat As New Pedagogy introduces a new pedagogy grounded in computer information technology as a means to enhance effective collaboration. Chat as a mode of instruction provides interactive learning, meaningful instruction, enhanced communication and collaboration, and more timely assessment, especially formative assessment that instructors use to modify their teaching. Classroom Without Borders
is a euphemism for non-traditional course offerings employing a variety of distance education technologies such as electronic mail, computer conferencing, two-way audio/video, videoconferencing, and satellite delivery. This article offers an introduction to classroom without borders, its dependence on distance-learning technologies, and its reliance on a global education community complete with institutional and individual stakeholders.

**Computer-Supported Collaborative Learning** explains how scripts for collaboration were originally developed in order to support text comprehension. They divide learning into a sequence of small steps, assigning each learner to a particular role, and offering a number of comprehension strategies such as questions, feedback, and elaboration. **Group Collaboration in Education** involves strategies that employ new technologies based on significantly enhanced educational platforms, while businesses often opt for collaborative tools designed to reduce costs and bring their products to market faster than the competition. Advances in technology make such paradigm shifts in group collaboration not only possible, but necessary. **Interactive Videoconferencing** relates how the union of once disjointed voice, video, and data telecommunication technologies, and the increasing adoption and cost-effective availability of high bandwidth network services among educational institutions, businesses, and home users, has rapidly altered the landscape of technology-mediated communications. In combination with the use of distance learning technologies, many instructional environments are adopting a blended approach to instruction that includes interactive video communications.

The participatory, collaborative, active, and interdisciplinary nature of a **Learning Community** and (specifically) a **Networked Learning Community** is posited as an approach to curriculum design requiring instructors and students to join efforts to coordinate proper courses into different programs of instruction, implement the coordinated courses, and evaluate the designed course content and learning objectives.

**Netiquette** is the combination of two common words, network and etiquette, and is used to denote proper or acceptable manners that should occur on the Internet by users conversing electronically. Netiquette comprises rules for good behavior adapted for electronic communications and shared in this important encyclopedia citation.

One of the key distinguishing draws of online education is the opportunity for instructors and students to interact via asynchronous **Online Discussion Groups**. Offered to a varying degree in different online academic programs, online forums are used for social interaction, collaboration of assignments and other assessable work, tools for individual project groups, tutorial purposes, or as a central part of the teaching strategy. This article presents both compulsory aspects of the asynchronous format and its challenges with respect to the assessment mix. **Online Interaction and Threaded Discussion** represents an asynchronous form of online interaction in which electronic messages are posted, archived, retrieved, and viewed online. Participants view and respond to the posted messages and, by doing so, create a strand of responses that is better organized and more intuitively tracked. Advantages include facilitating ongoing class discussions; expanding ideas, drafts, and finished projects; and soliciting comments and critical feedback. The article, **Online Learning Environments**, introduces the most popular communication formats including personal e-mail and listserv, online conferencing, chat rooms, discussion boards, and blogs, as well as many other synchronous and asynchronous forms of communication. **Scripts for Facilitating Computer-Supported Collaborative Learning** work by sequencing, role assignment, and collaborative strategy application, individually. Sequencing creates a number of different steps according to the order in which the task should be carried out. Assignment of roles introduces role taking theory, and often transforms learning into a more engaged and active venue. Four basic strategies supporting collaborative learning include clarifying, summarizing, questioning, and prediction.

In the article, **Service-Oriented Architecture in Higher Education**, the contributor presents a framework for analyzing service structure in networked and virtual environments within higher education, while offering an approach generic enough to be applied to a host of organizational environments. From another viewpoint of network architectures, **Shared Networks in Technology Education** establishes the relationship between the investment on information and communication technologies, and discloses the
impact of information technologies on educational institutions by presenting a view of the key variables in a global model for measuring the value of shared networks in technology education.

In *Synchronous and Asynchronous Learning Environments*, the contributor discusses the organizational and pedagogical aspects, as well as the benefits and disadvantages of synchronous and asynchronous technologies as platforms, both of which are employed equally during the creation of contemporary distance-learning environments. Synchronously, learners participate simultaneously with both the instructor and peers, with no time lag, in spite of the geographical separations. Asynchronously, the instructor and learners are separated by both time and geography, and learning is self-paced. *Technology Support for Collaborative Learning* introduces the reader to the time and place dimensions of online collaboration, and offers several practical examples of asynchronous and synchronous communication tools, such as audience response systems, electronic meeting systems (e.g., desktop Web cams and classroom videoconferencing), and convergence hardware (e.g., personal digital assistants (PDAs), pocket PCs, mobile phones, and other portable devices).

*Telemomentum* takes the traditional concept of mentoring and applies collaborative technologies to student advisement and counseling via online communications tools ranging from text to video-conferencing. It prevails over barriers encountered as a direct consequence of time and geographic separation, and promotes the mentoring relationship so crucial to successful instruction. From another viewpoint, as tools to facilitate learning, comes *Web Logs*, another term for text, graphics, hyperlinks, photos, audio- and/or video-based journal entries. In this citation, the author introduces the common components of a blog, to include the title, body of the log, comments, links, date/time posted, and categories or tags.

**Summary**

Regardless of its application, collaboration is an indispensable second level of technology competency. Technology-based communication skills are essential to information technology education (as it is other academic disciplines).

**DECISION MAKING**

**Decision Making Defined**

Technology for decision making refers to the “ability to use technology in new and concrete situations to analyze, assess, and judge” (Tomei, 2005). Before decision-making technologies can be effective, mastery of the concepts and skills from the previous two levels is assumed. Making decisions with the aid of technology requires a higher degree of technology understanding than either of the previous stages, and includes such important tools as spreadsheets, brainstorming software, statistical analysis packages, and database applications. The *Encyclopedia of Information Technology Curriculum Integration* offers an array of articles that address the importance of decision making to the discipline of information-technology education.

**Contributions of the encyclopedia.** Problem-solving skills are advanced with the aid of decision-making technology, as learners employ strategies for making informed decisions and solving real-world problems. *Data Mining* is the process of extracting previously unknown information from large databases or information warehouses, and using it to make crucial business decisions. As this article purports, data is plentiful while applied knowledge garnered from this data seems to be a most challenging dilemma. The common types of information derived from data-mining operations are associations, sequences, classifications, clusters, and forecasting. Mining data effectively involves the employment of algorithms and methodologies widely accepted in mathematical circles to include neural networks, decision trees, genetic algorithms, regression analysis, logistics regression, and *memory-based reasoning*. The advancement of expert *Data Mining Software* is the direct result of major improvements in technology applications. This article introduces many of the most popular diagnostic tools for analyzing data, and examines data gathering from different dimensions. The concepts of class relationship, clusters, logical relationships, sequential patterns, and consumer preferences are mentioned. In *Data Warehouse Software*, applications that provide flexible, secure, and rapid access to critical information and intelligent reporting are reviewed. Some of its many recognized advantages, compiled over a relatively few years, include end-user access to a wide
variety of data, increased data consistency and productivity, reduced computing costs, and an infrastructure that supports
data replication in operational systems. Noted disadvantages are the time-consuming demands of designing, developing,
and implementing warehousing software while security issues and incidents of poorly designed software have plagued
data-management applications.

**Decision Support Software** is classified as text-oriented, database-oriented, spreadsheet-oriented, solver-oriented, rule-
oriented, compound (or hybrid). Others classify such software as model-driven, communication-driven, data-driven, document-
driven, and knowledge-driven and identified three different user levels as passive, active, and cooperative. Model-driven
software manipulates statistical, financial, optimization, and/or simulation models to combine information from different
sources and promote effective decisions. Communications-driven software, as its name implies, fosters interaction between
groups, facilitates information-sharing, and supports collaboration and coordination. Data-driven software allows users to
manage data without abandoning manageability or operational integrity, while document-driven software provides solutions
to archiving, retrieving, and sharing documents. Knowledge-driven support software deals with general knowledge that aids
in the decision-making process. The basic ingredients of **Decision Support Systems** include the data management system,
the model management system, the knowledge engine, the user interface, and the user. Essentially, these support systems
are computer --based and promote the decision-making process. The citation explains how information is entered from the
decision maker to produce output from the model that ultimately assists the decision maker in analyzing a situation. **Decision
Trees** represent the theoretical basis of decision theory; they are excellent tools in the decision-making process. The citation
introduces genetic algorithm trees, orthogonal decision trees, and hybrid decision trees, as well as practical applications of
decision trees in data mining, use of decision trees in risk management, and decision trees in supply risk management.

**Digital Business Portfolios** are basically collections of artifacts used to validate claims made by the owner of the
portfolio. Artifacts that comprise a portfolio come in a variety of formats including text documents, Web pages, graphic
presentations, research papers, assessment instruments, original projects, videos, certificates of achievement, spreadsheets,
databases, digital images, and more. In the realm of education, portfolios take on the nature of learning and assessment, job
searches, interview showcase, and lifelong career growth portfolios. This article suggests some of the most common (and
critical) artifacts for each type of portfolio, and offers some practical production tips for creating personalized artifacts.

**An Executive Information System** is a computer-based system that serves the information needs of top-level managers,
including those of information technologists. Such systems differ from traditional management information systems in ease
of use and their responsiveness to executives needs. Some of the characteristics identified in this article include personalization
features, tracking options, analysis tools (e.g., status access, trend analysis, exception reporting, and drill-down capability),
integration of internal and external data, user-friendliness of the interface tools, and the intuitive graphical, tabular,
and/or textual presentation information. An **Expert System**, also known as a knowledge-based system, is a computer-based
application that captures human knowledge to solve problems that ordinarily require human experts. These systems are
also considered as a branch of artificial intelligence that aims at making computers capable of emulating human reasoning
behavior. The goal of expert systems is to ensure that scarce expertise can be utilized when a human expert is not available.
This citation shares the generic architecture of an expert system.

**Evaluating Online Resources** is a highly thoughtful, no-nonsense guide to evaluating online Web resources. Char-
acteristics for assessing the value of online materials include accuracy, reliability, validity, and authoritativeness of the
information; relevance and appropriateness of the vocabulary and concepts presented and clarity of objectives, methods,
procedures, and assessments used to attain the information; completeness of the coverage, currency of the information,
and logical development of the content; motivation of the creator that establishes a confidence in the results produced; and,
organization that exhibits a logical approach taken by the source.

**Facilitating Technology Integration** results from the diffusion, implementation, and infusion of technology within an
organization. The process of technology diffusion consists of three stages. Adoption refers to the decision to use a specific
technology for some intended outcome or purpose, in our case technology education. Implementation concerns itself with
specific actions taken by educational institutions to meet human and environmental factors that lead to the diffusion of the
technology. Integration refers to the specific practices as well as the quantity and quality of use that occurs once a technol-
ogy has been implemented. Several specific models are introduced in this citation.

**Group Decision Support Systems** represent interactive information technology-based environments that support con-
certed and coordinated group efforts toward completion of joint tasks. These systems have become popular tools in aiding
decision making in many organizational settings by combining the computer, communication, and decision technologies
to improve the decision-making process. Options for employing such technologies manifest themselves as either special-
purpose decision rooms, multiuse facilities, or Web-based groupware. This article explores how these state-of-the-art
technologies can improve the quality of group-based experiences by minimizing the negative effects of group decision
making, and maximizing the benefits of group collaboration. **Model-Based Decision Making** defines this special decision
making too, in the context of cardiac surgery. In medical terms, “risk stratification” means the estimation of the risk of a disease progressing or leading to complications or death. In order to do this, risk factors are recorded that are known to be associated with the progression of a disease or with the occurrence of complications. Based on the individual risk profile, tables, algorithms, or computer programs are used to determine the individual risk of the patient. While on the surface this citation might appear out of place in an encyclopedia focusing on information technology education, this article shares the fundamentals of model-based decision making sufficiently for any application.

Online Academic Advising describes the tools, trends, and challenges of making academic (or training) decisions using technology-based tools for improving academic advising practices. A host of electronic tools are presented in this citation including e-mail, online chat rooms, instructional management systems, instant messaging, listservs, blogs, podcasting, and a new technology for consideration.

Organizational Data Warehousing is a product of business need and technological advances, but has many applications in the field of information technology curriculum. As more and more administrators seek the tools to make data-driven decisions, five major elements of data warehousing are brought into play: data acquisition, data modeling and schema, metadata, data management, and data analysis. Data acquisition involves identifying, capturing, and transforming data in operational systems. Data acquisition builds and manages a data warehouse designed to extract, transform, transport, and make data available to users. Data modeling analyzes data objects to determine relationships among these data objects. Data management includes the access and storage mechanisms that support the data warehouse, and data analysis software includes a host of data-mining tools.

Software Evaluation is an important component in the process of choosing technology for learning and instruction. The author of this citation suggests the 15-minute rule, as well as some quick and easy guidelines to use for selecting software from the perspective of both learner and teacher. A simple checklist is offered for consideration.

System-Dynamics-Based Learning Environments refers to the computer-simulation-based decision support systems that target improved decision-making capabilities. The article discusses user interfaces and the role of human facilitators, and goes on to establish that the strength of these environments lie in the underlying system dynamics simulation models explored in considerable detail. Further, the article expands on investigations into the overall effectiveness of interactive learning environments, and how they will advance knowledge into the design conditions of an effective decision support system for task systems in the public sector.

Summary

Learners should grasp the ability to employ decision-making tools throughout their years of preparation and formal education. In addition to using spreadsheets for more traditional purposes, they also need experience in the many tools categorized in this section of the Encyclopedia of Information Technology Curriculum Integration.

INFUSION

Infusion Defined

Technology for Infusion recognizes technology as a powerful strategy for uncovering and exploring academic content, in other words, technology for learning. This level is concerned with the “identification, harvesting, and applications of existing technology to unique learning situations (Tomei, 2005).” For purposes of the Encyclopedia of Information Technology Curriculum Integration, citations at this level are further classified as either Theories and Research or Learning Applications.

Contributions of the encyclopedia. Infusion takes on an even more important role in the teaching-learning process as technology is incorporated into the curriculum. Infused technologies, offered by a knowledgeable instructor, maximize student learning options, address the diverse needs of individual students (gifted as well as special needs learners), develop higher order thinking skills, and contribute to stronger academic content throughout the curriculum. To support this level, the citations grouped under infusion are further subdivided as Theories and Research (which form theoretical foundations), followed by articles that share practical Learning Applications of successful infusions of technology.
THEORIES AND RESEARCH

For infusion to be effective, educators must determine when technology tools are most useful, and how they best address the multiplicity of tasks and problems to be encountered by the learner over a lifetime. The infusion articles found in this section of the encyclopedia offer research and best practice for consideration. The first article, Applying Critical Thinking Skills on the World Wide Web, describes the process of critical thinking from the perspective of learning as a productive and positive activity. Information technology education comes into play with an examination of two activities related to the Internet that are particularly promising for the development of critical thinking skills: the assessment of text-based resources and the development of Web-based scenarios. The primary objective of a Computer-Based Assessment is to save instructor time by using technology to assist in the more mundane aspects of student feedback (e.g., scoring and tallying). The citation introduces formative assessment, an evaluation designed to help students gain an understanding of content knowledge and the development of good learning habits. It goes on to examine ways in which assessments might be implemented using software in light of the needs and concerns of the learner as well as the institution. Finally, the article presents an assessment model used to evaluate and track increases in learner knowledge and skills. Differentiated Instruction and Technology is based on the premise that successful instructional approaches vary and adapt to individual and diverse needs of students in classroom. When teachers engage in differentiated instruction, they address a multitude of student interests, ability levels, and learning profiles. Many of the concepts utilized in differentiated instruction are used in special education to meet the needs of those students that are on the ends of the ability spectrum. Differentiated instruction extends the concept of individualizing to meet the needs of all students in the class, whether they are below average, average, or above average ability, through the implementation of learning profiles, learning contracts, interests, and, of course, technology. Technology-driven differentiated instruction is affected by many issues; the citation discusses privacy, collaboration and communication skills, organization, learning styles, and authentic learning.

Generative Learning Model to Teach Adult Learners addresses the needs of adult learners to actively participate in the learning process by generating meaningful relationships and transferring learning to new situations. This model also addresses the many needs of adult learners regarding new technologies, and how such technologies make for a more active learning process, aid adults in assuming a greater degree of control and responsibility for their own learning, link prior experiences to new learning, facilitate the transfer of learning activities to personal situations, and promote higher order thinking skills.

Immersive Learning Theory encompasses four essential learning elements: immersive, engagement, agency, and risk. The aim of this relatively new theory is to employ a learner-centered approach that includes direct and implement interactive activities. It typifies the central tenet of the cognitive-constructivist approach, where learners come to know and understand the world not by transmitting knowledge, but by interacting with it. This article explores how immersive learning is implemented with great success in higher education, and some of the more practical lessons with respect to active and interactive learning. Learning Styles in Online Environments reinforces the debate concerning the extent to which teaching methods are matched with student learning styles. This citation presents the results of researchers who found a strong relationship between learning styles and attitudes towards technology-assisted instruction, as well as other investigations suggesting just the opposite, that is, no such relationships exist. The article identifies key issues to be considered in relation to navigation, assessment, collaboration, and the use of online systems.

Mechanics Dynamics examines the use of personal computers in the educational sector; specifically, how they have changed the learning environment of higher learning institutions, and how they have addressed various learning styles. The article introduces several concepts directly related to teaching and learning in the classroom, at all levels of education and training. The concept of discovery learning is posited as an inquiry-based learning and multimedia tool for learner experimentation. Case study as a problem-solving environment is presented along with coach-based virtual discovery learning environments and solving engineering problem using a multimedia approach.

Multiple Intelligences explains Gardner’s multifaceted theory of intelligences of linguistic, musical, logical-mathematical, spatial, bodily-kineesthetic, intrapersonal, interpersonal, and naturalist. The main thrust of the citation, however, is the technology-based examples that frame real-life problem-solving situations involving multiple intelligences. A few of the technologies reviewed include WebQuest, multimedia, online collaboration, discussion board, blog, chatroom, and netiquette. Pedagogical Characteristics Affecting Student Learning discusses the many student attributes affecting learning, such as basic knowledge background, academic performance, exposure to modern educational technologies, and personal learning styles. In addition, the citation provides an abbreviated history of learning styles, with particular attention to Kolb’s Learning Style Inventory (LSI), Honey & Mumford’s Learning Styles Questionnaire, and the Felder-Silverman Learning Style Model. The paper goes on to discuss pedagogical characteristics affecting student learning, the extensive use of learning style measurement instruments, and their importance in the evaluation of computer-based learning and instruction.
Promoting Cooperative Learning relates to human interaction from the perspective of traditional classroom instruction as well as Internet-connected technologies. The effectiveness of online collaborative learning has been confirmed by various studies, many of which are offered in this citation. For example, online activities, intragroup cooperation, intergroup cooperation, interclass cooperation, and global cooperation technologies were studied. The number of hits and messages posted, evidence of shared dialogue and inquiry, and student feedback were examined, as students were asked to participate in a focus group meeting regarding their opinions on cooperative learning.

Technology-Assisted Problem Solving brings into focus the combined benefits of problem-based learning and technology-assisted problem solving. Problem-based learning begins with an often ill-defined problem definition for student consideration typically framed in the format of a scenario or case study. This citation orientates the reader to the process of problem-based learning as a series of steps that begin by organizing previous knowledge on the subject, posing additional questions, and identifying areas in need of additional information. The article moves quickly to a definition of technology-assisted problem-solving packages, describing them as specialized computer programs developed to work as stand-alone or Web-based servers to augment student learning. These technology-rich packages include the use of the computer to deliver instruction such as tutorials, questioning, feedback, analysis, and testing. The article concludes with a discussion of learning scenarios, knowledge representation, and the difference between domain knowledge and pedagogical knowledge.

Towards a Dimensional Model of the Stages of Online Learning offers a look at how technology has matured to become increasingly pervasive in shaping the context of learning. The citation encourages the reader to consider pedagogic strategies that effectively integrate the use of technology into learning, and introduces a model for online learning that includes five distinct stages: access and motivation, online socialization, information exchange, knowledge construction, and development. Each stage is defined and references presented before sharing the results of an investigation into the use of a commercial blogging tool to encourage students to develop reflective skills throughout the delivery of an undergraduate module. The case study presented provides an example of how students progress through the five stages of online learning. Transformative Learning introduces three types of reflection and seven levels of transformative learning. The types include content reflection as the examination of the content or description of a problem; process reflection that examines problem-solving strategies; and premise reflection that probes the process of questioning the problem. The seven levels of reflectivity include (general) reflectivity (an awareness of a specific perception, meaning, behavior, or habit); affective reflectivity (awareness of how the individual feels about what is being perceived, thought, or acted upon); discriminant reflectivity (the assessment of the efficacy of perception, thought, action, or habit); judgmental reflectivity (making and becoming aware of value judgments about perception, thought, action, or habit); conceptual reflectivity (self-reflection that might lead to questioning of whether good, bad, or adequate concepts were employed for understanding or judgment); psychic reflectivity (recognition of the habit of making perceptive judgments on the basis of limited information); and, theoretical reflectivity (psychological assumptions that explain personal experience from the perspective of seeing, thinking, or acting).

Vygotsky and the Zone of Proximal Development describes the span between what a learner can do independently and what he or she is capable of accomplishing with more expert assistance. Technology enters the picture when instructional design, student attitude and achievement, learner motivation, and choice are added to the mix. Effective development is most likely to occur within the zone when the instructor organizes the teaching experience to take full advantage of such interactions. This article discusses how learning situations should be structured as didactic drill and practice sessions or as media-enhanced independent research activities. Technology enhancements should be intentionally integrated into guided learning opportunities that offer technology-assisted situations in which students are supported in the construction of relevant understanding within an authentic context.

LEARNING APPLICATIONS

Infusion involves recommending materials such as DVD, video, laser, CDROM, and so forth, to the receptive learner. It would be best if teachers would model classroom infusion, demonstrating personal use of technology to research and evaluate information along with its relevance, suitability, comprehensiveness, and bias with respect to real-world problems. Towards that end, Active Learning and Its Implementation for Teaching offers a model of learning that suggests all learning activities involve some kind of experience or dialogue. Many elements of active learning are derived from principles of the constructivist approach that, this citation purports, is concerned with learning and knowledge suggesting that human beings are active learners who construct their knowledge from personal experiences in an attempt to give meaning to these experiences. Some techniques for implementing active learning are suggested in the article; some geared toward implementation in face-to-face courses, others can be implemented in computer-mediated courses. Blended Learning involves more than one delivery system for instruction. In most cases, educators discuss face-to-face learning and online learning in
some combination when they use the term “blended learning” in a technological context. The citation offers several forms of blended learning, including face-to-face, synchronous online and/or videoconference, asynchronous online, prerecorded video, DVD, television, and podcasting. Its benefits are shared as well, specifically, flexible scheduling, decreased classroom space demands, academic adjustment strategy, multiple instructional methods, multiple learning styles, and increased literacy skills.

**Communities of Practice** share common context, goals, and expectations while actively working to help one another learn. They involve situations in which teachers structure realistic problems or tasks, and encourage their learners to activate previous knowledge while applying this common knowledge towards a process-based solution. Infusing technology into a community of practice often extends the traditional educational settings into broader family dynamics, corporations, and other social contexts. This article discusses certain traits shared by successful communities of practice, traits such as how the role of teacher is shared between learners and instructors; the importance of activities that reflect the process of learning; increased collaboration between members of the community essential for the creation of new understandings; facilitative environment that encourages reflective practices and collegial debates and critiques via discussions, cooperative learning activities, peer tutoring, reciprocal teaching, and cognitive apprenticeships; and, the use of authentic tasks to prompt learners to use what they already know and determine what they need to find out. **Experience-Based Learning** has been touted as an approach that allows the learner to experience the complexities of real-world problems and gain practical experience in a simulated environment. Such learning takes many forms. While it can vary considerably in the type of problems it entertains, involvement of the instructors, use of supporting materials, impact of student learning outcomes, and nature of assessments, the one element that seems to remain constant is the idea that problem-centered learning is fundamentally an approach that presents the problem first. The citation shares the results of an independent study to identify differences in two approaches and compare the learning outcomes, assessments, and experiences of the learners.

**Fundamentals of Learning Theories** offers a short introduction into the different interpretations of learning theories and different beliefs about how people learn. As described in the citation, the goal of any learning theory is basically the same; that is, to explain the conditions under which a learner’s growth and development occurs. The article offers an inventory of the most well-known theories and theorists, including Thorndike’s Connectionism, Pavlov’s Classical Conditioning, Guthrie’s Contiguous Conditioning, Skinner’s Operant Conditioning, Hull’s Systematic Behavior Theory, Tolman’s Purposive Behaviorism, Gestalt Theory, and Freud’s Psychodynamics. In addition, the article goes on to explain how learning theory leads to effective learning through personal involvement and self-initiation, and more.

**Gagne’s Nine Events of Instruction** identifies the cognitive processes that occur in learning derived by the theorist from his observations on information processing and cognitive mapping. The acquisition of intellectual skills is based on five taxonomies of learning: verbal information, intellectual skills, cognitive strategies, attitudes, and motor skills, and classifies cognitive processes into nine instructional events including gaining attention (reception), informing learners of the objective (expectancy), stimulating recall of prior learning (information retrieval), presenting the stimulus (perception), providing learning guidance (encoding), eliciting performance (responding), providing feedback (reinforcement), assessing performance (assessment retrieval), and enhancing retention and transfer (generalization). In turn, these “nine events” serve as the basis for designing instruction and selecting appropriate media. This citation goes on to explain how each of the events functions in the process of learning.

**Individual Differences in Web-Based Learning** presents a comprehensive review of the influences brought to bear by specific factors (specifically, gender, prior knowledge, and cognitive styles) on Web-based learning. The article recognizes gender as an important variable that influences computing skills, and presents the results of an investigation into student navigation styles with a particular emphasis on gender bias. Other findings presented herein show that experts and novices differ in their performance depending on content structure and the importance of a learners’ prior knowledge when designing effective content structure. Experts were noted to profit most from a learning system that provides flexible paths, whereas novices seem to benefit more from a learning system that is more structured. Field dependency (as a key cognitive style) specifically affects learners. Field independent learners are more individualistic with less reliance on external help when processing information. They represent the majority of abstract learners, and are not easily influenced by others or overly affected by the approval or disapproval of superiors. Field dependent learners, however, have greater social orientation, tend to seek out external guides for processing and structuring their information, are more readily influenced by the opinions of others, and are affected by the approval or disapproval of authority figures.

The field of **Innovations in Learning Technology** has a long history of new products and ideas continually developed and introduced into the workplace. Innovations come in a variety of forms, and many of the most well-known educational innovations have been technology-based (e.g., personal computers, smart boards, digital projectors, virtual reality simulations, etc.). This article describes certain characteristics by which innovations are described, including dimensions of change, form, scale, sequence, and intentionality. The field of innovation in learning technologies, according to this citation, faces
two major challenges in the future. The first is to find the proper balance between innovation and stability. The second is to ensure that the human element of learning does not take a back seat to the technological element.

**Integrating ERP into the Curriculum** offers a variety of benefits and challenges when considering a business school curriculum. One of the most important benefits is the ability of ERP systems to help students understand underlying business processes that serve as a focal point for integration of knowledge across functional areas. Other important benefits for students include exposure to real-world business processes; enriched curriculum in which students obtain a broader perspective of the organization; exposure to technology with which they will work in their careers; stronger knowledge of company operations and substantially less training; ability to contribute to assigned projects; ability to translate requirements for meaningful applications; a higher level of confidence; and, less whining when the going gets tough. The final aspect of the article provides a proactive four-phase approach to ERP implementation in business curriculum.

An **Internet Field Trip**, also known as a virtual field trip, is a journey taken via Web sites without making a trip to the actual location. The citation suggests a number of identifying features that should be considered when designing an effective Internet field trips, such as clearly stated focus or learning objectives, infusing the virtual trip into classroom curriculum, a pretrip orientation with hands-on activities, a facilitator to guide students through the field-trip site, a postfield activity with follow-up activities and sharing, and valid assessment methodology. The review of the literature presented offers the TIED Model (target, implementation, evaluation, and development) for classroom teachers to design and develop, successfully, these unique technology-based experiences.

**Learning With Laptops** documents the process of generating content for a highly successful project entitled, One Laptop Per Child. The article describes the process of generating best-practice content especially designed to engage the minds of underprivileged children around the world. The project sought to provide a laptop with flash memory for each child at a relatively low cost, and a process for updating curriculum content at a relatively low cost. The article presents the Simple English Wikipedia, originally intended for use by English-speaking learners and teachers and, now, available in several other languages such as Spanish and Portuguese. Researchers found it possible to download, update, and reload material at participating schools linked to the Internet. The citation leaves issues of curriculum integration for future investigation, but does identify guides containing lessons to help children (and teachers) learn how to navigate and search.

**Maslow in the Digital Age** offers a new perspective for personal growth and its challenges in a digital world. The difficulty of balancing individual needs with the needs of others and society create conflicts based on the concepts of privacy, ownership, and personal need; conflicts exacerbated in recent years with the intrusion of so many technological innovations. As the virtual world expands, the impact of these experiences will likely more directly affect real-world relationships. This article begins with a primer on the Hierarchy of Human Needs, Maslow’s humanistic theory that forms the third leg of psychology and an alternative view of learning to the behavioristic bent of Pavlov and Skinner as well as the cognitive perspective of Piaget and Rogers. Maslow’s theory of human motivation, published in July 1943, described human motivation in terms of physiological needs, safety needs, love and belonging needs, esteem needs, and self-actualization needs. This citation brings to bear Maslow’s hierarchy of needs with the impact of technology, for example, safety needs and anonymity, as well as belonging, love, and virtual communities. **Piaget's Developmental Stages** has left a lasting impression on the theoretical as well as practical aspects of how child development is viewed. This citation guides the readers though an understanding of the four stages that include Sensorimotor stage (birth to 2 years of age), Preoperational stage (2 to 7 years of age), Concrete operational stage (7 to 11 years of age), and the Formal operations stage (11 years of age and beyond). Then, the article discusses technology as a venue for increasing the opportunities for learning at each cognitive stage. **Situated Learning** examines how humans have historically looked to situations in which they interact with one another to inform ideas about culture, morals, and ambition. Combining constructivist and social leaning theories, situated learning maintains that learning and cognition rely upon social interaction and authentic activity to enhance the learning environment. Situated learning generally occurs unintentionally (rather than deliberately), and is dependent upon an authentic context, culture, and real-world activities. Schools have increasingly come to rely on technology to enhance, supplement, and, stimulate curricula. This article cites many issues of instructional design and delivery related to situated learning, and how technology-based activities provide increasing opportunities for the construction of new understandings in the classroom.

Hundreds of software applications exist for use in the mathematics classroom. Many of these packages were developed with academic standards in mind, but several other applications exist that are useful in both academic and non-academic settings. **Technology and the Standards-Based Mathematics Classroom** explores the considerable research conducted to date that examines the effectiveness of technology as an instructional tool and various applications that address the different learning styles. In this citation, the contributor offers studies on the effects of simulation and high-order thinking technologies, use of multimedia software to decrease student anxiety, technology that supports the often-spoken challenge for students who simply do not perceive math as being relevant to everyday life, computer software that aids learners in solving multistep math problems, and mathematics software that helps learners retain their math skills longer than traditionally taught students.
Technology Assignments Using Team-Based Learning outlines key principles and practices that demonstrate how team-based learning is applied in developing technology-oriented team assignments and why this learning application consistently produces a variety of learning outcomes rarely achieved with other approaches of small-group assignments and activities. Practical examples are employed throughout the citation, especially in the areas of management of information systems and business curricula. The article goes on to explain the four essential principles for team-based learning, which include group formation and management, students accountability (individual and group work), student feedback, and attention to team assignments that promote both learning and team development. Finally, the article posits effective implementation of team-based learning as meeting certain conditions, to wit, significant problem, same problem, specific choice, and, simultaneous report.

Summary. Information technology at this level of the taxonomy offers numerous strategies that encourage learning by infusing technology into the curriculum. The successful infusion of technology includes the myriad of resources described in this section of the Encyclopedia of Information Technology Curriculum Integration, and will guide the reader towards an understanding of how instruction is effectively delivered using the theories and application presented herein.

INTEGRATION

Integration Defined

Technology for Integration represents “the creation of new technology-based materials, combining otherwise disparate technologies to teach (Tomei, 2005).” Appropriate technologies are identified and harvested (similar to the previous level). However, at this level, the objective of integration is to develop new, previously non-existent, innovative instructional materials to enhance the teaching experience. In the (non-technical) past, curriculum began with content materials gathered from chapters of a textbook, clips of a movie or audiotape from the library, or maps from a contemporary atlas. At this level of the taxonomy, information technology-based components create new materials. Many of those resources are described in this section of the Encyclopedia of Information Technology Curriculum Integration based on theories and research; lesson design, development, and implementation; and assessment and evaluation.

Contributions of the Encyclopedia. The host of advanced technologies makes them powerful tools for teaching in the 21st century, and the theories that are adopted to integrate that technology cannot be underestimated. As described earlier, the Taxonomy for the Technology Domain employs, as one of its premises, the concept of hierarchal order; in other words, learners and teachers must move up the taxonomy from literacy to collaboration, decision making, and infusion, before tackling integration and the development of original content materials. Digital cameras, scanners, CD-ROM burners, digital audio and video media players, and personal computers, equipped with state-of-the-art word processing, graphics presentation, and Web-editing applications have made student- and teacher-generated infusion of instructional materials not only possible, but promising technologies for teaching.

THEORIES AND RESEARCH

Malcolm Knowles defined andragogy as the art and science of helping adults learn, based on the premise that adults learn differently than children (pedagogy). Andragogy and Technology posits that adult learning (especially with technology) is best viewed from the combined perspectives of culture and technology. As such, this citation begins with a look at andragogy and how various cultural aspects impact group dynamics for individual learners. Online education, the article suggests, has the potential to revolutionize traditional models of learning, teaching, and sharing information. While cultural differences will continue to exist between countries, the reader gains an appreciation for how adult learners, in particular, can use technology to understand real-world situations and create new value for societies. With more and more educational institutions worldwide offering distance learning as an option, the demand for an understanding of andragogy and technology makes this an important article for the Encyclopedia.

Behavior Analysis and ICT Education presents an overview of the instructional technology associated with programmed instruction and interteaching in general and, specifically, its applications for teaching the Java programming language. The citation begins with a look at the history and success of programmed instruction as a technique that provides structured textual information in small units for study and mastery. Interteaching is derived from the application of a personalized system of instruction developed by a behavioral psychologist. The key aspect of this system is its emphasis on the student
as a responsible “knowledge expert.” This article reviews technology-enhanced behavior analysis by examining a program of study at the university level that has adopted programmed instruction and interteaching components of a Java programming language course. The practical examples provided will enhance the reader’s understanding of this important theory of integrated technology.

Constructivists take a different perspective on teaching. They believe that knowledge emerges as a direct result of how learners construct meaning from information they receive and from their participation in the learning activities. They gain knowledge from their interaction with the learning environment and from interacting among themselves. Technology enhances those opportunities and is the focus of the article, *Constructivist Learning Framework and Technological Application*. Constructivist learning principles have emerged as ideal foundation knowledge for implementing technology-based instruction. Some of the tactics discussed in this citation include electronic instructional plans as text-based resources that incorporate sound, video, movie, static images, motion clips, and animation; technology-rich learning environments that offer robust environments where students are physically and mentally immersed in the learning process; and, multimedia-enhanced instruction (DVDs, video CDs, flyers, motion pictures, still pictures, movies, animation, and posters) that support and reinforce visual learning. Collaborative learning activities (discussion boards, chat rooms, e-mail, etc.) are highlighted where technology can help students share ideas inside and outside the classroom.

**Distance Education and Learning Style** introduces the reader to a host of researchers who have provided practical insights into learning styles. The reader of this article can review Dunn’s learning styles, which focus on environmental, emotional, sociological, physiological, and psychological strands that affect individual learning. Gregorc’s “style delineator approach” is based on studies into the functions of the left- and right-brain hemispheres. As the citation explores the roles of faculty in support of the three most common learning styles of visual, auditory and tactile as another view of learning, the author moves to an investigation into the effects of technology with Grow’s study of faculty roles in accommodating learning styles four stages ranging from dependent to self-directed learning. Wang’s Model of Learning Styles and Teaching Methods examines other factors that determine instructors’ roles and teaching methods. The article finishes with the mission of distance education to help students develop a positive attitude toward lifelong learning, acquire skills to be self-directed, and achieve self-actualization by taking responsibility for their own lives.

E-government is the application of the information technology tools and techniques to the work of government. These tools and techniques are intended to serve both the government and its citizens and include such technologies as wide-area networks, the Internet, and mobile computing. E-government is a form of e-business that includes the processes and structures related to delivering electronic services to the public (citizens and businesses), collaborating with business partners, and conducting electronic transactions within organizational entity. In this article, *Integrating E-Government into the Business Curriculum*, several options are presented for consideration by business schools pursuing programs to incorporate e-government concepts and topics into their business curriculum. The first option discussed is to have a dedicated track/emphasis on e-government. The second option would be to integrate e-government concepts and topics into several existing foundation courses. The third option available to business schools is to develop a specialized course(s) in e-government that students can take as electives, incorporating both theory and best practices. This citation is a good starting point for business schools interested in incorporating e-government as a part of their curriculum.

The digitization of primary source items and their availability via the Internet has resulted in the exponential growth of information over the last decade. As the result of this process, access to these primary sources is no longer limited to people physically present at the libraries. The ease of accessibility through the Internet creates an opportunity for educators to integrate these digital primary sources into the curriculum. The article, *Integration of Digital Primary Sources*, discusses research on primary sources, defines primary source-based instruction (PSBI), connects practices used in PSBI to higher-order thinking skills, and offers examples of PSBI practices. The citation describes these practices and provides examples of each while linking the entire discussion to Bloom’s Taxonomy of Educational Objectives. Specifically, illustrations consider the use of primary sources as examples to document an event or some fact for students; association deepens student understanding by developing content ideas and concepts related to a specific event or topic; utilization demonstrates student to develop greater contextual understanding of an event or topic; examination explores inquiry and analysis; incorporation integrates content knowledge gains into a new understanding and explanation of a topic or event; and, interpretation establishes a deeper level of understanding that extends beyond the initial content and context of a given event or topic.

The *Learning Activities Model* is a theoretical framework for an analytical tool that assists designers of learning events based on categories of activities that serve as subdivisions of the learning process and matched to techniques, technologies, and methods as part of the design process. The first category of the model consists of activities concerned with the provision of materials, including the voice of the presenter or facilitator, visual aids, printed materials, and other media. Interactions play a key role in the model and expand the provision of materials by addressing interaction with materials, with the facilitator, and between learners. The citation goes on to suggest that, while the first four categories of the Learning Activities
Model describe the learning process as consisting of provided materials, interactions with materials, interactions with the facilitator, and interactions between learners, this is not a complete description of all learning activities. The final category of activities that can be planned and undertaken in order to facilitate learning include activities such as informal reflection; reflective practice; critical thinking; refining ideas, opinions and attitudes; and, comparing new to existing knowledge and experiences. Finally, the five categories described are brought together to form the Learning Activities Model as a theoretical framework of learning activities that has theoretical and practical applications, several of which are shared in this article.

**Learning Object-Based Instruction** shares the recent history of this digital resource starting from its earliest beginnings in the 1990s when the field of instructional technology began its struggle to develop models that fully take advantage of the vast potential that new technologies afford. Since then, and thanks in large measure to the boom of multimedia-capable hardware in the mid-1990s, a vast repository of digital materials has been accumulated consisting of instructional videos; interactive multimedia exercises; links to Web sites, reading exercises, recorded interviews with experts, interactive graphs, charts, diagrams, photographs, and maps; and a host of other forms of digital instruction. These materials were intuitively organized according to academic standards, instructional objectives, and specific topics addressed and -- learning object-based instruction was born. This article acknowledges the strong support from instructional designers and technologists who currently embrace the possibilities associated with learning objects. It also identifies the obstacles that have been placed in the way of a more general implementation of learning objects in curriculum design. He states that a learning object is any digital resource that can be reused to support learning.

**Mental Models** are important constructs used by educators to fashion processes such as learning, critical thinking, and problem solving. They are often best understood within a context of a relevant task. Mental models change shape with their application to specific situations. For example, mental models are discussed in relation to organizational management. In cognitive psychology, they are tools for the internal symbolic representation of the mind and how an individual interacts with and adapts to the external world. This article purports the need for clearer understanding and appreciation of a mental model in the design and development of concepts, learning objects, and (in our case) technology-rich learning applications. Application of mental models leads to the development of learner concepts and schemas, while supporting development of their mental modeling capacity.

**System Theory** is a recognized paradigm for dealing with abstract models of real processes in such a way as to accurately capture salient underlying dynamics while keeping mathematical tools manageable. In this citation, four general-purpose approaches to system theory are presented. First, a methodology for solving critical problems by selecting the most salient variables is offered. Next, the rule induction method is described, with a bent toward extracting underlying rules and implying conjunctions and/or disjunctions between identified salient variables. Thus, a first idea of their even non-linear relations is provided as a first step to design a representative model, whose variables will be the selected ones. A third approach is the Adaptive Bayesian Networks used commercially in database tools. Finally, a simple linear approximating model is introduced for the reader’s consideration.

**LESSON DESIGN, DEVELOPMENT, AND IMPLEMENTATION**

**Activity Theory for Studying Technology Integration in Education** serves as a starting point for both technologists and educators, aiding in the understanding of the complexity of technology integration and how activity theory can help. The citation offers five ways in which new technologies can be used to bring exciting curricula based on real-world problems into the classroom; provide scaffolds and tools to enhance learning; give students and teachers more opportunities for feedback, reflection, and revision; build local and global communities; and, expand opportunities for learning. Technology offers opportunities for learner control, increased motivation, connections to the real world, and data-driven assessments tied to content standards that, when implemented systematically, enhance student achievement as measured in a variety of ways, including, but not limited to standardized achievement tests. There are many benefits of using activity theory for studying the effectiveness of technology integration in classrooms. First, activity theory provides a framework to study the impact of technology integration. Second, it offers a holistic method for explaining technology integration. Third, it helps conceptualize the characteristics of technology integration activities in terms of interactions as well as social, cultural, and historical characteristics of the target population.

Classical conditioning, Connectionism, the Laws of Effect and Exercise, positive and negative reinforcement, computer-assisted learning, and other psychologies of teaching form the thesis for **Behavioral Theories that Guide Online Course Design.** The first of three interrelated articles explore the three most widely accepted schools of educational psychologies (the others being cognitivism and humanism) included in this Encyclopedia of Information Technology Curriculum Integration as they impact teaching with technology. The citation moves quickly into the crux of the article with examples of behaviorist theories used when designing online courses, specifically, Social-Cultural Model of Learning, Mastery Learning, Simulations, Direct Instruction, Theory of Elaboration, and Traditional Instructional Design Theory.
As luck would have it, *Cognitive Theories that Guide Online Course Design* follows directly on the heels of its predecessor, behaviorism, both historically and alphabetically. Here, the citation on cognitive theories and theorists encourages the reader to consider how teaching with technology helps the learner process information in ways that are meaningful to the individual on their way to becoming independent learners. Jean Piaget, Lev Vygotsky, Erik Erikson, and David Ausubel are mentioned by name, as well as key theories from the school of cognitivism that include the Theory of Multiple Representations, Cognitive Flexibility Theory, Bruner’s Three-Form Theory, Dual-Coding Theory, Gagne’s Conditions of Learning, Merrill’s Instructional Transaction Theory, and Moore’s Theory of Transactional Distance.

Logic courses are an intrinsic part of many university programs of study. *Computer Technologies in Logic Education* discusses the use of computer software for logic courses and traces its history before launching into an expose of the variety of software programs that have been developed to assist teachers and learners in introductory and advanced logic courses. Modern educational logic software helps learners in such areas as natural deduction, syllogistic logic, visual argument representation, and various techniques in modal logic. Logic software is explained in general and, in particular, in terms of logic and relational databases, logic in data-mining applications, and a futuristic look at logic and artificial intelligence.

Educators involved in the application of distance-learning technologies need to develop a sound understanding of learning theories and instructional strategies. Since teaching strategies are as diverse as learning styles, *Distance Learning Essentials* provides the necessary refresher citation into learning theories, learner characteristics, and instructional strategies that will guarantee technologies are brought into play to prevail over the challenges caused by the reality that no two people learn in exactly the same manner and no two teachers, online or traditional, deliver instruction alike. It is imperative that distance-learning educators become familiar with learning theories and widely accepted instructional approaches in order to ensure that learning occurs reliably at a distance.

*Educational Geotrekking* is an instructional design model supporting the creation of engaging learning opportunities and promoting the integrated development of geographical, mathematical, cultural, scientific, and other literacies, including geographical literacy (understanding the earth and its natural and cultural features), mathematical literacy (the ability to deal with the quantitative aspects of life), cultural literacy (the ability to function in the dominant culture), technological literacy (the ability to apply technology in everyday life), and scientific literacy (the ability to problem solve and communicate with respect to the world around us). In addition, this article discusses the relatively new concepts of portable geotreks, fixed-location geotreks, virtual geotreks, and transforming geotreks. Finally, the reader is introduced to Geotrekking.net, a Web site that has been established as a resource for educators interested in developing or sharing educational geotreks.

Rounding out the trilogy of schools of educational psychology, *Humanistic Theories that Guide Online Course Design* establishes the theories and theorists from the school of humanism that focus on the learner’s affective needs (i.e., feelings, emotions, values, and attitudes). Applied to teaching with technology, Abraham Maslow, Carl Rogers, and Lawrence Kohlberg represent the most well-known humanists, while the phenomenal field theory, self-actualization theory, theory on nondirective teaching, theory of moral development, theory of immediacy and social presence, and cooperative learning theory account for the greatest research and literature focus areas for this school.

Cognitive learning theories dominate contemporary *Instructional Design* practices. With the growing number of older adults per total population, this article focuses on the growing discussions regarding the cognitive learning needs of older adults. As an increasing number of older adults remain in the workforce longer and participate more and more as lifelong learners, instructional designers must become more aware of the learning needs of older adults. Older adults will continue to demand a different brand of training and education, and new technologies will serve as both the focus of these training curricula and tools for lifelong learning in all content areas. This citation considers the steps in analyzing adult learners, their cognitive learning strategies, and their common and unique blend of learning needs. The article goes on to identify common barriers to cognitive learning in older adults including not physical problems, cognitive matters, self-esteem and self-actualization issues, and social factors. The article posits that adults can overcome these and other barriers to cognitive learning with properly designed training programs, flexible training schedules, and employer education and recognition of their learning needs. Through standardization and the integration of technology into the nursing education process, nursing informatics is taking its rightful place within the nursing sciences. Against this background, *Integrated Curricula in Nursing Education* questions the process of transferring necessary knowledge between the theoretical side of nursing sciences and applied nursing, the training of practicing nurses, and the area of nursing informatics. The citation asks two vital research questions: How is knowledge produced and transformed within the profession? and, From where do researchers and practitioners obtain their inspiration for their research activities, and to whom do they disseminate their knowledge? The article continues with an in-depth discussion of the role of nursing informatics, the process of knowledge transfer via ICT, the necessary integration of ICT into education, and the development of nursing informatics professions.

*Interactive Multimedia* addresses the use of interactive multimedia in the field of engineering, and explains key features, potential benefits, and recognized shortcomings of these integrating teaching tools from an educational perspective.
The article presents a recap of works that explore the issues surrounding the role and benefit of interactive multimedia courseware. The results are important new knowledge for educators and instructional and multimedia designers in the use of multimedia technology to enhance engineering education. Key attributes of multimedia (multiple media, delivery control, and interactivity) are discussed and the four levels of multimedia interactivity (reactive, coactive, proactive, and transactive) are presented. Finally, text, audio, video, graphics, and animation are considered as the multimedia of choice for engineering applications. Closely aligned to interactive multimedia is the realization that the Microsoft Office suite has built an impressive following as the application of choice in many classrooms, K-12, higher education, and corporate training. The Interactive Power Point Lesson is a self-paced, student-controlled, individualized learning opportunity embedded with assessment used to provide individualized instruction as well as immediate feedback to learners. This article presents a nine-step process (following Kemp’s Model for Instructional Design) for creating an interactive lesson using PowerPoint. A menu of options and features are examined that PowerPoint a viable graphics development and presentation tool. Four features are held up as the key commands that make the interactive lesson possible; they include action buttons, hidden slides, the kiosk browser, and assessment slides. The structured format for designing these technology-rich lessons will be of particular interest to readers of the Encyclopedia of Information Technology Curriculum Integration responsible for teaching lessons in a formal multimedia classroom, computer lab, or a student’s home computer.

A lesson design model for differentiating teaching and learning of technology is offered in the K-A-RPE Model citation for those developing comprehensive technology programs. Knowledge, application, and research, practice, and evaluation offer the necessary distinctions among instructional technology programs for undergraduates, graduates, and doctoral programs of study with respect to technology skills and competencies. Similar to other more well-known taxonomies, the K-A-RPE Model is hierarchal, progressive, and assumes mastery and competency at all preceding levels. The knowledge level of the model describes technologies as personal learning tools. The application level integrates technology-based skills for inclusion into everyday instruction; research, practice, and evaluation discusses how new technologies apply technology for purposes of investigation, real-world preparation, and assessment. Examples of typical application outcomes at the undergraduate, graduate, and postgraduate level are included in the article.

Mobile Learning is one of the newest technologies pushing lesson design, development, and implementation towards increased access to learning. M-learning is still an emerging concept as educators continue to explore how mobile technologies impact the teaching and learning environment. This article describes several unique features of mobile technologies that could enhance the learning experience, including privacy issues; the potential to support learners with preferences for textual, audio, and video presentation of material; immersion techniques; data capture; and user control. For special application in this encyclopedia, this citation addresses six learning theories relevant to mobile technologies; specifically, behaviorism, constructivism, situational learning, collaborative learning, lifelong learning, and teaching support. The paper finishes its exploration of mobile learning with a look at some of the positive contributions promised by this technology, specifically, in the areas of improving basic skills; encouraging independent and collaborative learning; identifying learner weaknesses; bridging the gap between mobile literacy and communication technology literacy; engaging learners and maintaining their interest; and retention and focus issues.

Online Curriculum Development stimulates discussion of how content can be made more interactive with the integration of technology. Throughout the development process, it is important that curriculum developers remain focused on the core benefits of the technology as they pertain to their particular learning or administrative needs, and in ways that add value to effective existing processes. The process of rethinking how curriculum can be stored, restructured, and delivered is the key theme of this citation offered principally to curriculum authors, teachers, and ICT support staff. The paper examines technical aspects of online development, development from a cost perspective, and the impact of redesigning curriculum for online applications from the human resources side of the equation.

Pedagogical Agents in Online Learning focuses on the use of pedagogical agents in e-learning to provide information on their strengths and weaknesses; share research relevant to their instructional role in teaching; provide examples of their current use in lesson design, development, and implementation; and suggest possibilities for future implementation. The citation presents the perspective of the instructor’s roles as expert, motivator, and mentor, and how these agents serve as tools to impact learning. Of particular note, for purposes of this encyclopedia, is the interaction of pedagogical agents and technology and dealings with the adult learner who brings a wealth of experience to the instructional environment. Some of the experiences shared in this article describe deterrents to learning performance; others may increase learning. Pedagogical agents, combined with technology, have the potential to create personalized learning experiences that approach the student as an individual, and to reach farther than any living instructor.

The key advantage in the use of Simulation in Teaching and Training centers around how simulations allow the learner to interact with systems that often cannot be explored in real life because they are not readily available, they are too expensive, they would be too dangerous for the learner (e.g., making mistakes would endanger the environment or the learner),
or they simply do not exist in real life. In this article, three different approaches to simulations are uncovered. Interactive modeling comprises simulations where, in the process of training the learner, somehow interacts with safe, challenging, and as close to real-life environment as possible. Character simulations offer virtual agents who interact with the learner, provide help and advice, and support and accompany the learner through the instructional process. Finally, demonstrative simulations replicate the environment, situation, behavior, or other persons (such as a patient or the learner). The integration of technology into simulations has raised the bar for instructional content, application of learning theories, and treatment of teaching strategies in the use of simulations.

To use information technology to its potential in Software Engineering Education, a systematic approach is necessary. This article explores a myriad of strategies for integrating IT in engineering, strategies that involve necessary alternatives in the classroom; interactive classroom experiments; new horizons opened by the application of technology, communication, and collaboration; dissemination of course content; rich course content; reuse of knowledge; exploration of future careers; rich course assignments; and reducing duplication. Following alphabetically in order, Software Engineering in e-Learning Systems examines the role of software engineering in the evolution of e-learning systems. Several methods and techniques for incorporating software engineering in the design and development of e-learning software are introduced, including the software production process, reference architecture, software and process patterns, learning design approach, component-oriented design, and refactoring as real world examples of this discipline in action at the program level.

Taxonomies for Technology familiarizes the reader with several of the most popular systems for classification and organization. There have been a number of attempts to classify or organize learning technologies and while their classification frameworks are logically sound, they have not always been developed to assist in the design of learning events that use technology in the most effective and efficient manner. This citation compares and contrasts the Taxonomy for the Technology Domain with its six hierarchal levels of literacy, collaboration, decision making, infusion, integration, and technology; the Taxonomy of Learning Technologies classifying technologies as Representational or Collaborative (with its subcategories of "dialogic" and "productive"); the Media Classification Scheme for Human-based Systems classifying information technology according to Print-based system (books, manuals, workbooks, job aids, and handouts), Visual-based system (books, job aids, charts, graphs, maps, figures, transparencies, slides), Audiovisual-based system (video, film, slide-tape programs, live television), or Computer-based systems; and, finally, Bruce and Levin’s Media Taxonomy, divided into media for inquiry, media for communication, media for construction, and media for expression. Taxonomy of Collaborative E-Learning places a different bent on a conceptual framework for teaching online. In this citation, the levels of collaboration are introduced, along with a review of various collaborative methods and descriptive examples of their approaches. Collaborative e-learning focuses on e-learning and collaborative learning, and offers a framework for planning, organizing, and assessing curricula, courses, projects, and learning activities. Five levels of collaboration are discussed: dialogue (encourages incisiveness and creativity and brings coherence to seemingly fragmented and unrelated ideas); peer review (process of critique and feedback between participants); parallel collaboration (where assignments are completed by a group of learners and components of the assignment allocated among participants); sequential collaboration (when assignment are organized into a series of progressive steps and results combined into a single collective result); and synergistic collaboration (where a group of learners work together to plan, organize, and complete the assignment). Each level of this taxonomy is progressive (a common characteristic of most educational taxonomies). Additionally, no single level is considered better than the previous step; however, one level may be better than another in relation to established learning goals, the make-up or social maturity of the group, timing, or other issues.

The final citation in lesson design, development, and implementation is the Virtual Tour, a Web-based teaching strategy that presents multisensory, multimedia instruction appropriate for individual student exploration and group learning experiences. Similar to the previous citation on the Interactive PowerPoint Lesson, the virtual tour is also designed using an instructional systems design model; in this case, the ADDIE Model. A unique feature of the virtual tour is the integration of 1 of 14 front doors that serve as the facade for the lesson, and categorized as concrete or abstract; behavioral, cognitive, or humanistic; and, technically easy, challenging, or difficult. Six front doors are explained in greater detail, along with practical examples of how this technology-rich format is used to teach special-needs children.

**ASSESSMENT/EVALUATION**

Integration of technology at this stage of the taxonomy calls for a high mastery of teaching skills. Teachers are asked to design, develop, implement, deliver, and assess appropriate instructional technology-based materials to support the diverse needs of their learners. Towards that end, Evaluating Technology-Based Instruction examines the nature and quality of hardware and software used to assess the quality of the learning environment in which technology pedagogical processes, instructional software, and the physical environment of technology-based instruction. The article goes on to consider the
various stakeholders in the evaluation process: those who have interest in the learning outcomes as well as those who fund it. These interest groups include students, teachers, evaluators, technical support staff, and those funding the evaluation.

*Learning Through Projects* is arguably one of the oldest instructional methods in existence. It has taken several forms since enjoying considerable popularity in the beginning of the 20th century, and fell from favor in most academic disciplines (except for career and technical education) until its resurgence as a technology-rich teaching environment with the integration of information technology in the new millennium. This paper introduces the project method, originally intended to produce actual objects, maturing to include a variety of assessment tools such as portfolios, research projects, exhibits, performances, and creative writing assignments. Project-based instruction represents a second methodology for teaching, guided by the instructor to ensure that learners master subject area competencies through real-world (or in the case of technology, realistically simulated) experiences.

*Student Response Systems for Active Learning* explains the many applications of student response systems, also known as personal response systems, clickers, audience response systems, electronic response systems, classroom performance systems, and group response systems. These increasingly interactive tools promote audience learner participation during lectures, presentations, and classroom discussions by submitting immediate responses to questions using hand-held devices or specially designed response pads. With some training, practice, and lesson design, instructors will preplan questions throughout a lesson to conduct formative assessment of the content. Student response systems are also used to take attendance, ask questions, increase active learning, poll for student interaction, administer quizzes, and assess overall comprehension. This citation describes how these devices assist instructors in engaging the attention of students, making students actively participate in the learning process, and provide both the student and the instructor with immediate feedback on student understanding of material. Specific examples provide the reader with ideas for gathering information on students’ understanding of course concepts, and for developing opportunities to adjust course activities.

The final article in both this section, as well as this level of the Taxonomy for the Technology Domain, summarizes nicely the *Varieties of Authentic Assessment*, designed to reflect real-world situations (with the aid of integrated technologies) that reflect skills and competencies that learners develop and apply. Although there are a variety of authentic assessment methods, this article offers an assortment of methodologies that encourage connections between classroom experiences and real-world applications. Of particular value to readers of the *Encyclopedia of Information Technology Curriculum Integration* is the review of authentic assessment criteria that include consideration of consequences, fairness issues such cultural bias, validity and reliability, cognitive complexity, content quality and completeness, meaningfulness of the required tasks, and cost effectiveness.

**Summary**

In addition to producing instructional materials, integration includes other applications of technology important to the teaching-learning process. Integration involves the application of theory and research; lesson design, development, and implementation; and, a variety of effective assessment and evaluation strategies.

**TECH-OLOGY**

**Tech-ology Defined**

*Tech-ology* is a contraction of “tech” (technology) and “ology” (the study of); therefore, the final stage of the taxonomy addresses the study of technology. The *Encyclopedia of Information Technology Curriculum Integration* introduces a number of related issues that consider the effect of technology on the individual learner, the educational institution, the community, and society as a whole.

**Contributions of the Encyclopedia.** In addition to education, tech-ology is impacted by concerns raised by biotechnology (agriculture, cloning, genetics, health, medicine, reproductive technology); convergence (coming together of communication, computers, information, the Internet, and television); creativity (arts, intellectual property, piracy); affect on multiculturalism (including concerns with potential harm to customs, language, religion, social interaction); e-conomics (and the changes in business and e-commerce); equity matters (including the digital divide and global technology parity); government and politics (with online campaigns, fundraising, and advocacy); innovations such as artificial intelligence, cryotechnology, and robotics; and, certainly, national security fears such as cyberwarfare, information security abuses, and chemical and biological terrorism.
Computer fraud can take on different activities; it can be internal or external. **Combating Computer Fraud** involves a thorough understanding of who commits computer fraud, and why someone would engage in this type of criminal activity. There are several possible reasons for this type of conduct and this article categorizes computer fraud into one of several categories that include altering input, copying input, theft of computer time, software modifications (i.e., modifying, deleting, and/or copying licensed software), phishing (e-mails that direct users to other Webs sites), parming (which includes copying individuals keystrokes, poisoning, and theft of personal information), and identify theft. The citation goes on to describe various forms of protection against computer fraud, such as firewalls, authentications, virus software, and spyware.

**Digital Storytelling in Teacher Education** is a concept that is growing in popularity, offering considerable versatility as a technology-based instructional tool. This citation presents information and ideas to facilitate learning, productivity, and creativity through the variety of digital storytelling classroom uses. This article proposes three primary categories in which a digital story may be categorized. Personal digital stories use pictures, video, or other media to tell a story, visually depicting personal history or personal observations of an incident or historical account. Historical storytelling shares accounts of time-bound events, and presents a multimedia digital story vs. the traditional research paper. With easier access to multimedia tools with every system upgrade and each new software release, an emphasis on learning to use and integrate technology in teaching and learning move reflective digital stories into the instructional domain of more instructors. Using software that combines photos, text, music, and narration, learners create their own digital stories.

E-commerce is the largest growth area of today's economy, and is predicted to be the leading growth sector for many years to come. It now incorporates significant portions of business transactions that only a few years ago were still in the domain of traditional businesses. **E-Commerce Models and Consumer Concerns** introduces several of the most typical types of applications currently running in the World Wide Web, including internal e-commerce activities such as business-to-business (B2B) e-commerce, and business-to-consumer (B2C) e-commerce. Some external e-commerce activities are also discussed in this article. They include consumer-to-consumer (C2C) e-commerce, mobile commerce (m-Commerce) and location commerce (l-Commerce), business to business to consumer (B2B2C), customer to business to consumer (C2B2C), and peer to peer (P2P) e-commerce. Even government has become enthralled with e-commerce and its various forms, including government-to-business (G2B) and government-to-citizen (G2C).

**Embedding Ubiquitous Technologies** shares the realization that a third wave of instructional technology in education is upon us. Technologies that use sensors, wireless networks, and seamless learning environments are making their way into higher education, elementary and secondary classrooms, and training rooms with increasing frequency. Ubiquitous technologies are defined as tools employing, for the most part, Internet-connected wireless computing machines, personal technology devices, and handheld systems for use both in the classroom, at home, and at work, not shared with others. This citation discusses key issues associated with embedded systems, such as the urgency of learning need, initiative of knowledge acquisition, mobility of learning setting, interactivity of learning process, situating of instructional activities, and the integration of instructional content.

The agent concept provides a focal point for accountability and responsibility for coping with the complexity of software systems both during design and execution, and **Exploiting Agent Technology** makes an excellent citation for readers of the Encyclopedia of Information Technology Curriculum Integration, particularly at this level of the Taxonomy for the Technology Domain. Collaborative agents, interface agents, reactive agents, mobile agents, information agents, heterogeneous agents, and economic agents are introduced, and a project that includes a sequence of major steps is presented. The study, which resulted in the design of the Pyramid Model of the Project, describes grid construction, lab design, client/server model definition, definition of the interface of functional units, agent-based architecture construction, a module language for program refinement, and architecture specification.

**Impact of Technology** considers how technology impacts modern society, in general, and education, specifically. This citation begins by describing both a narrow and broad view of the terms technology and impact. A narrow view of technology limits discussion to specific technological artifacts, while a broad view of technology would include a discussion of the sociotechnical impact as well as the theoretical and applied knowledge needed to develop and use the artifacts; perfect for placement in this section of the Encyclopedia. Impact, too, is defined narrowly as increased test scores or improved attendance rates; more broadly as the transfer of learning into behavior. The article goes on to explain the difficulties in assessing impact of technology due to the inherently complex and interconnected nature of technology, interaction between instructional methods and media, and the lack of well-designed, long-term research studies reported in the literature. Even with these barriers, the article suggests some tentative conclusions.

**Industrial Technology Pedagogy** provides a particularly targeted citation for those readers of the Encyclopedia of Information Technology Curriculum Integration responsible for corporate and/or vocational training. Some of the key skills taken directly from industrial technology pedagogy discussed in this article include prevalent inadequacies in manual training, the importance of human relations skills in industrial technology, and integrating human relation skills into industrial
technology pedagogy. Industrial technology produces information technology managers and supervisors; as a result, this
citation offers the reader an understanding of how to delegate instructions and authority successfully, how to work in a
team environment, and how to work towards accomplishing the goals of that industry or business. Moreover, the article
embraces technology to assist with everyday problem solving and leadership challenges in industry as well as common
human relations skills.

**Intellectual Property** is the right to protect the published or unpublished works that include patents, trademarks, designs,
and copyrighted materials including literary, dramatic, musical, artistic, and certain other intellectual works. In this article, a
dynamic version for the support of intellectual property and organizational management to protect such data is offered in the
Digital Model for Education. Other tools used in the business sector for researching knowledge management are presented,
including digital dashboards, data warehouses, data mining, virtual reality modeling, and distance learning-based “just-in
time” training. Educational organizations, it is suggested by this citation, need to keep pace with advancements in intellectual
property trends, knowledge management, technology innovation, distance learning, and global political relationships.

Forensics is the application of sciences that help to seek out, examine, and answer questions about certain characteristics.
**Investigating Computer Forensics** examines the short history of Computer forensics that has evolved into its own field of
learning within the Information Technology discipline. Computer forensics is used to investigate these computer crimes,
and a host of other possible criminal activities. To withstand court challenges, computer forensics science investigations
must employ methodology that evidences rigor, detail, and logic conducted in measured steps that adhere to widely accepted
practices and procedures. For successful prosecution, explained in this citation, computer evidence must be built around
core legal requirements of evidence handling that include issues of admissibility, authenticity, completeness/thoroughness,
reliability and validity, and believability. The article concludes with several thought-provoking predictions such as the con-
tinued growth of computer forensics to help combat criminal activity from both an organizational as well as law enforce-
ment perspective; rising sophistication of cybercriminals will offer increased challenges to uncover deleted logs, modified
access attempts, altered data, and so forth; and, computer forensics must continue to mature into a more multidimensional
discipline, covering behavioral as well as increasingly technical characteristics.

**Multicultural Education and Technology Integration** describes the foundations of multicultural education, and depicts
how certain multicultural instructional strategies lend themselves to technology. According to this citation, the integration
of technology is vital in education; however, the use of technology to implement multicultural education has scarcely been
addressed by the academic community. Properly applied technologies enable instructors to introduce diversity into the
classroom using the Internet and multimedia, in particular, to provide varying viewpoints from varied backgrounds. Tech-
nology such as electronic media, simulations, and Web sites facilitates multicultural teaching by infusing cultural issues
into the curricula. A review of literature revealed in this article calls for proponents of multicultural education to conduct
more research that assesses how technology can facilitate multicultural instruction to better assist educators.

The **Net Generation** refers to the cohort of individuals born from 1976 to 2001, considered the first generation to grow
up in an Internet culture and a multimedia driven environment. This article relates some of the collective philosophies of
this generation, both cultural and social, that emerged during the formative years of this era. The Net Generation is the first
age group to be immersed into Internet culture; they view the Internet as their primary source of information and major
communication resource. The rise of interactive multimedia technologies provides a plethora of visual cues with less reli-
ance on manual or textual instructions to learn or conduct business. Trends in digital media (e.g., music, film, research, and
other materials) are transforming the foundations of educational practices, social interactions, and cultural attitudes. The
information-age mindset of this generation influences the ways in which we learn and work, and develop future initiatives.
Readers of the Encyclopedia of Information Technology Curriculum Integration will gain valuable insight into widely
recognized mindset of the 21st century learner.

**Online Course Settings** describes contributing factors experienced by a focus group of participants in an advanced
degree instructional technology program with respect to online course setting, and the barriers these predilections place on
students. Both extrinsic and intrinsic barriers are introduced. Examples of extrinsic impediments include an inherent fear
of using new technologies, financial circumstances, technical problems and (closely related), sufficient training, academic
skills, time management, writing and communication skills, and general technology experience. Intrinsic barriers cited in
this article that discourage participants include aspects of racism (cultural bias), feeling of unworthiness when working in
groups, lack of belonging, shyness and cautiousness, and a minority status within the class. Categorized into two key areas,
this citation found social limitations related to academics, financial, and technical problems, as well as intangible aspects
of racism evidenced by a sense of isolation and belonging and feelings of inferiority and unworthiness.

**Plagiarism and the Classroom** provides an overview of plagiarism in the classrooms, and discusses the important roles
awareness and education play in detecting and preventing such violations of academic integrity. Advice for educators is
included in this citation, along with recommendations for detection software and Web sites. Particular attention is paid
to issues of awareness, consistent and continuous emphasis on academic integrity, aggressive and consistent policies and enforcement, unambiguous instructions to students regarding assignments, and appropriate modeling by the instructor.

**Reexamining the Digital Divide** investigates the perceived differences in opportunity and achievement caused by economic and social disparities that limit access to technology. As presented in this article, the concept represents the recognized disparities caused by a lack of access to technology as it advances within society, leaving some sectors of society behind with respect to opportunities and abilities. Technology use is examined in terms of income, geographic location, gender, race, education, and age. Specifically, some contributing factors to the lessening effects of the digital divide involve the declining cost of technology, improvements to overall technical literacy skills (primarily as a result of schools and their technology programs at all levels), reduced cognitive requirements to master technology (i.e., user-friendliness of the hardware and software), reduced fear and anxiety associated with pervasiveness of technology, greater willingness to regularly use technology, and, finally, the expanding ubiquitous nature of technology.

**Spyware** is an unauthorized software program that monitors system activities without the knowledge or consent of the user. Typically, spyware collects personal information from the targeted hard drive and sends this data through the Internet to the perpetrator. The presence, scope, and potential damage of spyware make this citation one of the most important articles in the Encyclopedia of Information Technology Curriculum Integration. Often disguised as freeware or shareware applications, an unsuspecting user is often duped into tracking, recording, and dispatching their online behavior. This article offers clues to the presence of security breeches, as well as possible solutions, consequences, and legal implications of these applications.

**Technology and Student Achievement** begins with an introduction to the No Child Left Behind (NCLB) Act of 2001 and its impact on education in the United States. The citation presents a synopsis of a considerable body of research attempting to link student achievement with the presence of technology. The purpose of the study offered in this article was to investigate a possible correlation between the computer to student ratio and standardized student achievement test scores. The research paired math and reading scores with student to computer ratios, as well as math and reading scores with the number of computers able to access the Internet. Contrary to many articles, this project did not find a correlation between student achievement scores and the ratio of students to computers. No indication was found that established current inequities in terms of academic achievement among school-age learners with respect to instructional technology in general and computers specifically.

**Technology in the Cities** presents current and future applications of technologies to be used in cities throughout the world in relation to intimate, sociocultural instructional design, research, and evaluation considerations. The purpose of this article is to promote discussion and dialogue within the field of education as it is impacted by the exponential growth of technology and rapid advancement in cities and cultures throughout the world. The future predictions referenced in this article provide a primer for educators and researchers in their investigations of the pedagogical changes and developments that will be needed to meet the creative opportunities, challenges, and demands resulting from the development of future technologies.

Within the past decade, a growing body of evidence supports the ever-widening technological gap among members of society, with the greatest disparities in computer and information technology found among individuals in rural and urban locations and along socioeconomic lines. **Use of Technology in Urban Populations** describes a number of trends that indicate those with means have become information rich while the poor and working class lag further behind. Similar to the previous article on the digital divide, this citation reveals more of the disparities in information, communication, technology access, and utilization and its impact on income, education, and race. The article covers a variety of related topics including the adoption and use of technology in urban schools, defining the urban learner, urban education academic underachievement, adoption of technology in urban schools, educational technology can influence student academic performance, educational technology can develop higher order thinking and metacognition skills, educational technology can improve student motivation, attitude, and interest in learning, and educational technology can address the needs of low performing, at-risk students.

**Summary**

The impact of technology must be considered in many of the peripheral areas of information technology education, areas that include the teacher, career development, teaching as a profession, and the future of education as a discipline. This section of the *Encyclopedia of Information Technology Curriculum Integration* provides the reader an orientation to some of the key social and educational issues associated with information technology education as it enters the 21st century.
CONCLUSION

Literacy, Collaboration, Decision Making, Infusion, Integration, and Tech-ology offer a unique perspective for integrating information technology into the classroom. The complete Taxonomy for the Technology Domain is shown in the Appendix to this Preface, and serves as a guide for exploring the subsequent sections and article citations in this Encyclopedia of Information Technology Curriculum Integration.

ACKNOWLEDGMENT

The design and development of a publication that encompasses the breadth of a discipline as wide and varied as Information Technology Curriculum Integration cannot be successful without the aid and assistance of many contributors. To the authors and coauthors of the 150-plus citations that now comprise the Encyclopedia of Information Technology Curriculum Integration, my sincere appreciation for your attention to detail and your willingness to work closely on your manuscripts, editorial revisions, key words, index templates, acquisitions library form, checklists, and much more. To the members of the editorial review board—a dozen truly dedicated, expert, and technically astute professionals who read each of the submissions and offered their advice and counsel—your contributions made this publication possible when it was aground on several occasions. To the IGI staff, your involvement brought this project to fruition and you should be very proud of your skills and perseverance. To all who had a hand in producing this digest for the information technology education discipline, well done.

REFERENCES

Figure 1. Taxonomy for the Technology Domain (Tomei, 2005)

<table>
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<th>Taxonomy Classification</th>
<th>Defining the Level of the Technology Taxonomy</th>
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<tr>
<td>Literacy</td>
<td><strong>Level 1.0</strong> The minimum degree of competency expected of teachers and students with respect to technology, computers, educational programs, office productivity software, the Internet, and their synergistic effectiveness as a learning strategy.</td>
</tr>
<tr>
<td>Understanding Technology</td>
<td></td>
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<tr>
<td>Collaboration</td>
<td><strong>Level 2.0</strong> The ability to employ technology for effective interpersonal interaction.</td>
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<td>Sharing Ideas</td>
<td></td>
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<td>Decision-Making</td>
<td><strong>Level 3.0</strong> Ability to use technology in new and concrete situations to analyze, assess, and judge.</td>
</tr>
<tr>
<td>Solving Problems</td>
<td></td>
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<tr>
<td>Infusion</td>
<td><strong>Level 4.0</strong> Identification, harvesting, and application of existing technology to unique learning situations.</td>
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<td>Tech-ology</td>
<td><strong>Level 6.0</strong> The ability to judge the universal impact, shared values, and social implications of technology use and its influence on teaching and learning.</td>
</tr>
<tr>
<td>The Study of Technology</td>
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The editor would like to acknowledge the team of contributors and review board members who made this Encyclopedia possible. With over 150 submissions and 100 contributors, the time and energy required to make this publication a reality was impressive. Time and again, those whose names appear in the Table of Contents and as members of the Editorial Review Board were professional in meeting the deadlines and milestones for this project. I would work with any of them again any time.
About the Editor

Dr. Lawrence A. Tomei is the Associate Vice President for Academic Affairs and Associate Professor of Education, Robert Morris University. Born in Akron, Ohio, he earned a BSBA from the University of Akron (1972) and entered the US Air Force, serving until his retirement as a Lieutenant Colonel in 1994. Dr. Tomei completed his MPA and MEd at the University of Oklahoma (1975, 1978) and EdD from USC (1983). His articles and books on instructional technology include Integrating ICT Into the Classroom (2007), Taxonomy for the Technology Domain (2005), Challenges of Teaching with Technology Across the Curriculum (2003); Technology Facade (2002); Teaching Digitally: Integrating Technology Into the Classroom (2001); and, Professional Portfolios for Teachers (1999).
Active Learning and Its Implementation for Teaching

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INTRODUCTION

This chapter discusses active learning and its implementation for teaching. Although active learning is a general term in education, the focus of this chapter is on technological means/tools that can enable active learning. The means presented may be implemented in computer-mediated learning either by students operating a stand-alone local personal computer equipped with appropriate hardware and software or in both synchronous and asynchronous distance learning environments. More specifically, the current chapter discusses two technology-based means that can enable active learning—computerized feedback intervention and interactive animations.

The theoretical foundation of active learning is the constructivist approach. Constructivism is a set of assumptions about learning that guide many learning theories and associated teaching methods. The roots of constructivism are found in the writings of many distinguished philosophers and educators including Immanuel Kant, Lev Vygotsky, John Dewey, Jerome Bruner, Jean-Jacques Rousseau, Jean Piaget and many others.

Since the principles of active learning are applicable for both conventional and computer-mediated learning environments, they are presented first, along with the principles of the constructivist approach.

BACKGROUND

What is Active Learning?

Active learning involves students in course material through carefully constructed activities. It is about learning through doing, performing, and taking action and usually contrasts with a conventional lecture method. The action can be either mental or physical. Many face-to-face course teachers would like to move past passive learning to active learning, to find better ways of engaging students in the learning process. In active learning, students construct their own knowledge through interaction with themselves and others.

Fink (1999) offered a model of active learning, which suggests that all learning activities involve some kind of experience or some kind of dialogue. The two main kinds of dialogue are “dialogue with the self” and “dialogue with others.” The two main kinds of experience are “observing” and “doing.” “Dialogue with the self” involves cognitive concerns and refers to what happens when a learner thinks reflectively about a topic. “Dialogue with others” occurs when a teacher creates an intense group discussion on a topic. Sometimes teachers can also find creative ways to involve students in dialogue situations with people other than students (e.g., practitioners, experts). “Observing” occurs whenever a learner watches or listens to someone else doing something that is related to what they are learning about. “Doing” refers to any learning activity where the learner actually does something (designs an artifact, designs and/or conducts an experiment, critiques an argument or piece of writing, makes an oral presentation, etc.).

Many researchers testify to the efficiency of active learning. For example, Hake (1998) examined 6,542 students who participated in physics courses. He found that the conceptual understanding and the solving problem ability of students who applied interactive-engagement methods in their studies were significantly higher than students who studied according to traditional methods.

THE CONSTRUCTIVIST APPROACH AND ITS IMPLEMENTATIONS FOR TEACHING

Many elements of the active learning are derived from principles of the constructivist approach. This section
briefly outlines the principles of this approach and their application to teaching.

Constructivism is a theory concerned with learning and knowledge, which suggests that human beings are active learners who construct their knowledge from personal experiences and on their efforts to give meaning to these experiences. According to this approach, the learning environment should enable students to construct their knowledge through active learning and trial and error.

In the literature, three modes of constructivism are discussed: radical (Glasersfeld, 1995), contextual (Cobern, 1993), and social (Vygotsky, 1986). The focus in this chapter is on social constructivism. One of the better-known researchers who refer to social constructivism theory in education is Vygotsky (1986). He states that learners construct knowledge or understanding as a result of active learning, thinking, and doing in social contexts.

Social constructivism suggests that learners learn concepts or construct meaning about ideas through their interaction with others, with their world, and through interpretations of that world by actively constructing meaning. They cannot do this by passively absorbing knowledge imparted by a teacher. Learners relate new knowledge to their previous knowledge and experience. A constructivist model of teaching has five characteristic features: active engagement, use and application of knowledge, multiple representations, use of learning communities, and authentic tasks (Krajcik, Czerniak, & Berger, 1999).

The teacher’s task, according to this approach, is to tutor students and teach them how to learn. He/she is not a mere “purveyor of knowledge” or “provider of facts”, but is, rather, a mentor, facilitator, helper, and mediator for learning. The teacher must create a learning environment that will allow the student to construct his/her own knowledge by experiencing and interacting with the environment (Hill, 1997).

Some Techniques for Implementing Active Learning

The following techniques, as suggested in the literature, are geared toward implementation in face-to-face courses, but most of them can also be implemented in computer-mediated courses:

- Ask students to keep a journal for the course. The student should write about what they are learning, how they are learning, how this makes them feel, and so forth.
- Ask students to develop a learning portfolio.
- Ask students to do something (design, conduct, simulate, present, discuss, etc.).
- Create small groups of students and have them make a decision or answer a question.
- Find ways for students to engage in authentic dialogue with people other than fellow classmates who know something about the subject (on the Web, by e-mail, or live).
- Implement cooperative learning, problem-based learning, or project-based learning (these three teaching methods are discussed in other articles of this book).
- Let students participate in the lesson: pose questions, encourage students to ask questions, stimulate discussion and debates, assign short exercises and assignments, ask for feedback (oral or written), conduct short breaks (2-3 minutes) every 20 minutes or so, to enable students to discuss what was taught, and implement the Socratic method of questioning.

ACTIVE LEARNING THROUGH COMPUTERIZED FEEDBACK INTERVENTION

This section discusses feedback intervention provided to the student by the computer both in synchronous and asynchronous distance learning courses. “Feedback interventions are defined as actions taken by (an) external agent(s) to provide information regarding some aspect(s) of one’s task performance” (Kluger & DeNisi, 1996). This definition excludes several areas of investigation: (1) natural feedback processes such as homeostasis, intrinsic feedback, or the negative-feedback-loop of a control system that operates without external intervention; (2) task-generated feedback which is obtained without intervention; (3) personal feedback that does not relate to task performance; and (4) self-initiated feedback-seeking behavior. We concentrate here on feedback intervention provided to the student by an external agent (the teacher) as regards to certain aspects and outcomes of the learning process. The feedback
could also be automatic—the computer, both in synchronous and asynchronous distance learning courses, provides automatic feedback, which is prepared by the teacher in advance.

Following a literature review, it seems that the question on which we should focus is not whether feedback should be provided, but how feedback should be designed in order to improve learning. Based on research findings, a short discussion about the conditions under which computerized feedback has a positive effect on learning is presented below.

The Effect of Feedback on Performance

Many organizational psychology research studies show that feedback has a positive effect on performance level. Thus, for example, according to Locke and Latham (1990), a meta-analysis of 33 investigations shows that, in relation to pre-defined goals, feedback is more efficient than in a situation where goals were defined and feedback was not given or a situation in which feedback was given but no goals were defined.

Educational literature has plenty of evidence showing that well-designed feedback given by teachers has a positive effect on learning (Black & William, 1998; Cronbach, 1977; Crooks, 1988; Natriello, 1987; William, 2002). For example, according to Cronbach (1977), “… feedback or knowledge of results … [is] the strongest, most important variable controlling performance and learning … It has been shown repeatedly that there is no improvement without knowledge of results, progressive improvement with it, and deterioration after its withdrawal” (p. 404). William (2002) also summarizes, “After a year, we found significant improvements in the attainment (as measured by external tests) of students taught by teachers using formative assessment, compared with controls in the same schools.”

Since this section focuses on feedback provided (automatically) by the computer, let’s examine whether there is a significant difference between regular teacher feedback and computerized feedback in relation to the effect on learning. Early (1988) found that immediate feedback given by the computer stimulates more confidence, leads to better self-efficacy, and improves performance compared to feedback given by the teacher, either verbally or in writing. A possible explanation could be that feedback given by the teacher might detour the student’s attention to “him/herself” (i.e., the student will attempt to understand the teacher’s intentions, compare him/herself to others, perceive the feedback as something that is being subjectively aimed at him/her personally, perceive the feedback as a threat or even as being offensive in certain cases). On the other hand, feedback provided by the computer focuses the attention on the task. Jackson (1988) and Kumar and Helgeson (2000) also found that immediate feedback provided by a computer is more efficient than feedback provided through traditional methods.

Does feedback always have a positive effect on performance? Kluger and DeNisi (1996) argued that feedback could cause various effects on performance—in certain situations feedback improves the performance level. In others, there is no significant effect, and at times there is a negative effect. That is why just providing feedback is insufficient. In order for feedback to have a positive effect, one should plan it properly. The following are a few aspects to be taken into consideration when planning to provide feedback.

Negative Feedback

Here, the term “negative feedback” refers to feedback about a mistake made by a student. According to Kluger and DeNisi (1996), feedback influences students’ pleasantness and alertness and, therefore, their performance as well. Negative feedback could also have an unintended emotional influence. When an individual is given negative feedback, he/she evaluates the level of his/her performance in relation to the goal, and accordingly, he/she can proceed using one of four strategies: redouble the effort in order to meet the goal; decrease the goal level to one that can be achieved; reject the feedback; or give up and “run away” (physically or mentally) from the situation. Repetitive negative feedback might induce a reaction of learned helplessness.

Of course, the teacher must create a learning environment that leads the student to choose the first strategy—redouble the effort in order to achieve the goal. Practically, feedback about a mistake that directs the learner to interpret the mistake and challenges him/her toward additional thinking paths would be more efficient than laconic negative feedback, such as “you made a mistake, try again!”
Positive Feedback

Surprisingly, positive feedback does not necessarily result in better learning. Many researchers (see Kluger & DeNisi, 1996) found that praise could also harm performance. For example, feedback that is “too good” may encourage low effort by the student. A teacher, who is effusive with his/her commendation, even when there is no justification for it, might cause a lack of motivation (why exert oneself if the teacher praises everything anyway in order to form a positive climate in the classroom or in order to encourage students?). So, in order to improve performance positive feedback and praise should relate directly to the task.

Positive feedback, just as negative feedback, should be as detailed and informative as possible. It is not always sufficient to react with a “yes” or “untrue”. It is advisable to add an explanation such as: “your answer is not correct because…” or “the right answer is B since …”; “answers A and D are wrong because …”; “answer C is wrong because …”, and so forth.

Feedback Components

According to Levin and Long (1981), efficient feedback is composed of three components: definition of the required goal, provision of detailed feedback about the performance, and provision of direction to the student as to how close the gap between his/her performance and the goal is. Formative assessment is better than summative assessment given at the end of the semester when there is no longer the possibility to correct mistakes and close gaps in order to achieve learning goals.

In short, immediate feedback provided by the computer could, if it is correctly designed, stimulate more confidence, lead to better self-efficacy, and improve learning compared to feedback given by the teacher, either verbally or in writing. By merely investing a little effort, it is possible to design feedback provided by the computer so that a positive effect on learning is achieved. The feedback must: be focused and task-specific; contain relevant and detailed information; be given immediately; direct the learner to understand his/her mistake; challenge the learner toward additional thinking paths and point out other possible solutions.

ACTIVE LEARNING THROUGH VISUALIZATION AND MULTIMEDIA

The term “multimedia” refers to the combination of multiple technical resources used for the purpose of presenting information represented in multiple formats via multiple sensory modalities (Schnotz & Lowe, 2003). Accordingly, multimedia resources can be considered on three different levels: the technical level (i.e., computers, networks, displays, etc.); the semiotic level, referring to the representational format (i.e., texts, pictures, sound, etc.); and the sensory level (i.e., visual or auditory modality).

Here, we will relate mainly to the sensory and semiotic levels. Many educators assume that creating learning environments that contain visual and auditory effects while using tools such as animations and videos is sufficient for promoting cognitive processing and constructing elaborated knowledge structures. However, in many research studies, it was discovered that the use of visual and auditory effects does not necessarily improve learning and, thus, using technology per se does not guarantee success. In order to improve learning processes, the instructor has to plan correctly the manner in which the information is presented and to refer to its sensory and semiotic aspects.

Illustrations: Effects on Learning

In a series of four laboratory experiments, Mayer (2003) examined the conditions under which the addition of illustrations to either written or vocal texts foster meaningful learning. It was found that students learn more deeply: from words and pictures than from words alone; when extraneous material is excluded rather than included; when printed words are placed close to rather than far away from corresponding pictures; and when words are presented in a conversational rather than formal style. A possible explanation for these findings is that learning is more meaningful when information is absorbed via two channels—auditory and visual—when learners pay high attention both to words as well as to pictures and when they integrate the verbal representations with the visual representations.

In another lab experiment (Schnotz & Bannert, 2003), it was found that presenting graphics is not always beneficial for the acquisition of knowledge.
Active Learning and Its Implementation for Teaching

Whereas task-appropriate graphics may support learning, task-inappropriate graphics may interfere with mental model construction. Pictures facilitate learning only if the learners have low prior knowledge and if the subject matter is visualized in a task-appropriate way. If good readers with high prior knowledge receive a text with pictures in which the subject matter is visualized in a task-inappropriate way, then these pictures may interfere with the construction of a task-appropriate mental model. The researchers behind this experiment concluded that the structure of graphics affects the structure of the mental model. In the design of instructional material including texts and pictures, the form of visualization used in the pictures should be considered very carefully.

Animations: Effects on Learning

Animation is a dynamic depiction that can be used to make change processes explicit to the learner (Schnotz & Lowe, 2003). Many educators believe that animations are superior to static illustrations as tools for active learning. In order to comprehend a dynamic situation that is externally represented by a static graphic, the learner must first construct a dynamic mental model from the static information provided. In contrast, animations can offer the learner an explicit dynamic representation of the situation. On the other hand, the transitory nature of dynamic visuals may cause higher cognitive load because learners have less control over their processing pace. Lowe (2003) and Lewalter (2003) showed that merely providing learners with the dynamic information in an explicit form does not necessarily result in better learning.

An experimental study involving 60 physics students, conducted by Lewalter (2003), investigated the effects of including static or dynamic visuals in an expository text on a learning outcome. She found that either adding animations or adding static illustrations could result in better learning. However, she found no difference between animations and static illustrations with respect to knowledge acquisition about facts, and only a small non-significant difference in favor of the animation group with respect to comprehension. Kozma (2003) found that with regard to the use of representations, such as animations and video segments showing lab experiments, chemistry experts may extract more benefits than chemistry novices. Lowe (2003) found that explicit presentation of the dynamic aspects of the content in a multimedia-based/oriented learning environment does not necessarily have a positive impact on learning. In many cases, the use of static visuals including conventional signs for motion, such as arrows, or the use of a series of frames may be sufficient for learning.

To review, the use of active learning means such as animations, visualizations, and virtual experiments does not assure a positive effect on learning. In order to improve learning, the instructor has to thoroughly plan the use of pictures and animation according to the following principles: students learn more deeply from words and pictures than from words alone; pictures facilitate learning only if the learners have low prior knowledge and if the subject matter is visualized in a task-appropriate way; animations are more effective when the learner can control the pace and the direction, but even animations allowing a high degree of user control should incorporate considerably more support and direction if they are to function as effective tools for learning. Furthermore, when teaching science, it is not sufficient to present virtual experiments. Students must participate in hands-on experiments as well.

Conclusion

Active learning involves students in course material through carefully constructed activities. Active learning is about learning through doing, performing, and taking action, and usually contrasts with the conventional lecture method. The action can be either mental or physical.

The theoretical foundation of active learning is the constructivist approach. Constructivism is a theory concerned with learning and knowledge, which suggests that human beings are active learners who construct their knowledge from personal experiences and on their efforts to give meaning to these experiences.

Constructivism suggests that learners learn concepts or construct meaning about ideas through their interaction with others, with their world, and through interpretations of that world by actively constructing meaning. They cannot do this by passively absorbing knowledge imparted by a teacher.
Active Learning and Its Implementation for Teaching

The current chapter discusses two technology-based means that can enable active learning—computerized feedback intervention and interactive animations.

Immediate feedback given by the computer could, if it is correctly designed, stimulate more confidence, lead to better self-efficacy, and improve learning compared to feedback given by the teacher, verbally or in writing. A minimal investment of effort makes it possible to design feedback provided by the computer so that a positive effect on learning is achieved. The feedback must: be focused and task-specific; contain relevant and detailed information; be given immediately; direct the learner to understand his/her mistake; challenge the learner toward additional thinking paths; and point out other possible solutions.

The use of active learning means like animations, visualizations, and virtual experiments as such do not assure a positive effect on learning. In order to improve learning, the instructor has to thoroughly plan the use of illustrations and animation according to the following principles: students learn more deeply from words and pictures than from words alone; pictures facilitate learning only if the learners have low prior knowledge and if the subject matter is visualized in a task-appropriate way; animations are more effective when the learner can control the pace and the direction, but even animations allowing a high degree of user control should incorporate considerably more support and direction if they are to function as effective learning tools. With regards to the teaching of science, it is not sufficient to present virtual experiments; students must participate in hands-on experiments as well.

To conclude this chapter, there is nothing better than the following epigram: I hear and I forget, I see and I remember, I do and I understand (ascribed to Confucius, 551-478 BC).

REFERENCES


Active Learning and Its Implementation for Teaching


KEY TERMS

Active Learning: Active learning involves students in course material through carefully constructed activities. It is about learning from doing, performing, and taking action and usually contrasts with the conventional lecture method. The action can be either mental or physical.

Animation: Technique by which inanimate objects seem to come alive by flashing a series of minutely changed images at a rate which the brain interprets as movement.

Computerized Feedback: Feedback that is prepared by the teacher in advance and returned to the student (automatically) by the computer.

Constructivism: Constructivism is a set of assumptions about learning that guide many learning theories and associated teaching methods. This is a theory concerned with learning and knowledge, which suggests that human beings are active learners who construct their knowledge from personal experiences and on their efforts to give meaning to these experiences.

Feedback: The process in which part of the output of a system is returned to its input in order to regulate its further output. Often this is done intentionally, in order to control the dynamic behavior of the system.

Feedback (in an Educational Context): Actions taken by an external agent(s) to provide information regarding some aspect(s) of one’s task performance. We concentrate here on feedback intervention given to the student by an external agent (the teacher) as regards certain aspects and outcomes of the learning process.

Negative Feedback (in an Educational Context): Feedback from the teacher about a mistake made by a student. Sometimes used as a synonym for “criticism”.

Positive Feedback (in an Educational Context): Acknowledge students when they do something right; usually given in the form of praise or recognition.

Social Constructivism: Social constructivism suggests that learners learn concepts or construct meaning about ideas through their interaction with others, with
their world, and through interpretations of that world by actively constructing meaning. Learners construct knowledge or understanding as a result of active learning, thinking and doing in social contexts.

**Visual Literacy:** The ability to look at visual information with perception. A visually literate person understands how visual elements contribute to the meaning of the whole.
Active Learning Online

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INTRODUCTION

Knowles, Holton III, and Swanson (1998, 2005) define learning as emphasizing the person in whom the change occurs or is expected to occur. Other scholars (Boyd, Apps, & Associates, 1980) consider learning as the act or process by which behavioral change, knowledge, skills, and attitudes are acquired. Gagne (1985) defines learning as a process that leads to a change in a learner’s disposition and capabilities that can be reflected in behavior. Like human beings, animals also learn. However, the difference is, while animals learn via reflexes and behavior modification, humans learn through reflection (Wang & King, 2006, 2007). According to Dewey (1933), learners are faced with learning problems, and these learning problems perplex and change the mind so that it makes belief uncertain. It is this perplexity that leads to reflective thinking, hence learning. Without reflective thinking, learning may not occur.

Regardless of how learning is defined, there is widespread agreement upon the definition of learning. That is, learning is reflected in a change in behavior as the result of experience (Haggard, 1963, p. 20). In other words, learning must be associated with development and growth (Merriam, 2004). That is probably why Maslow (1970) sees the goal of learning to be self-actualization. And he explains self-actualization as the full use of talents, capacities, potentialities. Confucius, 25 centuries ago, views learning as focusing on the cultivation of the inner experience, both as a way of self-knowledge and as a method of true communion with the other (Tu, 1979, p. 103). To Confucius, the goal of learning is to free one completely from four things: arbitrariness of opinion, dogmatism, obstinacy, and egotism (Wang & King, 2006, 2007). Further, Confucius thinks of learning as emphasizing meditation to control oneself. Upon the basis of Confucius’s thinking regarding silent reflection, scholars have made the distinction between active learning and passive learning. Learning does not take place in a vacuum. Learning takes place in any type of environment, including online. The purpose of this article is neither to solely study active learning for its own sake nor to present an analysis of active online learning. It is rather an attempt to examine the relationship between active learning online and learners’ intellectual growth and development. Towards this end, this article’s background covers active learning and learners’ intellectual growth and development. The next section is devoted to how various learning theories can make active learning occur online; hence, learners’ intellectual growth and development. The last section of the article seeks to make a summary of this article and point out some future directions for active learning online. As modern institutions launch more and more online learning programs, what concerns educators and parents is whether active learning will occur online. Unless active learning occurs online (or growth and development occurs online), online learning will lose its true meaning in this knowledge society and information age we currently live in.

BACKGROUND

Concern over active learning online is not without validity. Some people are not aware of the kind of research conducted on active learning many years ago. Active learning has to do with control and shaping (Knowles, et al., 1998, 2005). Control and shaping lie at the heart of Skinner’s (1968) definitive treatment of learning. Skinner (1968, p. 10) found,

*Recent improvements in the conditions which control behavior in the field of learning are of two principal sorts. The Law of Effect has been taken seriously; we have made sure that effects do occur under conditions which are optimal for producing changes called learning [control] and once we have arranged the particular type of consequence called a reinforcement, our techniques permit us to shape the behavior of an organism almost at will.*
Out of Skinner’s definitive research regarding active learning, Gagne (1985) posited a whole set of factors both external and internal to the learner that collectively may be called the conditions of learning. Gagne, Wager, Golas, and Keller (2005) further argue that external factors, like the learning environment, the resources in that environment, and the management of learning activities interact with internal conditions, such as states of mind that the learner brings to the learning task, previously learned capabilities, and personal goals of the individual learner (p. 7). It must be pointed out that it is these internal capabilities that affect active learning. Indeed, active learning would be meaningless if it were not associated with growth and intellectual development. Although it is not easy to explain growth and intellectual development, using just one theory, Bruner’s (1966) explanations appear to be so authoritative that only active learning can achieve them:

- Growth is characterized by increasing independence of response from the immediate nature of the stimulus.
- Growth depends upon internalizing events into a “storage system” that corresponds to the environment.
- Intellectual growth involves an increasing capacity to say to oneself and others, by means of words or symbols, what one has done or what one will do.
- Intellectual development depends upon a systematic and contingent interaction between a tutor and a learner.
- Teaching is vastly facilitated by the medium of a language that ends by being not only the medium for exchange, but the instrument that the learner can then use himself in bringing order into the environment.
- Intellectual development is marked by increasing capacity to deal with several alternatives simultaneously, to tend to several sequences during the same period of time, and to allocate time and attention in a manner appropriate to these multiple demands. (pp. 4-6)

These classical studies on active learning have laid a solid foundation upon which scholars can draw from in order to develop an understanding on what may contribute to active learning online. The Internet presents a totally different learning environment to learners and educators. Most people personally believe that the Internet is void of human interaction. Instructors lose control over learners simply because instructors and learners do not get to interact face-to-face. In fact, for active learning online to occur, there is a plethora of theories and principles for instructors to apply to the Internet environment. If used positively and correctly, all these theories and principles are geared to help learners achieve active learning online. The following section addresses the theories and principles that contribute to active learning online. Both educators and parents need to familiarize themselves with these theories and principles. Above all, applying them will make active learning occur online.

**MAKING ACTIVE LEARNING OCCUR ONLINE**

For active learning to occur online, the same principles of learning that are being applied to traditional classroom learning should be applied online. The principle of contiguity contends that the stimulus situation must be presented simultaneously with the desired response. To apply this principle to active learning online, an online instructor can give a student the task of classifying an example of a concept. For example, faced with a page of animals and the instruction to touch the elephant, the student touches the elephant via a radio button online and receives affirmative feedback from the instructor. The objective of instruction in this case is that the student identifies a picture of an elephant. Although the instructor may not see a learner face-to-face, feedback can be provided via a phone call, e-mail messages, videoconferencing, and even a Web cam. Nowadays, it is very popular for instructors and learners to communicate with one another via Yahoo or Hotmail instant messaging. Synchronous communication is no longer limited to chat rooms. Therefore, the principle of contiguity is totally applicable to the online learning environment.

The principle of repetition has been preferred in the third world countries and it means that the stimulus situation and its response need to be repeated, or practiced, for active learning to be improved and for retention to be more assured. A Chinese proverb goes like this, “if a learner reads a book a thousand times, the meaning of the book will be self-explanatory.” This says a lot
about the importance of the principle of repetition. It
must be pointed out that there are situations in which
repetition of newly learned ideas does not improve
either learning or retention (Ausubel, Novak, & Han-
sian, 1978; Gagne, 1985). There are multiple tools for
online instructors to use in order to repeat a stimulus
situation so that learners’ responses can be practiced.
For example, the same discussion question can be asked
again and again from different perspectives. And the
same question can be asked differently according to
the six levels of Bloom’s taxonomy. Western educators
may have some negative views on this principle of
repetition as it is directly associated with rote learning
and memorization. However, automaticity comes from
rote learning and memorization. People learn to drive,
using the principle of repetition. When people can drive,
no one cares to think about this automaticity. It is the
principle of repetition associated with rote learning and
memorization that contributes to automaticity. Active
learning rests with automaticity. Without automaticity,
learners are passive learners, being led by the nose by
their instructors.

The principle of reinforcement indicates that learn-
ing of a new act is strengthened when the occurrence
of that act is followed by a satisfying state of affairs
(Thorndike, 1913). According to Gagne, Wager, Golas,
and Keller (2005), reinforcement may be internal as
well as external. For active learning online to occur,
learners often ask instructors to provide their feedback
on a certain written assignment. If learners’ thinking
is correct in doing that written assignment, positive
feedback should be provided immediately via e-mail,
a phone call, or a Web cam. Then the principle of re-
inforcement is utilized successfully online.

The principle of social-cultural principles of learn-
ing contends that there are individual variables such as
content sequencing on student learning, the students’
perception of the relevance of the content to be cov-
ered. For example, learners from authoritarian cultures
may like the linear model of content sequencing, and
online instructors who do not follow this linear model
may disappoint these learners. Learners from Western
cultures may prefer problem-based learning models. If
an online course does not contain any specific real-life
problems for learners to solve, active learning online
may not occur among the Western learners.

The principle of andragogy contends that adult
learners tend to take more online courses because of
their multiple responsibilities as full-time employees,
parents, and community leaders (Wang, 2006). This
principle describes adult learners as being self-direct-
ing, as deriving only positive benefits from experience,
as possessing great readiness to learn, as voluntarily
entering an educational activity with a life-centered,
task-centered, or problem-centered orientation to
learning, and as being internally motivated (Long,
2004, p. 23). Based on this principle, online instructors
should involve online learners in the planning process.
Learners should be allowed to negotiate, with their
online instructors, the content of the syllabus that is to
be covered in an online class. According to Knowles
(1970, 1973, 1975), learners should be given learning
contracts. Once these are done, online instructors can
successfully release the energy of online learners.

The principle of situated cognition suggests that
learned capabilities are acquired in a particular context,
and the perceived utility of that context has implica-
tions for later retrieval and use. Therefore, a guiding
principle to be derived from this principle is that learn-
ing that occurs in authentic contexts where it can be
meaningfully applied is more likely to be remembered
and recalled when needed. With today’s online teach-
ing tools, online instructors can use a variety of tools
such as digital cameras, digital camcorders, and MP3
players, to create authentic contexts where learners’
interests can be greatly aroused.

The principle of activity theory maintains that
learning occurs as a result of activity. All activity is
purposeful, and by participating in activities, learning
occurs (Gagne, Wager, Golas, & Keller, 2005). Again
with today’s cutting edge technology, online learning is
no longer text based. Online learning is full of activities
and instructors try to do all they can to bring interaction
to a high level in the online learning environment.

CONCLUSION

It is true that active learning occurs in any type of
setting, including online. Passive learning occurs
when online educators fail to understand the theory of
learning, the conditions of learning, historical research
on learning, and fundamental principles of learning.
Learning theorists developed learning theories with the
intention that both educators and learners should apply
them in practice. These theories contain a guiding set
of assumptions, an ordering system that neatly sum-
marizes the facts, and/or assumptions, generalizations,
and hypotheses that tend to cause active learning to occur. The ubiquitous Internet provides just another type of learning environment. All the learning theories, conditions of learning, and principles of learning can be applied to the online learning environment in part or in whole. To say that active learning online does not occur is tantamount to saying that learning theories and principles of learning do not apply to online learning. In truth, learning does not take place in a vacuum. It is in relationship to others that humans learn actively. The Internet provides a fertile ground for instructors and learners to establish either a directing relationship or helping relationship, depending on instructors’ teaching styles and learners’ learning styles (Wang, 2005). Growth and intellectual development are possible if educators strive to arrange optimal learning conditions online. Finally, it must be pointed out that active learning online reinforces one’s growth and intellectual development. However, active learning online would not occur without three essential elements, and those are, learners (students), faculty, and more importantly, technological infrastructure. Gibson (2006, p. 148) argues that future directions should address access and success in terms of active learning online. And these include the importance of the following:

- Support for the technological infrastructure;
- Inclusive instructional designs that are not only culturally appropriate, but also accessible for differently-abled or those for whom English is not their first language;
- Learner support, including preparatory educational experiences to help learners learn at a distance, learn with technology, and learn in adulthood;
- Technology support to ensure both faculty and learners are able to function in the environment and have ready help when needed;
- Faculty support for teaching with technology and the design of instruction.

**REFERENCES**


**KEY TERMS**

**Active Learning**: Active learning can be defined as methods by which learners actively participate in the learning process, e.g., discussion group, problem solving, experimentation. It is used to differentiate it from passive learning by which learners are led by the nose. It is widely believed that active learning may lead to the creation of new knowledge and new skills needed by learners.

**Activity Theory**: Activity theory is aimed at understanding the mental capabilities of a single human being. However, it rejects the isolated human being as an adequate unit of analysis, focusing instead on cultural and technical mediation of human activity.

**Contiguity**: Contiguity refers to how associated a reinforcer is with behavior. The higher the contiguity between events, the greater the strength of the behavioral relationship.

**Learning**: This definition of learning is taken from *International Dictionary of Adult and Continuing Education* compiled by Peter Jarvis in 2002. According to Jarvis (2002), there are many definitions of learning, all reflecting the academic specialisms from which the study is conducted. 1. The process of acquiring knowledge, skills, attitudes, values, beliefs, emotions, senses, and so forth. 2. The sum total of the process of acquiring knowledge, skills and so forth, for example, a learned person. 3. Sometimes, it is wrongly used as a synonym for education, for example, adult learning. Significantly, it is replacing the term education in the educational vocabulary.

**Reinforcement**: Reinforcement is any change in an organism’s surroundings that:

- Occurs regularly when the organism behaves in a given way (that is, is contingent on a specific response),
- Is contiguous with the behavior (associated in time and space), and
- Is associated with an increase in the probability that the response will be made or in another measure of its strength.

**Repetition**: Repetition refers to the act or process or an instance of repeating or being repeated. In marketing, repulsion may have a different meaning. Repetition has been proven to increase recall and comprehension, particularly if the message is complex. However, a message may lose effectiveness if the consumer is overexposed to the advertisement through excessive repetitions, causing the consumer to lose interest in the message. Unless learners are internally motivated to learn, repetition may prove to be boring.

**Situated cognition**: Situated cognition emphasizes studies of human behavior that have “ecological validity.” In other words, situated cognition takes place in real situations (for instance, outside the laboratory). In more traditional laboratory, studies of (for example) how people behave in the workplace, real-world complications such as personal interruptions, office politics, scheduling constraints, private agendas, and so forth, are generally ignored, even though these necessarily change the nature of the activities. Situated cognition attempts to integrate these complexities into its analytic framework.
Activity Theory for Studying Technology Integration in Education

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INTRODUCTION

Information and communications technology (ICT) is rapidly changing the ways in which we do things. It has permeated almost every aspect of our society and has provided useful tools for communications, calculations, entertainment, design, and information gathering. As ICTs traverse traditional knowledge and communication barriers, many of the values of society are both enhanced and threatened. Using ICT has required new knowledge and skills; the instructors and students of today need many new skills to learn, work, and adapt to the ever-changing world. ICT is a subject of study and a tool to enhance study in other curricula areas. Technological literacy is defined as computer skills and the ability to use computers and other technology to improve learning, productivity, and performance. Successful technology integration is marked by students having access to an appropriate range of tools and being able to select and use them to help obtain information in a timely manner, to analyze and synthesize information and present it professionally in solving a problem. Technology integration should be an integral part of classroom culture.

Rogoff (1994) believes that technology can act as a catalyst influencing change from a traditional classroom to an environment of community of learners. A constructivist approach can be an effective way to successfully integrate technology in schools. The environment provides facilities for students to learn by doing, to work with others, and to have authentic experiences making learning motivating and relevant.

Research has found that there is very strong connection between appropriate teacher use of technology and increased student achievement (Valdez, McNabb, Foertsch, Anderson, Hawkes, & Raack, 2000). Technology integration is often concerned with classrooms. However, the real question must focus on integration into teaching practices, learning experiences, and the curriculum. Integration (from the Latin integrare, to make whole) includes a sense of completeness or wholeness and incorporates the need to overcome artificial separations by bringing together all essential elements in the teaching and learning process—including technology (as one of the elements, not the sole element) (Earle, 2002).

Technology provides cognitive tools for students as they make sense of the information gathered, allowing experts, teachers, and students to communicate their thoughts and interests in the subject matter and simulating real-life situations and problems. Many studies have been conducted to evaluate the effectiveness of teachers’ integration of ICT in classrooms (Van Braak, 2001; Wetzel, 2001). Although these approaches have been successful, they lack exemplary use of ICT for instruction and learning (Jaber & Moore, 1999). There is a need to explore how teachers engage students in meaningful and beneficial learning and where the computer is seen as a part of everyday classroom activity (Dias, 1999). It is important to move beyond reporting on the factors that influence teachers to integrate ICT to how the interplay of these factors contributes to successful ICT integration by the teachers into the classroom.

As can be seen, successful integration of technology into the classrooms depends on many factors. How do we study the effectiveness of technology integration in schools? We believe that cultural historical activity...
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The use of technology for e-learning

Since Galanter’s first binary math tutorial in 1959, most early computer teaching was frame-based programmed instruction. Various audio and visual components were added as the technology became available, but development costs were extremely high. More cost-effective for vocational education were computer-based testing and tracking systems that guided learners through individualized instructional materials. Computer-based education and simulations were most cost-effective in specialty areas such as aviation or medical training where conventional methods were extremely costly or risky. In the 1980’s, the installed base of micro-computers expanded and hardware and software standards emerged for the multimedia edutainment market. The uptake of computers in schools was rapid in response to a perceived need for widespread computer literacy training. Advances in networks such as BitNet led to widespread academic e-mail while dial-up bulletin boards paved the way for asynchronous chats, thus a ready market existed for the surge in a public Internet that started in 1995 with the appearance of easy-to-use graphical Web browsers and content creation tools.

The term “e-learning” came into popular use after the claim it “would make e-mail look like a rounding error” (Chalmers, 1999). Web sites were implemented to support both face-to-face and distance instruction so that within 10 years most tertiary education courses came to use some form of Web support. Most e-learning today uses the Web to facilitate communications and interactions among the learners and with the instructor. Much of it occurs in a hybrid or “blended” environment that still has a face-to-face component.

The low cost of mounting Web-based courses has also threatened the existence of more traditional distance education organizations (Abrioux, 2006). Although computers are now common in schools and at home, in the K-12 sector distance e-learning has only taken hold in homeschooling and in small schools mostly in rural or minority language settings where there are insufficient student numbers to have content specialist teachers present for every subject. ICTs have so successfully become part of the educational milieu that the term e-learning itself is beginning to be considered as anachronism.

Bransford, Brown, and Cocking (2000, p. 207) note five ways in which new technologies can be used:

1. Bringing exciting curricula based on real-world problems into the classroom.
2. Providing scaffolds and tools to enhance learning.
3. Giving students and teachers more opportunities for feedback, reflection, and revision.
4. Building local and global communities.
5. Expanding opportunities for learning.

Each of these poses an opportunity for technology integration, and successful integration will see growth in both technology skills and content knowledge. ICTs provide access to up-to-date resources and diverse views on current events in culture, social studies and science, or even become virtual participants on remote field trips. The integration of metacognitive tools into information retrieval interfaces (Winne et al., 2005) demonstrates how successful integration can scaffold and influence learners’ approaches to learning. While drill and practice are less common in formal instructional programs, they are a mainstay of many educational computer games where “twitch speed” must be combined with strategic reflection to achieve goals. Learners are encouraged to reflect on their personal progress and goals in e-portfolios.

Community building is not constrained to distance education but is also important in local work groups forming collective concept maps for knowledge building exercises (Scardamalia, 2003), for allowing novices to compare knowledge maps with those of experts, or in pairing classes for the exchange of meaningful second-language communications. A plethora of information is available on the Internet, and motivated learners
can bypass formal instruction and freely choose and achieve many of their own learning goals. Today’s aspiring rock musician can be found glued to community resource sites such as Guitar-Pro Plus (http://www.guitar-pro.com).

THE IMPACT OF TECHNOLOGY INTEGRATION

Technology offers opportunities for learner-control, increased motivation, connections to the real world, and data-driven assessments tied to content standards that, when implemented systematically, enhance student achievement as measured in a variety of ways, including but not limited to standardized achievement tests (Valdez et al., 2000, p. iii). It is our belief that enlarging the curriculum with the integration of technology can help change the paradigm of existing learning environments. Technology is a tool or a means to an end goal. It is not the end itself.

The changing paradigm of this learning offers many benefits to students. Technology provides opportunities for students to confront problems and make decisions in an imaginary environment that is realistic enough to provide meaningful issues and appropriate consequences (Knapp & Glenn, 1996). Although technology is not a panacea for education reform, it can act as a significant catalyst for change. Technology can also be a powerful tool to support collaborative learning environments. There is ample evidence that technology integration in schools has facilitated the acquisition of higher-order thinking skills in students (Lim & Hang, 2003).

Although both earlier-mentioned approaches offer several benefits for integrating technology and learning, many important issues remain to be solved in order to achieve a greater level of adoption. Here we just briefly elicit some of them.

- **Establishing Evaluation Methods:** The present learning systems based on learning objects and learning designs suffer from a problem of how to evaluate a (e)learning system that will comprehend both aspects—technology that supports learning processes (e.g., to evaluate the technical quality of the solution) and learning processes themselves from pedagogical, psychological, and social perspectives (e.g., to evaluate the level of the interaction among different learners in a learning design). Furthermore, such evaluation methods can help us evaluate if state-of-the-art technologies (e.g., semantic Web) really have expected social impact, having in mind that most effective technical tools (e.g., e-mail, MSN, and Skype) are not based on advanced technological principles (Alani, Kalfoğlou, O’Hara, & Shadbolt, 2005).

In the rest of the chapter, we describe how activity theory can be employed to address theses issues. Before we do that, a brief review of activity theory is given.

OVERVIEW OF ACTIVITY THEORY

Activity theory is a socio-cultural, socio-historical lens through which we can analyse human activity systems. It focuses on the interaction of human activity and consciousness within its relevant environmental context (Leontiev, 1981; Vygotsky, 1978). The basic unit of analysis in activity theory is human activity. Human activities are driven by certain needs where people wish to achieve certain purposes. The activity is mediated by one or more instruments or tools. The basic principles of activity theory include object orientedness, internalisation/externalisation, mediation,
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A hierarchical structure, and development. The most immediate benefit of activity theory is in providing a triangular template for describing these relationships and looking for points of tension as new goals, tools, or organizational changes create stress with the current roles, rules, and artefacts.

An activity always contains various artefacts (e.g., instruments, signs, procedures, machines, materials, laws, forms of work organisation). Artefacts have a mediating role. Relations between elements of an activity are not directed, but mediated. For example, an instrument mediates between the subject and the object of doing. The object is seen and manipulated not “as such”, but within the limitations set by the instrument (Kuutti, 1996). Artefacts are created and transformed during the development of the activity itself and carry with them a particular culture—a historical remnant of that development. The relationship between subject and object of activity is mediated by a tool. A tool can be anything used in the transformation process, including both material tools and tools for thinking. The relationship between subject and community is mediated by rules and the relationship between object and community is mediated by the division of labour—how the activity is distributed among the members of the community, that is, the role each individual in the community plays in the activity, the power each wields and the tasks each is held responsible for. Rules cover both implicit and explicit norms, conventions, and social relations within a community as related to the transformation process of the object into an outcome. Each of the mediating terms is historically formed and open to further development (Kuutti, 1996). The basic structure of an activity can be illustrated as in Figure 1.

**ACTIVITY THEORY FOR STUDY OF TECHNOLOGY INTEGRATION**

We believe that many computer skills can be acquired in context while students are learning curriculum content in a meaningful way. Technology integration activities are influenced by social, cultural, and political issues. It must be seen as an ongoing innovative process designed to meet instructional and learning needs (Robey, 1992). Technology integration can enable the development of a community of learners sharing and building knowledge of the technology and the content together. It also affects the learning environment, teacher roles, teacher beliefs, student roles, and practice and the teaching and learning process. It is our belief that technology integration must be understood in the context of larger organizational issues. It is not technology per se that has resulted in improved student outcomes, but rather how the technology was used and integrated into instructional processes (Bernauer,

Figure 1. Basic structure of an activity
It is not what technology by itself can do, but what teachers and learners may be able to accomplish using these tools.

Benefits of Activity Theory for Technology Integration

There are many benefits of using the activity theory for studying the effectiveness of technology integration in classrooms. First, activity theory provides a framework to study the impact of technology integration. It enables us to have a much richer understanding of the interaction among teachers, context, students, and their environment as teachers make changes in teaching methods and begin to adopt new technologies and resources into their teaching practice. Second, the activity theory provides a holistic method for explaining technology integration. Third, the activity theory allows us to conceptualise the complexities of the research context in terms of the characteristics of the technology integration activities, the factors that affect change, and the interactions among factors that allow us to study the social, cultural, and historical characteristics of the target population. The environment that the target population operates in includes the community, rules, and division of labour. Fourth, the activity theory also allows us to identify the goals of the target population we are trying to study. It requires us to understand the character and history of the subject, the object (outcome) that the subject is aiming to achieve, the characteristics of the surrounding community, and the tool/technology integration available to the subject. Activity theory allows us to explore the interaction of human activity and the mental models of the individuals as they interact with the relevant environment context and to finalise appropriate research questions and methodologies. Typical research questions are:

- How does the use of technology integration strategies change over time?
- What factors impact the teachers’ teaching methods, technology integration strategies, and the use of technologies over time?
- How do the social and cultural factors affect the adoption of technology integration?

Activity theory allows the study of the different stakeholders involved in the study. It can be used to study and measure the previous training and experiences of the subjects before participation, interaction with peers and tutors, as well as during technology integration. It allows us to establish practices and support structures for teaching and learning, changes in availability of technology and curriculum resources throughout the study.

Principles of Activity Theory for Technology Integration

There are several principles of activity theory that can be used to study the impact of technology integration in classrooms. The three central principles of mediation, context, and development are discussed in detail:

Mediation

Tools mediate or shape the way human beings interact with reality. Shaping external human activities results in shaping internal ones. In activity theory perspective, the technology is a tool in a learning environment. Human activity, in our case learning by students, is mediated by the tool, technology. Tools, means to divide work, norms, and language can all be seen as artefacts of the activity, that is, they are made by humans, and they mediate the relations among human beings or between people and the material or product in different stages. Artefacts are there for us when we are introduced into a certain activity so they shape our activity, but they are also a product of our activity, and as such they are constantly changed through the activity.

Context

It is obvious that activity cannot exist as an isolated entity. The very concept of activity implies that there is an agent who acts (an individual or collective “subject”). An activity is directed at something, so there should be things the agent is interacting with. According to activity theory terminology, activity mediates interaction between subjects (agents) and objects (things). In activity theory, the human mind emerges, exists, and can only be understood within the context of human interaction with the world and this interaction, that is, activity, is socially and culturally determined (Kaptelinin, Nardi, & Macaulay, 1999) as shown in Figure 2.

In activity theory, activity and context cannot be separated. The activity system itself is the context. What takes place in an activity system composed of object,
actions, and operations is the context. Context is constituted through the enactment of an activity involving person (subject) and artefacts. Context is therefore the activity system, and the activity system is connected to other activity systems. In activity theory, context is not persistent and fixed information. Continuous construction is going on between the components of an activity system.

Development

Humans not only use tools, they also continuously renew and develop them either consciously or unconsciously. They not only use rules, but also transform them. To analyse context, we need to know the beliefs, assumptions, models, and methods commonly held by the group members, how individuals refer to their experiences on other groups, what tools they found helpful in completing their problem, and so forth. In addition, there are also external or community-driven contexts. These include issues such as (Jonassen & Rohrer-Murphy, 1999):

- What types of limitations are placed on the activity by the outside agencies?
- How are tasks organized among the members of the group working towards the object?
- What is the structure of the social interaction surrounding this activity?
- What activities are considered to be critical?
- How flexible is the division of labour? How well are these roles and their contributions being evaluated?
- What formal or informal rules, laws, or assignments guide the activities in which people engage?
- Is there a difference between implied rules and those formally stated?

In order to study the impact of technology integration, it is important to consider its development. In activity theory, all practice is seen as being reformed and is shaped by historical development. Consequently, it is important to understand how tools are used not only in a laboratory setting but to understand how they are used over a period of time. In that time, development may occur making the tool more useful and efficient than might be seen in a single laboratory experiment. Activities are not static or rigid; they are constantly evolving. To understand a phenomenon means to know how it is developed into its existing form (Kaptelinin, 1996). It is important to analyse the development of the activities such as the nature of changes that occur in different historical phases of the activity. In addition,
it is also necessary to analyse the mediators and their transformation over time in order to provide important historical information about how and why activity systems exist as they do. Thus it is important to examine the role that persistent structures, such as artefacts, instruments, and cultural values play in shaping activity (Jonassen & Rohrer-Murphy, 1999).

CONCLUSION

Determining the level of integration of technology in e-learning is still one of the biggest challenges that should be solved by the (e)learning community. In this paper, we have given a brief description of the state-of-the-art in integration of technology in e-learning. We have emphasized two important issues that should be solved to better estimate the level of technology integration, namely developing efficient ways for capturing learning context and establishing sound evaluation methods. To address these issues, we have proposed the use of activity theory considering the nature of learning processes where technology integration must be analyzed in terms of larger organizational issues. In fact, technology integration is evaluated by what teachers and learners may be able to accomplish using these tools. To do so, we have also identified three main principles of activity theory for technology integration: (1) Mediation that is analyzed in terms of tools used for mediation between humans (students and teachers) and content and between humans themselves; (2) Context that is determined by human interaction with the world and this interaction is socially and culturally determined; and (3) Development of tools that are continuously renewed and changed either consciously or unconsciously.

This paper is written with the purpose to be used as a starting point for both technologists and educators explaining the complexity of evaluation of technology integration and how activity theory can be applied in that task. We hope that this chapter will stimulate researchers to start applying activity theory: to reveal better technological requirements for learning processes in various organizational environments based on different rules and regulations; to estimate the level of technology integration in current learning scenarios and discover potential weaknesses; and to determine how current tools can be changed, so that they can improve the level of interaction between students, learners, and tools following social specificities of diverse learning settings. The one issue of interest that we have not dealt with is “What happens to human content knowledge when or if the mediating technology is removed?”

REFERENCES


Activity Theory for Studying Technology Integration in Education


KEY TERMS

Cultural Historical Activity Theory (CHAT): Addresses human activities as they relate to artifacts, shared practices, and institutions. It seeks to understand human activities as complex, socially situated phenomena.


Technology Integration: The incorporation of technology resources and technology-based practices into schools.

Tool Mediation: In activity theory, tools shape the way humans interact with reality. It usually reflects the experiences of other people who have tried to solve similar problems. Tools are created and transformed during the development of the activity itself and carry with them a particular culture—the historical remnants from that development.
INTRODUCTION

In the 21st century, learning and Internet-based technologies are becoming increasingly interwoven. For a growing proportion of children in the developed world, blogs, social networking, multiplayer online games, and instant messaging systems are figuring significantly in their daily lives (Sefton-Green, 2004; Somekh, 2004). Education systems have, for a long time, recognized the potential of technology to enhance and enrich teaching and learning; however, the realization of that potential has more often than not been disappointing (Cuban, 2001; Somekh, 2001). In Australia, we continue to receive strong statements from the Government about the educational importance of integrating ICT into teaching and learning (cf. Learning in an Online World, MCEETYA, 2005); but the reality is, schools and universities are struggling to achieve such goals.

BACKGROUND

The Partnerships in ICT Learning (PICTL) project was an Australian Government Quality Teacher Program funded by the Department of Science, Education and Training (DEST), and the Australian Curriculum Studies Association (ACSA). Eight projects were initiated across each state and territory, and recommendations were made to the DEST about school-based models for ICT learning in preservice and teacher professional-learning communities.

This chapter reports on the Australian Capital Territory (ACT) project that was designed to explore the use of collaborative technologies with preservice teachers. Research has shown that the preparation of ICT-savvy teachers is a pressing problem that requires schools and teacher education institutions to work together to develop more effective approaches (Downes, Fluck, Gibbons, Leonard, Matthews, Oliver, Vickers, & Williams, 2002). The effective integration of technology into teacher education courses positively impacts on school ICT practices (Franklin, 2007). The work reported here was founded on the understanding that ICT integration requires educators to consider issues of innovation and reform in their own practices before they address wider integration issues. The ACT project was a pilot research project designed to integrate collaborative technologies into a preservice pedagogy unit as a way of initiating a professional dialogue about the use of information and communication technologies (ICT).

The key aims of this project were to:

- Investigate how various technologies, such as blogs and team learning systems, can be used to foster collaboration; and,
- Assist preservice teachers to reflect upon their understanding of the conditions that motivate teachers to expand their use of ICT.

Project Design

In this project, we worked with 12 final-year preservice teachers enrolled in a core Secondary Teaching Studies (Technology) unit at the School of Education and Community Studies at the University of Canberra. In this pedagogy unit, we devised a series of university-based experiences, where the students learnt to use new technologies, and considered the facilitation models that would promote ICT integration. The ACT project made use of two emerging technologies: the Zing meeting system (http://anyzing.com); and Elgg (http://elgg.net), a blogging and social networking application. While these students had already completed a core ICT in Education unit, they had not previously used either blogs or Zing.

The Zing system connects multiple keyboards to a shared collaborative space, and was originally designed as a meeting system for business. Work with Zing has shown that when users meet in this way, they are able
to carry out complex thinking, support sense making, and foster the decision-making processes (Fitzgerald & Findlay, 2004). In this project, we used Zing both to illustrate an innovative collaborative application and, as a way of conducting focus groups for the research aspect of the project. Early in the semester, the students were introduced to Zing through a series of hands-on training sessions.

Elgg was used as a tool to help the students begin to explore in depth the application of blogs and, in a broader sense, electronic portfolios and social networking. Elgg is a robust and flexible platform that is being used by a wide variety of educational groups. The developers, Ben Werdmuller and David Tosh, describe the platform as a personal learning landscape that combines the Web 2.0 functionalities of blogs, e-portfolios, and social networking. Each student was required to create an Elgg account, and to use the blog functionality to record their observations and reflections throughout the semester.

DATA COLLECTION, ANALYSIS, AND RESULTS

The project generated data using a variety of processes. The Elgg system, with its blog functionality, allowed the preservice teachers to document their experiences in this project. The Zing team learning system allowed us to conduct a series of focus-group meetings with the students. Midway through the project, we also ran a PMI (plus-minus-interesting) survey. Our analytical methods drew primarily on thematic and qualitative approaches to make sense of the data. With some of the data, we were able to use cloud tags to visualize the data, based on keyword analysis. The cloud tags are weighted frequency graphs of popular keywords that are often generated dynamically. The combination of the data, in conjunction with our experience in teaching and working within this unit, meant that we were able to develop quite a rich picture, even though it was based on a small number of students.

Focus groups: Talking to Preservice Teachers about ICT

We asked the preservice teachers to consider which skills, capabilities, and knowledge they thought current school students would need in order to be successful in the future. In their focus-group discussions, the group identified a number of key themes including children’s competence with ICT, the importance of life-long learning skills, an appreciation of ethical issues (i.e., values and morals), and the importance of developing self-confidence and a belief in themselves. Taking the text generated by this discussion, we created a cloud tag that represented the weighted frequency of key words in their discussion (Exhibit 1). There was a high degree of congruence between the cloud tag and the key themes that the group enumerated.

Exhibit 1. What skills, capabilities and knowledge do school students need?

When then asked “What does ICT in learning mean to you?”, they identified themes in the data that recognised that ICT was strongly implicated in future learning, particularly with regard to enhancing learning and communication. The “problems” of ICT with respect to access and equity were also evident in their discussions. Again, generating a cloud tag (Exhibit 2) produced a picture that was congruent with the focus-group themes.

Exhibit 2. What does ICT in learning mean to you?

Reflections on Using the Personal Learning Landscape (Elgg)

With our preservice teachers, we attempted to create a virtual space that allowed them to engage in a community of practice (Wenger, 1999). The Elgg system offered features of Web 2.0 technology (Alexander, 2006) that emphasised the importance of connectivity and engagement. The metaphor of a personal learning landscape was entirely congruent with the project’s aim of fostering learner–centred approaches. Elgg offered these students both a virtual space and a digital identity.
that they managed. This approach stands in contrast to most e-learning applications that are controlled by a lecturer or teacher and are focused predominantly on the delivery of content.

Usage statistics from the Elgg site showed that it was a space that was used extensively by the students for communication and exchange. Throughout the course of the project, each student maintained a blog and in addition, created six community accounts around topics of interest. As of May 8, 2006, there had been 138 blog posts amongst the 12 students, with 71 comments posted by their peers and 152 files uploaded to the site. As the use of Elgg developed throughout the project, we observed an increasing number of comments being made on peer’s blog posts, suggesting that a critical and reflective dialogue was beginning to develop. Generally, the students were very positive about their experience of blogging, and they were able to make connections to possible classroom applications. The students’ comments were very positive, and it was clear that they had already thoughtfully considered the application of these tools in schooling (Exhibit 3).

Collaborative Technologies Survey – PMI

About midway through the project, we conducted a PMI (plus-minus-interesting) survey with our students as a way evaluating our work. The survey return rate was quite good at 60%, and a descriptive analysis showed that these students were generally positive about the use of blogs and Zing. For almost all of our students, this unit was the first time they had engaged with these technologies and therefore, they would still require much more time to realize its full pedagogical potential. It is evident, however, that even after a short period of time, they can at least articulate the potential of these technologies (Exhibits 4 & 5).

The majority of comments were positive, and the main criticisms were related to the user interface and the potential risk of a discussion losing focus. A strong theme emerged with Zing around the role it played in helping people to express themselves. Comments such as “…develops a thinking process …” and “great for written collaboration and brainstorming” highlighted the cognitive aspects of the tool, which is situated within a highly social space. Students recognized that working together as a group afforded not only cognitive rewards, but also social benefits. Two students commented that “It changed the whole group dynamics for the better” and “Everyone seemed a lot more relaxed.

Again, the plusses outweighed the minuses, with two themes emerging. First, the Elgg system offered a place to blog and store files, both of which would be essential characteristics of an electronic portfolio system. Second, there were a number of comments that related to the way the platform supported both the individual and community activities, encouraging connections with others and building a community. Students

Exhibit 3. Preservice teachers comments on using blogs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I can, however, see a place for blogs in schools. Especially as a tool for students to reflect … I will look to them as a tool for lodging ideas for discussions, and this exchange of various ideas will come in handy in future projects.</td>
</tr>
<tr>
<td>2.</td>
<td>I have some thoughts on using this in my teaching of Agriculture-ideas such as setting up a trading site where we could use e-markets to model real market imperatives for producers-using an Elgg site to facilitate self-evaluation and reflective learning and sharing of ideas between students and using ICT to access models of agricultural functions.</td>
</tr>
<tr>
<td>3.</td>
<td>Elgg would offer a tremendous opportunity to establish communities of distance education students where they could interact with each other, share experiences, and supplement the contact they have on the very few occasions they come to the distance education face-to-face school—it would be particularly brilliant for those students who are overseas.</td>
</tr>
<tr>
<td>4.</td>
<td>Blogs are a new opportunity for educators; they offer educators a tool that is interactive and provides an immediate publishing tool…This concern is that the greater the interaction with students, the more expectation is placed on the educators.</td>
</tr>
</tbody>
</table>
**Exhibit 4. A PMI on Zing**

<table>
<thead>
<tr>
<th><strong>Plus</strong></th>
<th><strong>Minus</strong></th>
<th><strong>Interesting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Great way to introduce a structured/informative discussion</td>
<td>• Easy to get off-track – constant supervision + penalties for non-relevant conversation are needed</td>
<td>• The timer is a good way to help the thought process.</td>
</tr>
<tr>
<td>• Everyone has to participate…even shy students can have a go at it.</td>
<td>• No graphical capability</td>
<td>• Structure is good</td>
</tr>
<tr>
<td>• Zing teaches students to work/brainstorm within a time frame.</td>
<td>• Experience replacement for Butcher’s paper</td>
<td>• Has potential to be much better</td>
</tr>
<tr>
<td>• Develops a thinking process, which can be integral</td>
<td>• Can be abused</td>
<td>• Good interface for a collection of information</td>
</tr>
<tr>
<td>• Can monitor + censor conversations</td>
<td>• Too easy to get distracted</td>
<td></td>
</tr>
<tr>
<td>• Great for written collaboration and brainstorming</td>
<td>• A bit ugly</td>
<td></td>
</tr>
<tr>
<td>• It changed the whole group dynamics for the better.</td>
<td>• Requires technology</td>
<td></td>
</tr>
<tr>
<td>• Everyone seemed a lot more relaxed.</td>
<td>• Seems to be a lot of technology required</td>
<td></td>
</tr>
<tr>
<td>• All voices heard</td>
<td>• Can get out of hand without close monitoring</td>
<td></td>
</tr>
<tr>
<td>• Lots of fun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Multiple uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fun, collaborative, fast, and productive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lets people contribute without pressure of group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Gets people to voice without verbal communication</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

...did raise issues with the system primarily around the user interface. It is important to note that the version of Elgg we used in this project has been redeveloped with significant improvements in the user interface, site administration, and range of functionality.

**DISCUSSION AND IMPLICATIONS**

The project resulted in the redevelopment of a secondary teaching-methods unit that allowed these students to participate in a learning program using collaborative technologies to explore pedagogical ideas. This unit served as an important “test bed” for the development of exemplary models of ICT integration in our teacher education program, and has generated substantial interest from the faculty. As we worked with the preservice teachers, we became increasingly aware of the importance of modelling good technological and pedagogical practice around the use of technology, a finding consistent with the literature (Garcia & Rose, 2007). Achieving this has been very difficult at our university because, at the time of the project, ICT systems and services that could support the use of blogs or other Web 2.0
technologies were not available. Given this situation, we were forced to look for a hosted solution outside the university. There is a complex relationship between technical realities and pedagogical opportunities when working in this space, and there is certainly a need for a more focused dialogue between the providers and users of ICT services. To date, the trend in universities has been towards monologic technological systems (e.g., e-learning systems, such as WebCT) that tend to promote a one-size-fits-all approach to e-learning. This results in the technology being overemphasised at the expense of the pedagogy. Research has shown that it is the development of sound pedagogical content knowledge that is at the heart of effective ICT integration (Ferdig, 2006; Franklin, 2007). The clear message is that universities must find ways of supporting both pedagogical and technical innovation in ways that allow their staff and students to take leading roles in supporting school-based professional development. It is this professional learning that will help build a suitable knowledge base for schools to draw on as they plan their ICT futures.

Based on our small-scale survey and student reflections, it is clear these students are keen to further investigate the place of collaborative systems in their teaching and learning. Experience shows that effective learning about ICT requires time to develop (Mouza, 2003; Sandholtz, Ringstaff, & Dwyer, 1997) and therefore, teacher education faculties must approach this work on an entire degree basis. The students did express concerns about the level of technical skill and continuing professional development required to effectively use these systems in the classrooms. Developing classroom-based projects will provide opportunities to explore shoulder-to-shoulder professional learning models; however, ongoing support for the development of ICT skills and competencies will still be important (Nicaise & Crane, 1999; Sherry, 2000).
Universities and schools need a flexible and responsive ICT infrastructure that can adapt to the rapidly changing Web 2.0 landscape. In particular, educators need computer resources to experiment with new technologies. In effect, they need technological “sandpits” matched with online and face-to-face opportunities to share their experiences. It will be important to remove some of the barriers to adoption that have been created by the “locking down” of computer networks.

The sustainability of collaborative technologies will remain possible as long as preservice teachers feel that they have the support and commitment in the school setting to implement new ICT practices. As Scardamalia and Bereiter (1994, p. 266) remind us, “Nobody wants to use technology to recreate education as it is…,” but this is a significant risk if we cannot find sustainable ways of supporting knowledge-building, as opposed to “knowledge telling” in education. Comments from students highlight the need for good support to work against the prevalence of traditional methods in schools.

FUTURE DIRECTIONS

There has been substantial interest in the social networking and electronic portfolio model integral to the Elgg system. The further investigation of digital portfolios that can be used to document experiences and demonstrate teacher capabilities as they develop as professionals will be a legacy of this project. There has also been considerable interest in methods of engaging University students in the use of social technologies. Arising from this work has been the recent funding of a new research project based on the application of social software and Web 2.0 technologies in higher education. This research project will consider how these technologies can support peer-to-peer learning, where students exchange ideas and resources, while also providing a space in which they can create new ways of connecting with each other (http://mashedle.edu.au).

CONCLUSION

This project was an exciting and timely development for our faculty, and was driven by a desire to avoid “re-inventing the familiar” (Scardamalia & Bereiter, 1994, p. 266) by focusing on new collaborative technologies. These learner-centred models of ICT use and integration promote students as producers, not just as users; and encourage team learning, as opposed to just individual learning. Given the Web 2.0 direction of technology (Alexander, 2006), and the increasing importance and relevance of team learning to organisational learning (Senge, 1990), we believe these approaches have the greatest potential to drive effective ICT integration in education.

This research has highlighted some of the benefits of the teacher education about the use of new collaborative technologies. The realization of these technologies is only possible if preservice teachers feel they have the support and commitment in the school setting to implement new ICT practices.

Questions of sustainability were not able to be adequately answered in the short time frame of this project. However, it is our belief that there will be “no going back” once the conversation about collaborative technologies has begun. Schools are facing the reality of a growing band of IT-savvy students, and an ever-widening gap between the home and school use of technology. The technological systems and models of pedagogy that school systems choose to promote will ultimately determine the future of ICT in education. The future is here, and how we choose to distribute this future will be telling.

REFERENCES


KEY WORDS

**Blog:** An online journal or diary where entries or postings are displayed in reverse chronological order (e.g., http://edublogs.org or http://blogger.com).

**Cloud Tag:** A weighted-frequency list of popular tags or keywords. Often used in social networking systems to visualise the activity of the community.

**Elgg:** An open source software system designed to allow users to create social networks for sharing resources. It has been developed by Ben Werdmuller and David Tosh.

**Multiplayer Online Games:** Internet-based computer games that allows large numbers of users to play together in the same virtual arena.

**PMI:** A thinking strategy where the user is asked to consider the issue at hand in terms of its Plus, Minus, and Interesting dimensions. A key strategy in the work of Edward de Bono.

**Social Networking:** A generic term for Internet-based systems that allow users to create communities based around shared interests for the purposes of sharing and exchange.

**Web2.0:** An emerging suite of second-generation Internet-based software systems that allow users to form communities of interest for the purposes of sharing and exchange.

**Zing:** A collaborative software system that allows groups of users to meet and work together either face-to-face or online. Zing is a form of a group decision support system.
Andragogy and Technology

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INTRODUCTION

More than 30 years ago, Malcolm Knowles defined andragogy as the art and science of helping adults learn. The essence of this principle is based on the premise that adults learn differently than children. Knowles’ andragogical studies were significant. One reason for this was that pedagogy, the art and science of educating children, had been well researched, but educating adults had not been as thoroughly studied.

Today, Knowles’ definition and andragogical principles are still applicable, but andragogy is continually refined through the expansion of its basic theory. This article proposes that andragogy be viewed from two additional perspectives: cultural and technological.

From a cultural perspective, because individuals are unique, so are their learning experiences. According to Brooks (1986), andragogy regards adults as social beings who are products of history and culture. Although many of the adult learner characteristics apply to the majority of adults, learning is influenced by cultural norms and values. Each culture learns using different methods and demonstrates what they have learned in different manners.

For example, in China, rote memorization is the main teaching method to prepare K-16 students for a series of national examinations. Learning is identified through test results. In contrast, American K-16 students are encouraged to learn and to reflect about the relevance of a topic with their daily lives and tested via essays, even in math or science. Therefore, the methods which students use as they process information and assessment vary culturally.

The second way andragogical study can expand is through the inclusion of today’s accessible technology. With more technology available, adult learners help themselves more readily. Innovations such as online schools, chat rooms, instant messenger (IM), MP3 players, and Web cameras aid adult learners who typically juggle work, family, and school. Adult learners more easily continue their education, especially if they were once limited geographically and now participate in online classes.

As the debates and discussions continue, one thing becomes clear: the learning needs of adult learners are indeed different than those of a child. As time goes on, andragogical theory will be continually refined. One may hope that its study becomes more holistic, taking into account the nuances of an adult learner’s culture and how technology fosters increased educational opportunities.

BACKGROUND

In 1833, German teacher Alexander Kapp coined andragogy. The word itself is derived from the Greek word aner, meaning man. Thus andragogy is defined as the art and science of helping adults learn. Andragogy fell into disuse and then was reintroduced in a report by Rosenstock in 1921. Malcolm Knowles applied the term to his concept of adult education in the 1970’s.

Malcolm Knowles, in his seminal work, “The Adult Learner: A Neglected Species” (1973), maintains there are four basic assumptions of andragogy that differ from pedagogy, yet Knowles continued to consider his seminal work. “And, ever evolving his own ideas and learning from others, he continued to modify his andragogical assumptions” (Lee, 1998). With regards to children and andragogy, Knowles shared, “. . . andragogy is simply another model of assumptions about adult learners to be used alongside the pedagogical model of assumptions, thereby providing two alternative models for testing out the assumptions as to their fit with particular situations. Furthermore, the models are probably most useful when seen not as dichotomous but rather as two ends of a spectrum, with a realistic assumption (about learners) in a given situation falling in between the two ends (Knowles, 1980, p. 43).

1. Their self-concept moves from dependency to independency or self-directedness.
2. They accumulate a reservoir of experiences that can be used as a basis on which to build learning.
3. Their readiness to learn becomes increasingly associated with the developmental tasks of social roles.
4. Their time and curricular perspectives change from postponed to immediacy of application and from subject-centeredness to performance-centeredness (Knowles, 1980, pp. 44-45).
5. Motivation to learn: “As a person matures the motivation to learn is internal” (Knowles, 1984, p. 12).

Over the years, there have been discussions and debates about Knowles’ definition and andragogical theories as a system of ideas, concepts, and approaches to adult learning. For example, Cross (1981) felt there are four questions to answer regarding Knowles’ concept. Within this framework, Cross provides a new approach, differentiated instruction, to provide programming for individuals based in their differences of personal and situational characteristics.

1. Adult learning programs should capitalize on the experience of participants.
2. Adult learning programs should adapt to the aging limitations of the participants.
3. Adults should be challenged to move to increasingly advanced stages of personal development.
4. Adults should have as much choice as possible in the availability and organization of learning programs.

It is from the perspective provided by Cross (1981) that we consider how these questions and the main tenants of andragogy fare when considering cultural differences and the impact of technology upon the learner. While andragogy includes behaviorist, cognitive, psychological, and humanist approaches, it is always with respect to the adult learner as a proactive and responsible person, focusing on the students as “mature” human beings.

**ANDRAGOGY VS. PEDAGOGY**

For a full look at andragogical study, it is important to understand the innate differences between the mature adult learner and the way a child learns.

Pedagogy, or teacher-directed instruction as it is commonly known, places the student in a submissive role requiring obedience to the teacher’s instructions. It is based on the assumption that learners need to know only what the teacher teaches them. The result is a teaching and learning situation that actively promotes dependency on the instructor. (Hiemstra & Sisco, 1990).

As the recipient of knowledge deemed appropriate by the teacher, students are expected to learn. As noted by Lee (1998),

*Children have a subject-centered orientation to learning: adults tend to have a problem centered orientation. That is, children master content to pass a course or be promoted to the next grade; adults seek the skills or knowledge they need to apply to real-life problems they face.*

The origins of didactic teaching method are found in the “monastic schools of Europe in the Middle Ages. Young boys were received into the monasteries and taught by monks according to a system of instruction that required these children to be obedient, faithful, and efficient servants of the church (Knowles, 1984). From the monasteries of Europe the belief of pedagogy was established and eventually “spread to the secular schools of Europe and America and became and remains the dominant form of instruction” (Hiemstra & Sisco, 1990). Interestingly, known for his work regarding adults, Knowles’ thoughts regarding children and their learning are worth further consideration today as educators are able to use technology to aid the whole individual in need of educational opportunities appropriate for each. Knowles presents sound educational input regarding children. “Kids have just as much need for learning to be life-centered, task-centered and problem-centered. It’s just that the nature of their tasks, problems and lives is different,” Knowles told TRAINING “The only universal characteristic of adult learners is the quality and quantity of their experience....” (Lee 1998).

Almost by definition, the adult learner is one who returns to study, on a full-time or part-time basis after a period of time spent in other pursuits. As a result, each student brings a rich background culled from life and work experiences, which include roles as an employee, spouse, parent, citizen, and community or church worker. These insights make it easier for adults to recognize how ideas are transformed into action and how theory can be transformed into practice outside the classroom.
Additionally, adult learners often feel compelled to take an active role in their own learning, and they are more willing than younger learners to make sacrifices in setting goals for themselves and in striving to reach them. For example, they decide how to expend their energies, what skills they wish to acquire, the persons they aspire to become, or the kinds of relationships they hope to build. Also, adult learners are more likely to prioritize the competing forces in their lives. Of course, some adult learners do have poorly defined goals and priorities.

There are many reasons for this superior motivation. Often adult learners are able to devote only part of their time to study because of work or family obligations. Time is precious and when they can study, they take it seriously. Younger learners tend to take their studies less seriously. Moreover, adult learners are often motivated by a desire to advance in a job or to make a career shift.

Adult learners have certain advantages, but there are problems, too. Often, they fear change and the demands placed on them by instructors who do not always comprehend the anxieties felt in a new situation. These anxieties are compounded in adults who have experienced failure in school and who associate learning with unpleasant memories of unsympathetic teachers, tests, low grades, and punishments. Sometimes they have a low self-concept that causes them to shrink from exposing their ignorance to others and to dread further failure.

The physiological changes wrought by the aging process also may create difficulties for the pursuit of learning. These changes include deterioration of sight and hearing, loss of energy and strength, decline of memory, and a lengthening of reaction time. Clearly, not all adults age at the same rate or display the same characteristics as they age. Nevertheless, the changes, or the fear of changes, might create anxieties that interfere with learning. However, humans adapt when faced with new challenges. Adult learners’ high motivation often helps them forget their handicaps, especially they are excited about learning.

Andragogy and Culture

As individuals with our own experiences and culture, our development is based on unique circumstances. However, as individuals we share a bond as humans that transcend our differences. Therefore, expanding andragogical study to include culture is important because everyone is unique, bringing individual experiences to the classroom. From learning as a group to learning with a group, cultural aspects impact group dynamics as each individual learner varies.

Additionally, Jarvis (1987, p. 11) writes that “learning is not just a psychological process that happens in splendid isolation from the world in which the learner lives, but that it is intimately related to that world and affected by it.” Likewise, Tennant and Pogson (1995) highlight both psychological and social development and their relationship to adult learning. Their research also stresses that “the nature, timing, and processes of development will vary according to the experiences and opportunities of individuals and the circumstances in their lives” (Tennant & Pogson, 1995, p. 197).

Outside of North America there actually are two dominant viewpoints: “… one by which the theoretical framework of adult education is found in pedagogy or its branch, adult pedagogy …and the other by which the theoretical framework of adult education is found in andragogy … as a relatively independent science that includes a whole system of andragogic disciplines” (Savicevic, 1981, p. 88). Looking at Eastern culture’s way of learning provides insight into further andragogical issues. However, generalizations are dangerous, especially when trying to categorize cultures. For example, to refer to Eastern cultures as one type negates their individuality from region to region. Fundamentally, adult are adults throughout the world. No longer dependent upon their parents, adults provide food, clothing, and shelter for their own families.

With China being the world’s most populated country, it is worth considering how adults are educated there. Historically, the Chinese educational system based in Taoism, rooted in a legacy of questioning and independent thinking. However, it was after the open door policy following 1979, when more qualitative courses introduced, such as strategic management, marketing, human resource management, and management information systems. Interestingly, but expectedly, these patterns also coincided with the dominant ideologies of the day. While the Cultural Revolution, from 1966 to 1976, stressed Marxist and socialist ideas, Taylorism became popular after 1979, allowing for improving production efficiency without threatening socialist ideology, yet allowing for quick economic reform (Borgonjon & Vanhonacker, 1994). Traditional Chinese management education was thus
Andragogy and Technology

biased towards a quantitative approach, away from a people-oriented one, as observed by many Western scholars (for example, Borgonjon & Vanhonacker, 1992; Braine, 1996; Warner, 1992). (Jelen & Alon, 2005, p.129).

Andragogy and Today’s Technology

Currently, there are more than 1,000 educational institutions in the United States offering some type of distance learning programs (Lozada, 1997). Experts estimate that, by the year 2007, approximately 50% of learners enrolled in higher education courses will take courses through distance education (Kaucsc, 1994). To date, distance-learning programs are available at the university level allowing adults the opportunity to continue their education.

Knowles (1975) himself offered reasons for the evolving scholarship in the area of self-directed learning. One immediate reason was the emerging evidence that people who take initiative in educational activities seem to learn more and learn better than what resulted from more passive individuals. A second reason is that self-directed learning appears “more in tune with our natural process of psychological development” (1975, p. 14). Knowles observed that an essential aspect of the maturation process is the development of an ability to take increasing responsibility for life. Third is the observation that the many evolving educational innovations (nontraditional programs, Open University, weekend colleges, etc.) throughout the world require that learners assume a heavy responsibility and initiative in their own learning.

Knowles also suggested a more long-term reason in terms of individual and collective survival.

It is tragic that we have not learned how to learn without being taught, and it is probably more important than all of the immediate reasons put together. Alvin Toffler calls this reason “future shock.” The simple truth is that we are entering into a strange new world in which rapid change will be the only stable characteristic. (Knowles, 1975, p. 15)

Additionally, Merriam and Caffarella (1999) present a contextual perspective that considers two essential elements: the interactive nature of learning and the structural aspects of learning grounded in a sociological framework. Although the contextual perspective is not new to adult learning, it has resurfaced as an important consideration over the past decade (Merriam & Caffarella, 1999; Tennant & Pogson, 1995). It is the “interactive dimension” that Merriam and Caffarella (1999) share, which lends itself to the use of technology with adult learners. According to Merriam and Caffarella (1999), learning cannot be separated from the context in which the learning takes place. If the learner’s circumstances and context are relevant to the process of learning as what the “individual learner and/or instructor brings to that situation,” then the use of technology should be considered within the scope of this learning.

Heaney (1995) observes that “a narrow focus on individual—in the head images of learning—separates learning from its social contents, both the social relations which are reproduced in us and the transformative consequences of our learning on society” (p. 149). Rather, from Heaney’s perspective, “learning is an individual’s ongoing negotiation with communities of practice which ultimately gives definition to both self and that practice” (p. 148) may provide an interesting consideration for online virtual communities of practice, which aid adult students using modern technology.

As one can see, Internet-mediated distance education has the potential to revolutionize traditional models of education, learning, teaching, and sharing information. While cultural, linguistic, legal/governmental, and infrastructural differences still exist between countries, the present article shows how one may overcome these difficulties to create value for societies and educational institutions alike.

FUTURE TRENDS

As to future trends in andragogy, there are other ways andragogy could expand and refine. For example, the aspect of “maturity” should be considered at some future point. A shortcoming of the andragogy is evident when a 13-year old girl may be more mature and driven than a 40-year old man, thus, who is more “mature?”

Additionally, as China continues to look West to meet its educational need to increase the number of MBAs with online distance educational programs, it is worth noting, while we may consider [distance education] the paradigm ubiquitous in the West, it may not enjoy the same acceptance level elsewhere (Shive, 2000). A careful analysis of the antecedents and success factors of
Internet-mediated distance education to foreign students is paramount for the evaluation of this medium in the Chinese context. (Jelen & Alon, 2005, p.132)

Furthermore, what works in the West is not necessarily appropriate for the Asian countries. While most college faculty knows how to “chalk-and-talk,” the design and production of effective learning tools and activities in an online environment is a distinct skill. Teamwork between content specialists, curriculum designers, and online technicians from both cultures will be necessary, but can complicate the process and progress significantly (Shive, 2000). “While there is no magic solution to an endeavor of such ambitious magnitude, we advocate a multi-dimensional strategy that begins with partnership building as a distinct milestone long before content and delivery are considered” (Jelen & Alon, 2005, p.135).

Concerning future technology and andragogy, more research is necessary to question if the advances made in distance education are necessarily all good. As stated by Bullen (2002), “applying andragogy to distance education is difficult because distance education often involves the mass-production of course materials and andragogy implies a more individual and customized approach.” He also states that there are cost implications that could limit students who need to study from a distance, which could result in higher dropout rates.

However, Bullen also says that despite the problems and limitation, distance learning emphasizes the adult student’s needs, which makes it suitable for students who prefer to exercise more control over their learning. Its emphasis on the process of learning rather than content make it appropriate for courses that may not have clearly-defined content goals but in which cognitive and metacognitive skills might be the focus.

**CONCLUSION**

The essence of andragogy is based on the premise that adults learn differently than children. Although, Knowles’ definition and andragogical principles are still applicable, andragogy is continually refined through the expansion of its basic theory. Two additional perspectives for consideration are: cultural and technological. Many of the adult learner characteristics apply to the majority of adults; learning is influenced by cultural norms and values.

The second way andragogical study can expand is through the inclusion of today’s accessible technology. With more technology available, adult learners help themselves more readily. Innovations such as online schools, chat rooms, instant messenger (IM), MP3 players, interactive video conferencing, and Web cameras aid adult learners who typically juggle work, family, and school. Adult learners more easily continue their education, especially if they were once limited geographically and now participate in online classes. As educators become acclimated to the cultural and technological impact upon adults and their learning perhaps a more holistic approach will continue to evolve. By taking into account the nuances of an adult learner’s culture and how technology fosters increased educational opportunities, educators’ understanding of andragogy will be realized with individualized learning opportunities any day, anytime, from any location.

**REFERENCES**


Andragogy and Technology


KEY TERMS

**Adult Learner**: An individual whose major role in life is something other than full-time student (based on Arthur Chickering). See ed.fnal.gov/lincon/staff_adult.shtml

**Andragogy**: The art and science of helping adults learn premised on at least four crucial assumptions about the characteristics of adult learners that are different from the assumptions about child learners on which traditional pedagogy. See Smith, 1996, 1999). Andragogy, the encyclopaedia of informal education (see www.infed.org/lifelonglearning/b-andra.htm).

**Behaviorism**: A theory of animal and human learning that only focuses on objectively observable behaviors and discounts mental activities. Behavior theorists define learning as nothing more than the acquisition of new behavior. URL: www.funderstanding.com

**Chat Rooms**: A site on a computer network where online conversations are held in real time by a number of users (Dictionary.com)

**Cognitive**: The social cognition learning model asserts that culture is the prime determinant of individual development. Humans are the only species to
have created culture, and every human child develops in the context of a culture. Therefore, a child’s learning development is affected in ways large and small by the culture—including the culture of family environment—in which he or she is enmeshed (see www.funderstanding.com/vygotsky.cfm).

**Didactic Teaching Method:** Lectures, drill and practice, and worksheets that encourage students to memorize facts and procedures (see www.edletter.org/past/issues/2002-so/instruction.shtml).

**Differentiated Instruction:** To differentiate instruction is to recognize students varying background knowledge, readiness, language, preferences in learning, interests, and to react responsively. Differentiated instruction is a process to approach teaching and learning for students of differing abilities in the same class. The intent of differentiating instruction is to maximize each student’s growth and individual success by meeting each student where he or she is, and assist in the learning process (see www.cast.org/publications/ncac/ncac_diffinstruc.htm).

**Distance-Learning:** A type of education, typically college-level, where students work on their own at home or at the office and communicate with faculty and other students via e-mail, electronic forums, videoconferencing, chat rooms, bulletin boards, instant messaging, and other forms of computer-based communication. Most distance learning programs include a computer-based training (CBT) system and communications tools to produce a *virtual classroom*. Because the Internet and World Wide Web are accessible from virtually all computer platforms, they serve as the foundation for many distance learning systems (see http://www.webopedia.com/TERM/D/distance_learning.html).

**Humanist:** Engages with the whole person and with their experiences for learning that combines the logical and intuitive, the intellect and feelings; found a ready audience. “When we learn in that way,” Rogers said, “we are whole, utilizing all our masculine and feminine capacities.” URL: www.infed.org/biblio/learning-humanistic.htm

**Instant Messaging:** The act of instantly communicating between two or more people over a network such as the Internet (see en.wikipedia.org/wiki/Instant_messaging).

**Interactive Video Conferencing:** Videoconferencing is a live, two-way, interactive electronic means of communication. Two or more people in different geographic locations can engage in face-to-face audio and visual exchanges using cameras, monitors, and document software (see www.netc.org/digitalbridges/vc/).

**Mature Learner:** The adult learner who is a proactive and responsible person


**Online Schools (or cyber school):** Virtual learning resources, “online schools,” “Cyber School,” “net school,” or “virtual school” are often used interchangeably to refer to educational organizations that offer K-12 courses through the Internet or Web-based resources. Virtual schools and related forms of Web-based education have grown dramatically in recent years (Fulton, 2002). Cyberschool is an education program in which normal curriculum is taught in an online forum, instead of inside of a classroom. This program is currently available in some schools in Canada (see http://en.wikipedia.org/wiki/Cyberschool).

**Pedagogy:** Study of teaching methods, including the aims of education and the ways in which such goals may be achieved. The field relies heavily on educational psychology, or theories about the way in which learning takes place.. pedagogy (2006). In Encyclopedia Britannica. Retrieved June 15, 2006, from Encyclopedia Britannica Premium Service. URL: http://www.britannica.com/eb/article?tocId=9108621

**Self-Directed Learning:** An instructional process where a learner assumes primary responsibility for the learning process; and as a personality characteristic centering on a learner’s desire or preference for assuming responsibility for learning (see www.infed.org/archives/e-texts/hiemstra_self_direction.htm).

**Web Cameras:** A digital camera designed to take digital photographs and transmit them over the Internet (see www.wordreference.com/definition/webcam).
Anywhere, Anytime Learning Using Highly Mobile Devices

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INTRODUCTION

In a world that is increasingly mobile and connected, the nature of information resources is changing. The new information is networked, unlimited, fluid, multimodal, and overwhelming in quantity. Digital technologies, such as mobile phones, wireless handheld devices, and the Internet, provide access to a wide range of resources and tools, anywhere and anytime. This type of access and connectivity has also had an impact on how we collaborate on projects and share media and therefore, greatly increases opportunities to learn inside and outside institutionalized school systems. Learners now have the tools to take learning beyond classrooms and the school day.

The development of handheld devices can be traced back to Alan Kay’s vision of the Dynabook. As early as the 1970s, Kay envisioned a mobile, kid-friendly, notebook-sized computer with artificial-intelligence capabilities that would support children’s learning inside and outside of school. Similar ideas soon followed in the form of devices such as the Psion I (1984), the GRiDPaD (1988), Amstrad’s PenPad, and Tandy’s Zoomer (1993), the Apple Newton (1993-1995), and the eMate (1997-1998). During the 1990s and early 2000s, Palm developed a series of handheld devices that defined the handheld market in North America, while Microsoft developed several versions of its Windows Mobile software that could be found on mobile devices made by such companies as HP, Dell, and more recently, Fujitsu Siemens (Bayus, Jain, & Rao, 1997; HPC Factor, 2004; Williams, 2004).

There are also many devices whose primary function is entertainment or communication, including media players such as Apple iPods, portable gaming devices like the Sony PSP and the Nintendo DS, and, of course, mobile phones. These types of devices are becoming increasingly popular and multifunctional, with iPods being able to store and play music, pictures, and video; portable gaming devices sporting wireless capabilities for interaction between devices (and in the case of the PSP, Internet access); and mobile phones being used to shoot pictures and video, upload content to the Web or e-mail it elsewhere, do text messaging, and make phone calls. Whatever the device, convergence seems to be increasingly important, and growing numbers of young people are using these mobile, digital, and connected tools daily, whenever and wherever they need them, and this includes schools.

BACKGROUND

Mobile computing enthusiasts have advocated the use of highly mobile devices for teaching and learning to get closer to a ubiquitous computing environment, defined in 1991 by Mark Weiser as a setting in which “a new way of thinking about computers in the world … allows the computers themselves to vanish into the background” and become indistinguishable from everyday life (p. 94). Weiser emphasized that ubiquitous computing does not just mean portability, mobility, and instant connectivity, but also the existence of an environment in which people use many computing devices of varying sizes that interact with each other, combined with a change in human psychology, to the point where users have learned to use the technology well enough that they are no longer consciously aware of its presence and do not have to be. This version of ubiquitous computing has recently been revisited by
scholars such as Yvonne Rogers (2006), who proposes a modified version in which UbiComp technologies are designed not to do things for people but to engage them more actively in what they currently do (p. 418);

and Bell and Dourish (2007), who argue that ubiquitous computing is characterized by power-geometries (the ways in which spatial arrangements, access, and mobility reflect hierarchies of power and control); heterogeneity (as opposed to standardization and consistency in technology, use, and regulation); and management of ubiquitous computing that is messy.

Weiser’s somewhat revised vision of ubiquitous computing fits well with current visions of technology integration in education and its potential impact on teaching and learning. Academic research has shown that computer use and student learning gains are “closely associated with having computers accessible to all students in teachers’ own classrooms” (Becker, Ravitz, & Wong, 1999; see also Shin, Norris, & Soloway, 2007). Highly mobile devices provide a solution because of their small size and comparatively low cost in acquisition and ownership (Norris & Soloway, 2004; Sharples, 2000a), and they supplement the existing technology infrastructure. Some scholars have defined the resulting learning environment as “handheld-centric,” “providing all students with access to valuable resources on a shared but timely basis,” where each tool has been earmarked for its intended use (Norris & Soloway, 2004; Tatar, Roschelle, Vahey, & Penuel, 2003). Another group of scholars is looking at learning with highly mobile devices from a broader perspective. They have coined the term m-learning, “the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies” (Sharples, Taylor, & Vavoula, 2007).

Highly mobile devices are also altering the nature of technology integration in teaching and learning, and can act as catalysts for radical changes in pedagogical practices (Fung, Hennessy, & O’Shea, 1998). Their fundamental difference from more traditional desktop computing environments lies in the fact that users “interacting with a mobile system interact with other users [and] interact with more than one computer or device at the same time” (Roth, 2002, p. 282; see also Cole & Stanton, 2003). Consequently, highly mobile devices lend themselves well for both individual and collaborative learning, if used appropriately. Roschelle and Pea (2002), for example, highlight three ways mobile devices have been used to enhance collaborative learning—classroom response systems, participatory simulations, and collaborative data gathering—and suggest there are many more uses (see also Roschelle, 2003).

Moreover, because of their small size, portability, and connectivity, highly mobile devices do not constrain users like desktops and laptops do. As such, they encourage learners to use technology across the curriculum and in everyday activities, and embrace it as a lifelong-learning tool to be used anywhere and anytime (Inkpen, 2001; Sharples, 2000b), eventually leading to the type of ubiquitous computing that Weiser envisioned and Rogers, and Bell and Dourish advocate.

### Teaching and Learning with Mobile Devices

Highly mobile devices possess certain characteristics that allow for frequent and immediate access to a variety of tools and information sources for teachers and students, and their use in classrooms and other learning environments is bringing about many changes. However, it is important to understand that simply putting more digital tools in schools is not the solution to making technology use for teaching and learning meaningful and effective. Rather, teaching, learning, and technology need to be reconceptualized before the full educational possibilities inherent in small, versatile, and mobile digital technologies can be realized.

In The Educators Manifesto (1999), McClintock proposes that digital technologies change what is pedagogically possible. To take advantage of these possibilities, teaching must be continuously redefined within the changing context that new tools such as handheld computers create. Teaching should be reconceptualized as “conducting learning,” thereby putting more responsibility for learning on the learner. Second, teaching must no longer be thought of as restricted by the spatial and temporal boundaries that current educational systems impose. Third, the content and focus of teaching must be redefined to meet the needs of the 21st century world (Swan, Kratcoski, & van ‘t Hooft, 2007).

If teaching is to be reconceptualized to take full advantage of mobile tools, so should learning. As digital
tools are becoming increasingly mobile, connected, and personal, they have the potential to make learning student-centered, and can support both individual and social construction of knowledge. In particular, students need to be given more responsibility for their own learning. Four areas in which learning should be redefined as more student-centered are engagement and motivation, individualization and choice, collaboration and peer learning, and learning for all students (Swan et al., 2006).

Mobile technology has the potential to have a substantial and positive impact on teaching and learning. Merely introducing the tools in the classroom will not suffice; it is even more important that educators think about how teaching and learning need to change in order to take full advantage of the good things that digital technology has to offer for students and teachers alike.

The first step in rethinking teaching and learning within a context that includes the latest digital tools is simple, yet radical. Educators need to embrace the technology and learn about the ways in which younger generations are using it. Current students live in a world that is connected 24/7 and high tech, with an overwhelming amount of communication devices and information channels. Within this context, digital tools are increasingly personal, mobile, networked, social, accessible, flexible, multimodal, and contextual (see e.g. Roush 2005, Thornburg, 2006; van ’t Hooft & Vahey, 2007).

Second, we need to rethink the role of technology in schools and the fundamental impact this changing role is going to have on teaching and learning. Too often, we look at technology as being integrated in the existing curriculum, which entails doing the same things we were doing, and using technology as an add-on. Indeed, we probably need to stop thinking about technology integration altogether, but instead see technology as an agent of transformation that will enable us to do new things in new ways. As stated above, for example, mobile technology has the potential to break through the temporal barriers of the school day and the brick and mortar of school walls, making learning an authentic and relevant aspect of everyday life, and not just schooling (Alexander, 2004; Breck, 2006).

Third, fundamental changes in teaching and learning as brought about by pervasive digital tools require that teachers carefully reexamine how they view and use technology, and how this impacts their teaching philosophy, curriculum, and practices. This type of examination is not going to take place overnight. It takes time and effort. It takes motivation and engagement, individualization and choice, collaboration, and a group effort by all. In the end, it may, and probably will, require fundamental changes in the ways in which we teach our children.

Fourth, there are always the technical and logistic issues to be overcome. These include more traditional issues related to networking, compatibility, security, maintenance, and training, as well as new problems created by new technologies, such as copyright infringement, violation of privacy, and cyberbullying.

Fifth, while highly mobile devices provide affordances that many other technologies cannot, there are always limitations on their use. Therefore, it is essential that teachers (and) students consider when it is appropriate to use a mobile tool for purposes of learning and when it is not. Whatever the choice of tool, it should not get in the way of learning. For example, it would be unwise to try to do extended video editing or high-end graphics design on a mobile device.

Finally, we cannot overlook the most important partner in all of this, the students. Current generations of students prefer quick and easy access; communication and networking; digital, hyperlinked, and multimedia content; and just-in-time learning that is relevant and useful. In addition, in a digital and connected world, learners are mobile; active, communicative, and resourceful; and construct context through interaction (Alexander, 2004; Roush, 2005; Sharples, 2005). How will they be affected by fundamental changes in teaching and technology use for formal and informal learning?

**FUTURE TRENDS**

Various pilot and research projects have attempted and are attempting to bring about changes in teaching and learning by introducing highly mobile devices. In classroom settings, a large-scale implementation of handheld computers has investigated what happens to teaching and learning when many devices are introduced in formal educational settings (Vahey & Crawford, 2002). Other examples include Room-Quake, which used handheld devices and a variety of artifacts to simulate earthquakes; and the application of handheld computers in combination with scientific
Anywhere, Anytime Learning Using Highly Mobile Devices

probes. In informal environments, we have seen mixed reality games that combine the real world with virtual environments (often through the use of digital overlays or location-based resources) to enable users to experience and reflect on both. Examples of such projects include Environmental Detectives (explore imaginary scientific problems or environmental disasters using Pocket PCs and GPS in a real setting), Frequency 1550 (using cell phones and GPS to learn collaboratively about the history of Amsterdam), and MobiMissions (a game in which players create missions for others and can choose which missions to take on). Most of the initiatives listed here are described in greater detail by Rogers and Price (2007).

However, as admirable as these projects are, the real work needs to be done in bridging the gap between learning in formal and informal settings. This could consist of the use of highly mobile devices to augment field trip experience and, at the same time, provide students with resources for learning, upon return to the classroom, in the form of digital data collected during the field trip. An early example of such a project is Ambient Wood, an attempt to digitally augment a woodland habitat. A more recent example is MyArtSpace, in which students choose which data to collect and store during a museum visit, for later use in the classroom (Vavoula, Sharples, Lonsdale, Rudman, & Meek, 2007), but these types of examples are still few and far between.

Research can be helpful here. Future inquiries in the area of wireless mobile learning devices should be focused on how this technology is changing interactions between learners, digital content, and technology, and how education will need to adapt to a world that is increasingly mobile and connected (van ‘t Hooft & Swan, 2007). Other questions of interest include: How can we create the best possible tools for learning without the technology getting in the way? How can mobile technologies best accommodate and support active and collaborative learning? How does context affect learning, especially when it constantly changes?

Finally, the current dearth of large-scale implementations of highly mobile devices can be blamed on a variety of reasons. For one, educational institutions usually do not have the resources to provide every student with a digital tool. Second, they haven’t figured out yet how to take advantage of the mobile devices that many students already own or have access to. In fact, in many instances, it is not only inability, but also unwillingness on the part of the “traditional” education sectors to perceive these same devices that are an integral part of the everyday life of a young learner as a viable platform.

As a result, schools are banning devices such as mobile phones, when they could be used as mixed-media creators and communicators, and are instead trying to hold on to a computing model based on desktops and laptops that is slowly coming to its demise. Ultimately, the plethora of mobile devices and the manner in which they are embedded in the lives of young learners will raise the question, “Who supplies education?”

CONCLUSION

Younger generations are not fazed by constant change. They are growing up in societies that are in constant flux, where access to information is overwhelming, and technology is mobile, connected, and constant; they do not know a world without it. They know how to use the hardware and software, and are not afraid to learn to use new tools. However, they need guidance in learning how to use digital tools in ways that are meaningful, productive, responsible, and safe. In order for this to happen, teaching and learning in educational institutions will have to change to accommodate the use of highly mobile devices anytime and anywhere. Only then will students gain the knowledge, skills, and attitudes that are needed to be successful in the 21st century world.

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Anywhere, Anytime Learning Using Highly Mobile Devices


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**KEY TERMS**

Bluetooth: An industrial specification for wireless personal area networks (PANs). Bluetooth allows devices to connect and exchange information over a secure, globally unlicensed short-range radio frequency.

GPS: Global positioning system. It consists of a receiver that uses three or more GPS satellites to calculate its location.

**Highly Mobile Devices:** Digital devices that have high mobility, a small footprint, computational and display capabilities to view, collect, or otherwise use representations and/or large amounts of data; and the ability to support collaboration and/or data sharing. Devices include PDAs, mobile phones, some tablet computers, networked graphing calculators, UMPCs, the new generation of handheld gaming systems, iPods, motes, and data loggers.

**Informal Learning:** Learning in which both goals and processes of learning are defined by the learner, and where the learning is situated rather than preestablished.

**M-Learning:** “The processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies” (Sharples, Taylor, & Vavoula, 2007).

**Mobile Phone:** A portable electronic device for personal telecommunications over long distances, often supplemented by features such as instant messaging, Internet and e-mail access, global positioning (GPS), and a digital camera. Most mobile phones connect to a cellular network.

**PDA:** Personal digital assistant. A handheld computing device that is characterized by a touch screen, a memory card slot and Infrared, Wi-Fi, and/or Bluetooth for connectivity. Data can be synchronized between PDAs and desktop or laptop computers.

**UMPC:** Ultra mobile personal computer. A small form-factor tablet PC (larger than a PDA but smaller than a tablet PC) that features a touch screen no larger than 7 inches, flexible navigation and input options, and WiFi connectivity.

WiFi: Short for “wireless fidelity” and a popular term for a high-frequency wireless local area network (WLAN), using the 802.11 protocol.
APEC Cyber Academy: An International Networked Learning Environment

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**INTRODUCTION**

Web-based learning environments have become an integral part of both traditional face-to-face and online education (Bonk & Graham, 2006; Moore, 2005). Over the past decade, the boom of online learning has contributed to the creation of course management systems that are designed to provide better accessibility to students. Many of the systems claim to support pedagogical visions with good human-computer interfaces (HCI) that encourage peer collaboration, knowledge construction, mentoring, and community building, using such basic tools as content management, course delivery, discussion boards, and assessment modules. The functionalities of a Web-based learning environment can either dictate or extend the instructional activities that a teacher can apply in the classroom.

Most systems are primarily designed for college or adult learners, and only manage syllabi and instructional content. However, increasing numbers of students at primary and secondary levels are going online for at least some of their learning needs. In the U.S., for example, K-12 enrollment in online courses has risen from approximately 50,000 in 2001 to 700,000 during the 2005-2006 school year (Picciano & Seaman, 2007). Online participation seems especially strong in districts that are small or physically more isolated than others, as the Internet provides access to learning choices and resources not available otherwise.

**BACKGROUND**

Online learning comes in a wide variety of shapes and sizes. It can be completely online or blended; it can be synchronous or asynchronous, or a combination of both; it can be collaborative or independent (Garrison & Anderson, 2003; Turoff, 2005). The key to both learning and computer mediation is the “notion of interaction,” that is, interaction with content, interaction with instructors, and interaction among learners. Interaction with content refers to how learners interact with the course materials and the concepts and ideas these materials represent. Interaction with instructors includes the ways in which instructors teach, guide, correct, and support their students. Interactions among learners can be formal or informal and take on many forms, such as debate, collaboration, discussion, and peer review. All modes of interaction support learning and each can be uniquely enacted in online learning environments (Moore, 1989; Swan, 2003). In addition, the three modes of interaction depend on each other in practice, whether in face-to-face or online environments (Rourke, Anderson, Garrison, & Archer, 2001).

Hillman, Willis, and Gunawardena (1994) propose that new technologies create a fourth type of interaction, at least temporarily. This interaction takes place between learner and HCI, that is, the specific technologies, platforms, and applications used to access learning tools and resources. The quality of the interface thus affords or constrains the quality and quantity of the other three interactions (Gibson, 1996). A good HCI is especially important when working with children in primary and secondary schools if it is to encourage peer collaboration, knowledge construction, mentor-
APEC Cyber Academy

INTERNATIONAL NETWORKED LEARNING: APEC CYBER ACADEMY

APEC Cyber Academy, a networked learning environment, was originally designed for K-12 students of APEC (Asia-Pacific Economic Cooperation) member economies, and was developed to address the specific characteristics in pedagogy and HCI that are essential for supporting international collaboration among primary and secondary school learners. The original intent was to provide a place for students and teachers to communicate, share, and engage in virtual learning experiences in an international context. Launched in 2002, the project is hosted by the APEC Digital Content Production Center currently under the auspices of APEC/EDNET and the Ministry of Education of Taiwan. With its emphasis on active learning and creative digital content, the APEC Cyber Academy has attracted a growing number of international users. As of January 2007, there were more than 14,000 registered learners from various countries around the world (Lin, Chou, & Bagley, 2007).

Theoretical Foundations

The APEC Cyber Academy is founded on Vygotski’s (1978) constructivist and Bandura’s (1977, 1997) self-regulated learning theories. The two theories complement each other well in fostering learner-centered learning. While Vygotskian constructivism emphasizes knowledge is co-constructed with peers or experts and through immersion in a social context, self-regulated learning places a strong emphasis on cultivating an individual learner’s ability to be an autonomous learner. As such, the APEC Cyber Academy serves as a venue for implementing innovative pedagogy that promotes motivation, creative thinking, critical thinking, and collaborative learning as outlined by Bonk and Reynolds (1997).

The main goal of the APEC Cyber Academy is to create an international learning environment for K-12 students to interact and collaborate on projects following the principles of social constructivism as well as self-regulated learning. The main objectives are: (1) providing a networked learning environment that follows the design principles of HCI to facilitate interaction for learning; (2) utilizing state-of-the-art technology to assist learning and assessment; (3) applying the pedagogical principles of collaborative learning into the design of online activities; (4) fostering international friendship among K-12 learners through online collaboration and computer-mediated communication; and (5) improving ICT (information and communication technology) skills through project-based learning.

Application of HCI Principles

A good HCI helps to reduce anxiety and fear of computer usage, assists with smooth introductions for novice users, provides direct manipulation of objects, offers input devices and online assistance, and allows for information exploration through easy navigation (Markopoulos & Bekker, 2003; Schneiderman, 1998). As mentioned, abundant guidelines have been written on what constitutes a good interface for computer-based training and learning. Dunham and Sindhvad (2003) summarized usability studies on children’s behavior and concluded the following HCI elements are most important in the design of a child-centered learning environment:
1. **Animation**: Children are attracted to animation and tend to click on it when available (Bernard, 2003). Gilutz and Nielsen (2003) found that the appropriate use of sound and animation can help children to stay focused on a Web site;

2. **Geographic navigation metaphors and minesweeping**: Children prefer visual metaphors of geographic representations, such as rooms, villages, 3-D maps, or other simulations of real environments. They are willing to engage in minesweeping, such as scrubbing the screen with a mouse to find clickable items or to enjoy a sound effect;

3. **Reading online**: Children are willing to read instructions before starting an activity as long as the instructions are kept brief and simple. Children usually do not scroll pages to look for information;

4. **Icons as recognizable symbols**: Children between 8 and 12 prefer icons that represent symbols or languages that they are familiar with from their real environments;

5. **Advertisements**: Children will click on advertisements and think that they are part of the content.

APEC Cyber Academy’s learning environment follows many of the usability guidelines for young learners. Animations are used where appropriate (e.g., navigation buttons), graphic representations are child friendly, and universal symbols are used consistently. One of the main activities utilizes the metaphors of camping, and provides a number of scavenger hunt games for collaborative problem solving, story telling, and media sharing. Instructions are kept short and to the point. All content and navigation buttons are accessible within the length of one screen (800 X 600 resolution), and there is no advertising on the site.

**Collaborative and Project-Based Learning**

The platform includes a lobby, playground, lecture hall, learning space with project-based learning programs, and several communication channels. The main component is the learning space, in which the Networked Collaborative Learning Program and ICT Cyber Camp are located. Various modules within these two programs encourage learners to interact; collaborate on projects; and create, upload, and share a variety of artifacts such as stories and videos. In addition, APEC Cyber Academy provides many students with opportunities for second-language acquisition; while the working language of the platform is English, the majority of students are from Southeast Asia with a native language other than English. Learners can practice their language skills by way of specially created modules, such as the Magic House in the ICT Cyber Camp, or the creation of digital media that is shared online.

**Interaction and Feedback**

All modules are built to fully support learner-computer interaction, learner-learner interaction, learner-teacher interaction, and learner-content interaction. Learners can find ample online and human support throughout the learning process by way of discussion boards, e-mail, real-time text and video chat with peers and teachers, and artifact showcases. Two types of online tutors are available: one being human tutors who maintain discussion boards and interact with students by way of the integrated synchronous and asynchronous communications channels, the other being an online intelligent agent named WuKong.

Assessment of learning is ongoing and takes place in a variety of ways. Students are encouraged to evaluate each other’s work in constructive ways using online feedback tools. In addition, experts are invited to assess the quality of student participation and artifacts. Finally, interpersonal communication is evaluated using a built-in tracking system. Building up a versatile international learning community is one of the primary goals of **APEC Cyber Academy**. Therefore, participants of the camp are strongly encouraged to interact with their peers, especially with those who are in different teams or from different countries, by using forum and communication tools in the camp. A built-in tracking system is utilized to automatically aggregate the frequency of interpersonal communication for each team.

**FUTURE TRENDS**

Internet technologies have developed at unprecedented rates in recent years, and they will continue to do so. Many of the currently available Web 2.0 tools allow for collaborative knowledge creation (e.g., wikis), social networking (e.g., MySpace), open reflection and
discussion (e.g., blogs), media creation and manipulation (e.g., Jumpcut, Fauxto, Piknic), and media sharing (e.g., YouTube, Uth TV, Flickr, BubbleShare). As these activities are Web based, they have the potential to reach a global audience.

Many of the students we teach today are fluidly accessing digital, networked, information wherever and whenever the need arises (and this includes learning needs). They simply do not know a world without it. However, just like actions have consequences in real life, so do they in cyberspace, and this is an aspect of being online that children often forget or are unaware of. Therefore, it is essential that students at younger ages have access to safe, virtual environments that provide opportunities for learning about and practicing safe, responsible, and ethical online behavior. For example, students need to learn how to use communication channels, such as discussion boards, for their intended purposes, which include posting appropriate material in the appropriate location, as well as replying to other participants’ posts when called for. This is an area in which much work remains to be done, both in terms of developing suitable and useful learning environments and resources, as well as academic research.

Second, as stated, online learning can easily range from local to global levels, and anything in between. Consequently, it is imperative that in online learning activities, such as the APEC Cyber Academy, that involve cross-cultural communication and collaboration, opportunities are provided for participants to learn about and come to appreciate cultural similarities and differences. In addition, online instructors/facilitators need to be aware of cultural differences in the learners’ online behaviors, taking them into account to foster online collaboration among culturally diverse learners (Kim & Bonk, 2002).

A third and related issue is that of peer assessment. Feedback on student artifacts is extremely important, and can be very powerful when it is constructive and timely, as it allows students to not only evaluate what their peers create and share, but also reexamine their own work within a much more tangible context. Even young students can learn to do this well. Again though, cultural differences with regards to providing and receiving feedback need to be taken into account. In addition, the development of useable and solid assessment tools is essential here.

Finally, even though students are communicating and collaborating at a global level, they need support. In many cases, online facilitators or instructors are not adequate, and local, face-to-face guidance is needed. It is because of this need that teacher preparation is crucial, that is, teachers need to learn ahead of time what learning materials are offered (and how they may fit in with existing local curricula and standards), who is participating, what students are expected to do, what communication and support channels are available for students and teachers, and how assessment of learning will be done. In addition, teachers should be able to provide suggestions for improving existing materials and resources.

**CONCLUSION**

Online learning has seen explosive growth in higher education over the past decade. It is only reasonable to expect that a similar trend will occur in primary and secondary education. The APEC Cyber Academy is a good example of how networked learning environments that follow pedagogical principles and HCI guidelines can encourage students to develop 21st century skills such as the use of ICT to gather, organize, validate, and communicate information to solve problems, and communicate and collaborate with others on levels ranging from local to global. By participating in learning that is characterized as such, students can and will develop an understanding of what it means to use ICT in safe, ethical, and meaningful ways, and develop the means to become responsible, digital, and global citizens.

**REFERENCES**


APEC Cyber Academy


KEY TERMS

Asynchronous Learning: Allows the sequence of interaction between the teacher and the student to happen at different times. Examples of asynchronous tools include e-mail and discussion boards.

Blended Learning: Learning that combines face-to-face instruction with computer-mediated learning.

Cyber Academy: A Web-based learning environment for elementary and junior high students to enjoy learning constructively in an authentic collaborative manner.

Human-Computer Interface (HCI): The interface used by humans to access a computer system. A common HCI is the operating system.

Information and Communication Technology (ICT): Phrase used to describe a range of technologies for gathering, storing, retrieving, processing, analyzing, and transmitting information.

Online Learning: Course where most or all of the content is delivered online, with at least 80% of seat time being replaced by online activity.

Synchronous Learning: Takes place when instructors and learners are present at the same time in a real virtual-learning space, allowing for real-time interaction such as through instant messaging.

Web 2.0: A perceived second generation of Web-based services that emphasize online collaboration and sharing among users.
Applying Critical Thinking Skills on the World Wide Web

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INTRODUCTION

Like a phoenix rising from the ashes, every decade brings a renewed call for the importance of teaching critical thinking. Across the disciplines the importance of the subject is universally recognized, an interesting phenomenon since there is no common definition of critical thinking. To a scientist, critical thinking is often equated with the scientific method. To a philosopher, critical thinking implies a logical analysis of an argument and the ability to develop abstractions. To an engineer, critical thinking refers to effective problem-solving skills.

All of these definitions have common elements. In each approach, a problem or concept is identified and a rational approach to the problem or case is applied. Critical thinking requires an analysis of the validity of an argument as well as the ability to anticipate potential consequences. It is analysis justifying the acceptance of an idea and determines a direction for action. Critical thinking skills are situational and are difficult skills to master since there is no mental template that is true for all cases.

As access to information expands, it is important that computer users develop the skills to critically assess the value of the information that is presented to them. This is a basic skill for effective Internet citizenship and a foundational skill for critical thinking. The ability to identify a central concept or problem and to assess the validity of supporting information in an argument is particularly important in a media that has no gatekeepers to vet the quality of the information presented.

BACKGROUND

Critical thinking has been described as a productive and positive activity. It is a process rather than an outcome and is dependent upon the subject area in which it is applied. Although critical thinking is traditionally thought of as a dispassionate process, there are subjective elements within the thinking process that can add meaning to the interpretation of events.

Modern approaches to critical thinking are founded in pragmatic approaches largely developed by Charles Sanders Peirce, William James, and John Dewey in the United States during the 1800s. In 1878, Peirce wrote an essay titled “How to Make our Ideas Clear” that established the philosophical foundation of pragmatism (Peirce, 1878). He described thought as a result of the “irritation of doubt,” and believed that thought ended in the formation of beliefs. When two beliefs produce the same result, they are equivalent beliefs. This concept allows for the simplification of problems by focusing on the primary cause of the problem rather than a secondary problem.

This idea can be illustrated by a simple example. Suppose you have lost the remote control for your television. Your television will not work at all without it. Your spouse believes that it is lost in the living room. You believe that it is lost in the kitchen. After an extensive search, neither one of you finds the remote control yet both of you are certain that you are correct. This certainty has two effects: it prevents you from looking in the bedroom where the remote control is conveniently located in the laundry basket and it prevents you from recognizing that if the remote is really truly lost, questions such as “Where was it lost?” “Who lost it?” and “Who ran it through the washer?” do not matter. The problem is not that the remote control is lost but that you now have a nonworking television. This is the problem that you need to solve rather than continuing to look for the remote control.

In order to break a mental impasse, examine the results. If the remote control is lost, the television will not work. If the remote control has been washed and dried, it will not work and since the remote control is needed to operate the television, the television will not work. The outcome is the same: a nonworking televisi-
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Both beliefs have the same outcome so they are equivalent beliefs. The problem then is not what action to take about the remote control but rather the problem is what action to take about the television.

William James expanded on the work of Peirce and examined how ideas become accepted through experience (James, 1907). James wrote that it is very difficult for new beliefs to replace older beliefs as long as the older beliefs are perceived as true by an individual. The initial response when presented with information that cannot be fully reconciled with an existing worldview is to try to modify the old ontology to accept enough new information to allow the old belief to function in the adjusted reality. Only when this is not possible will a new belief replace an older one. James wrote:

A new opinion counts as ‘true’ just in proportion as it gratifies the individual’s desire to assimilate the novel in his experience to his beliefs in stock. It must both lean on old truth and grasp new fact . . . When old truth grows, then, by new truth’s addition, it is for subjective reasons (James, 1904, ¶ 29).

James recognized that even the most logical systems of thought have subjective underpinnings. John Dewey believed that active manipulation of the environment was an important part of developing knowledge. He proposed a modification of the scientific method to describe this process of knowledge acquisition which he calls the process of inquiry. The process of inquiry has four stages: habitual solutions to the environment are recognized to be no longer effective, information is gathered related to the problem, reflection on the information results in possible solutions, which are tested, and successful solutions are integrated into everyday life (Dewey, 1938).

According to pragmatists, critical thinking is triggered by positive as well as negative events. The motivation to acquire new knowledge is often a response to a perceived problem. For many routine tasks, individuals depend upon scripts or mental schemes to address these problems (Schank, 1990). In such cases, there is no motivation to adopt a new mode of thinking as long as the original process is still effective. It is the need to solve a current problem that motivates individuals to seek solutions.

Initially all individuals are reluctant to give up old concepts in favor of new ideas, so much so that the initial impulse is to modify the original concept to make it fit a new circumstance. Failing this, individuals tend to adopt only as much of the new concept or method as is needed to effectively address the problem. Rarely will individuals wholly abandon a previously successful methodology in favor of a new approach to a problem. Modification of the existing method to accommodate the new circumstance or information is the preferred course of action.

This pattern explains why it is so difficult to restructure Internet resources in nonlinear frameworks. Although the technology exists to create environments that can be accessed in multiple ways, the majority of Internet documents are based on the same structural framework as a printed document. These electronic versions of paper documents succeed because the format is familiar to the user. The problem that the Internet effectively addresses is an accessibility problem. In general it does not address innovations in content presentations since the majority of users prefer formats that allow users to obtain printed copies if desired. The much heralded paperless revolution has never taken place because such an innovation does not solve a perceived problem for the majority of users.

This process has been reconceptualized as phases or stages by multiple writers. Broomfield (1987) describes the phases of critical thinking as five stages. A trigger event motivates the need for change and a review of the perceived problem. The initial approach to the problem commonly begins with denial of the importance of the needed change and then moves to clarify the nature of the problem. Once the problem has been clearly identified, attempts are made to identify new approaches and to blend those approaches into previously used methods. If this fails, a new approach will be developed and adopted. This new approach becomes a permanent part of a thinking pattern only as long as it continues to support the need for which it was developed. Once it fails to meet this need, the cycle will begin again and the individual will seek out alternate solutions to the problem.

Paul and Elder (1996) identify seven universal standards to develop critical thinking skills: clarity, accuracy, precision, relevance, depth, breadth, and logic that could be used by teachers to assess student learning.

1. Clarity of a resource refers to how well the writer communicated a central idea.
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2. Accuracy refers to the degree of truth in a statement.
3. Precision describes details in a claim or statement of fact that strengthen the validity of that statement.
4. Relevance is a judgment of the effectiveness of the information at buttressing the main idea of the paper.
5. Depth examines the complexity of the presentation of the idea.
6. Breadth measures the inclusion of alternate points of view in the resource.
7. Logic refers to the structure of the argument and the effectiveness of the whole presentation.

Facione (2006) defines his conception of critical thinking using the IDEALS acronym that included six steps defined by series of questions.

- **Identify the problem**—“What’s the real question we’re facing here?”
- **Define the context**—“What are the facts and circumstances that frame this problem?”
- **Enumerate choices**—“What are our most plausible three or four options?”
- **Analyze options**—“What is our best course of action, all things considered?”
- **List reasons explicitly**—“Let’s be clear: Why we are making this particular choice?”
- **Self-correct**—“Okay, let’s look at it again. What did we miss?”

(Facione, 2006, p. 22)

As can be seen from this brief literature review, in nearly every variation of critical thinking methods, there are four basic steps:

1. A need is perceived.
2. Information on possible solutions is collected to meet that need.
3. The quality of information and proposed solutions are assessed in terms of relevance to the need.
4. If successful, the new solution will replace the old. If the solution is unsuccessful, the process will repeat until a successful solution has been identified.

**APPLICATIONS**

Two activities related to the Internet that are particularly promising for the development of critical thinking skills are the assessment of text-based resources and the development of Web-based scenario problems. The Internet is an information rich environment and the effective retrieval and assessment of accurate information is an essential part of the problem-solving process. Learning to accurately assess the quality of text-based resources available on the Internet is an important transference skill from traditional print media. The interactivity of the Internet allows for the development of nonlinear experiences that model crisis points and problem situations that individuals might encounter in reality. Such simulations allow individuals to test out potential solutions in a controlled environment.

**Assessing Text-Based Resources**

Although the Internet represents a significantly different delivery method for text-based media than paper delivery, individuals do not modify the way they act on the information based on the delivery method (Hoffman, 2006). Many print publications essentially are repackaging their print publications for Web-based delivery without significant changes in the content, a practice known as shovelware (Cyi, 2000). Since electronic media effectively duplicates print media, techniques used to analyze the content of printed text transfer to critical content reviews of much text-based media that is delivered electronically.

Since the Internet is primarily a text-based media, a needed skill is the ability to read effectively. Adler and Van Doren (1972) divided reading into stages such as prereading, superficial reading, and active reading. The first two categories are likely the levels at which most readers encounter text-based media. These levels involve a quick review of the general content of the document which in many cases, leads the reader to a quick decision regarding the relevance of the material for the reader’s purpose. Only documents that are useful for the reader’s purpose will be read more carefully. Active reading is reading at a more critical level to determine exactly what is being said, if the ideas are important, and how the main idea is being supported. At
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At this level, reading becomes an internal dialogue between the author and the reader, with the reader questioning the information presented by the author.

Potential of Electronic Text

Electronic text has been found to affect reading comprehension in young children (Matthew, 1997). Since effective reading requires repeated reviews of the content, electronic texts could encourage critical thinking by enticing readers to review the text through the use of interactive features. Matthew (1997) notes that this could be a negative feature of electronic text as well as a strength if the interactive features shift the learner focus from the text to the game-like qualities of the electronic format. Although the readability of online electronic text is an important concern, Muter and Mauruto (1991) found no significant difference between the reading comprehension scores of adults who read electronic text when compared to adults who read the same text in printed format.

Although comprehension appears to be comparable between electronic and print formats, how individuals chose to use these formats is different. Even among technologically proficient individuals the majority of students who are required to read electronic texts prefer to print the documents rather than read them online even when these documents were very large (Longhurst, 2003; Robertson, 2006). For some groups, reading online is not even considered to be true reading. In an examination of cultural concepts of reading, Anderson and Gunderson (2001) describe that Internet reading was not considered to be serious reading among immigrant families. It is difficult to determine how effective reading electronic text is at encouraging critical thinking. Electronic formats are visually appealing and the use of hypertext links may encourage a more superficial reading of the text (Walsh, Asha, & Sprainger, 2007).

Traditionally, knowledge acquisition has been conceptualized as a hierarchical and linear process. The development of hyperlinks frees electronic texts from the constraints imposed by print media and provides a method for the creation of nonlinear models. The development of nonlinear information resources is proving to be difficult. Robertson (2006), in an examination of online history sources, found that many nonlinear sites lack a structure that allows for associative thinking. Robertson noted that it is common for these resources to follow a sequential or hierarchical format. The creation of new structures that fully support the discovery of conceptual relationships outside a predetermined process will require the extensive use of hyperlinks allowing users to discover these relationships from multiple starting points and connecting points in the information gathering process. Granic and Lamey (2000) propose that as participants adjust to a virtual world, critical thinking skills will become essential as linear and hierarchical mental frameworks are replaced by subjective, multiple perspective frameworks that are not based on any formal authority system. In such a cognitive system, critical thinking skills will be increasingly important as more traditional filters of information break down. The freedom that the Internet offers to develop individual perspectives of knowing will require a new level of responsibility to justify those perspectives.

Web-Based Scenario Problems

As the Internet environment develops in sophistication beyond the simple duplication of print resources, multiple techniques are emerging that take advantage of the nonlinear formats that can be created on the World Wide Web. The use of hyperlinks allows for information to be explored in nonsequential ways and makes it possible to develop environments and activities specifically designed to enhance critical thinking skills. One of these methods is the Web-based scenario problem.

Stewart and Bartrum (2002) describe the basic steps needed to develop effective scenario problems. First, an appropriate scenario problem must be selected. Scenario problems must be open ended with multiple possible solutions and the solution of the problem should require a judgment by the individual engaged in the scenario. Second, the complexity of the problem needs to be determined and limited to bound the scope of the problem. Since scenarios are open-ended problems they can easily be expanded by adding more decision points and consequences. Third, misleading or false information should be included in the problem to develop content assessment skills. The final three stages are refinements to the problem and include the enhancement of the scenario through the addition of graphical images, unexpected events to be built into the problem to hold the interest of the user, and an opportunity for the user to review and summarize the consequences of each decision.
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Scenario problems are particularly effective at developing problem definition skills and exploring alternative solutions and consequences. Scenarios are usually developed around a narrative in which the user must make decisions that will have consequences within this narrative and are an effective way to simulate workplace situations (Juneau, 2006). Scenarios have been used to develop problem solving skills in a wide variety of fields including political ethics (Wielhouwer, 2004), health occupations (Camp, 1996), emergency management (Glowacki, Unger, Fries, & Kwitowski, 2005), and residential construction (National Association of Home Builders, 2005).

FUTURE ISSUES AND CONSIDERATIONS

As technology advances the process of critical thinking may change. Gallaopoulos (1994) foresees that as computer software and hardware advances, some aspects of problem-solving will be performed by computer programs that interact with people on human terms. These problem-solving environments will use discipline specific resources and will automate part of the design process. The result will be faster development time and perhaps a change in emphasis in elementary critical thinking, moving from information assessment toward process assessment. Artificial intelligence systems can be developed that free users from collecting relevant information. Such developments will create interesting social questions since the sifting of information through technology places a hidden censorship role in the hands of software developers. Critical thinking skills will still be needed in such an environment to examine the new problems that such technology will create.

CONCLUSION

As long as the Internet remains primarily an information resource, critical thinking skills will be essential in evaluating the quality of the information presented in electronic format. Actively engaging in the review and assessment of the presented information is essential to fully understand the content that is presented. The conception of what constitutes critical thinking may be based on 19th-century ideas, but the process of seeking information in response to specific individual needs is still a primary motivator in acquiring new knowledge. Recognition of the individual needs behind the behavior should be helpful in designing appealing, useful and popular electronic information frameworks in future generations of information technology resources.

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KEY TERMS

**Belief:** The result of thought is the formation of a belief. Beliefs represent ideas held to be true by an individual. Such ideas may be the result of direct experience or may be determined through reflective thought alone.

**Critical Thinking:** Critical thinking is thought which is directed toward the cessation of doubts and the testing of new knowledge and beliefs. The purpose of critical thinking is to modify or adopt a belief system that will best meet the needs of an individual or group.

**Electronic Text:** Books and other printed materials that are available in a media format that can be displayed on a computer. The media format may be online or may use a compact disk, digital video disk, or other storage device as a distribution media. In many cases, electronic text exactly duplicates the text found in the printed version of the same work.

**Nonlinear Web Design:** A nonlinear Web design allows the user to explore resource without predetermining the path that the user will use to access that information. Although nonlinear Web designs are based on hierarchical structures, the use of multiple formats and hyperlinks allows the user to examine conceptual relationships in the resource using a pattern that is not limited to a sequential format.

**Ontology:** Ontologies define how the ideals and beliefs of reality are perceived by individual or group of individuals. Ontologies are definitions and ordering systems of a world view. These world views limit the willingness of a group or individual to accept a new concept or idea depending on how that concept fits with the existing perception of order.

**Pragmatism:** A philosophical school of thought that defines the value of belief based on the consequences of that belief. It is an important influence in the United States in multiple disciplines including education, engineering, and the social sciences as well as a major school in philosophy.

**Scenario:** A problem that presents an open-ended situation that requires a judgment or evaluation to solve. Scenarios are used to explore and test possible problem solutions in a controlled environment that limits the number of variables that can impact the solution. For this reason, they are effective tools for developing basic problem solving skills.
Assistive Technology for Individuals with Disabilities

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INTRODUCTION

Census 2000 figures indicate that more than 19% of the U.S. population aged five and older are people with disabilities (Goddard, 2004). Technology has the great potential for improving the education and quality of life of individuals with special needs. Blackhurst (2005) identifies six distinct types of technology impacting education: (1) technology of teaching (instructional approaches designed and applied in very precise ways); (2) instructional technology (videotapes and hypermedia); (3) assistive technology (AT) (devices designed to help people with disabilities); (4) medical technology (devices which provide respiratory assistance through mechanical ventilation); (5) technology productivity tools (computer software and hardware); and (6) information technology (access to knowledge and resources).

AT (also called “adaptive technology”) can particularly help balance weak areas of learning with strong areas of learning for students with disabilities (Behrmann & Jerome, 2002). There is a growing recognition that an appropriate up-to-date preparation of teachers/tutors and other educational professionals working with students with disabilities has to focus on information and communication technology (ICT), especially on AT (Feyerer, Miesenberger, & Wohlhart, 2002).

Since educational attainment can enhance occupational attainment, individuals with disabilities (mobility impairment, visual impairment, hearing impairment, speech impairment, and learning disabilities) should be encouraged to participate in higher education. AT for students with disabilities increases options for assisting students with a variety of exceptional learning needs, allowing them to accomplish educational goals that they could not accomplish otherwise in the same amount of time or in the same manner (Rapp, 2005).

BACKGROUND

AT was practically unknown in 1975, the year of landmark legislation establishing equal educational rights for students with disabilities (and personal technology tools for education were in their infancy at that time); in 1997, the Individuals with Disabilities Education Act (IDEA) amendments required AT consideration in every student’s Individualized Educational Program (IEP) (Dalton, 2002). IDEA is the nation’s special education law, originally enacted in 1975 (Boehner & Castle, 2005): “The Act responded to increased awareness of the need to educate children with disabilities and to judicial decisions requiring states to provide an education for children with disabilities if they provide an education for children without disabilities” (p. 1).

The late 1970s and early 1980s saw the introduction and refinement of the micro-computer; the 1980s also witnessed an increased emphasis on AT and the emergence of technology literature and computer software targeted directly at special education; and major technology advances such as the evolution of the Internet occurred during the 1990s (Blackhurst, 2005).

The first significant law dedicated to AT was the Technology Related Assistance for Individuals with Disabilities Act (TRAID) of 1988 (Public Law 100-407), which established a definition and criteria for those in the field of AT (Campbell, 2004):

The legislation’s primary accomplishment was to provide grant funding for states to establish AT resource centers.... Although many regard AT (such as computer software) as high tech, this definition is all encompassing. The law also provides for low-tech devices, such as pencil grips, weighted writing implements, and magnifying glasses.... In 1998, the federal government passed the Assistive Technology Act (ATA) (Public Law 105-394), which reaffirmed the government’s commitment to AT. (p. 168)
Assistive Technology for Individuals with Disabilities

With the implementation of these federal laws, institutions of higher learning are able to utilize state agencies in the development of technology programs based on a universal design model.

In 2001, the American Library Association Council approved the AT policy that libraries should work with people with disabilities, agencies, organizations, and vendors to integrate AT into their facilities and services to meet the needs of people with a broad range of disabilities, including learning, mobility, sensory, and developmental disabilities (Goddard, 2004).

ASSISTIVE TECHNOLOGY FOR INDIVIDUALS WITH DISABILITIES IN THE INCLUSIVE EDUCATION SYSTEM

Over the past two decades, for instance, the enrollment of students with disabilities and the demands for related services in higher education have greatly increased (Christ & Stodden, 2005). Online programs have worked to make Web sites accessible to deaf and blind users particularly by providing closed-captioned text and textual descriptions of graphics, even though experts have found out that online programs often lack accommodations for students with learning disabilities such as dyslexia and attention-deficit disorder (Carnevale, 2005).

Inclusion and AT Devices

Inclusive education (the practice of keeping special education students in regular classrooms as much as possible and feasible) is part of the regular school system in many European countries, and inclusive teachers should be able to reach the special educational needs of all students (Feyerer, 2002). ICT can facilitate this challenging task, and AT has the enormous potential to improve access to education and employment for disabled individuals. AT also has the potential to ensure that computing is as effective and as comfortable as possible for all learners.

AT devices include: books on tape for a student who cannot read; word processors, laptop computers for a student who has a problem with writing; augmentative communication devices for a student who has communication problems; and a large monitor for a visually impaired student. A vast array of application program software is available for instructing students through tutorial, drill-and-practice, and simulation; AT can be combined with instructional programs to develop and improve cognitive, reading, and problem-solving skills (Behrmann & Jerome, 2002).

Students with disabilities often need adaptations made for them so that they can be successful in school. AT can give learners the help that they need by providing “low” technology strategies (switches, writing devices, or software applications), and “high” technology strategies (those that use sophisticated devices or software applications for students with mild and severe disabilities that enable them to access information) so that they can perform tasks that they would otherwise be unable to do (Lewis, 1998). Inclusive teachers should be able to reach the special educational needs of all learners, and AT should be part of inclusive teacher training (Feyerer, 2002).

Current Applications and AT Resources

AT is divided into two categories: (1) any item, piece of equipment or product system, whether acquired commercially-off-the-shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities; and (2) any service that directly assists a university’s teacher education programs to provide future teachers with knowledge of AT and its importance in helping students learn (White, Wepner, & Wetzel, 2003).

The typical AT products or devices for individuals with learning needs are outlined in Table 1. Table 2 describes valuable AT Web sites for students with disabilities.

Challenging Questions, Universal Design, and AT Research

The primary goal of AT is the enhancement of capabilities and the removal of barriers to performance. Five Guiding Principles for Assistive Technology (2004) planning are quite useful: (1) AT can be a barrier; (2) AT may be applicable to all disability groups and in all phases of education and rehabilitation; (3) AT is related to function, not disability; (4) assessment and intervention involve a continuous, dynamic process of systematic problem solving; and (5) AT does not eliminate the need for social and academic skills instruction.
### Challenging Questions

Teachers face challenging questions: Are there simple tools that might be incorporated with the student that would provide enough support so that referral to special education would not be necessary? And would these provisions allow the student to remain in the regular education classroom? That is why the perceived usefulness of AT by teachers and their perceptions of ability positively affect students, and their understanding of inclusion, in serving students in inclusive settings; thus various in-service AT training sessions are extremely important.

Technology should be used by individual students who are entitled to special education services if it is needed to access the general education curriculum; re-

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**Table 1. AT products or devices for individuals with learning needs**

<table>
<thead>
<tr>
<th>Product/Device</th>
<th>Description</th>
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<tbody>
<tr>
<td>Alternative keyboard</td>
<td>It is different from standard keyboards in size, shape, layout, or function. It offers individuals with special needs greater efficiency, control, and comfort.</td>
</tr>
<tr>
<td>Captioning</td>
<td>A text transcript of the audio portion of multimedia products, such as video and television, which is synchronized to the visual events taking place on screen.</td>
</tr>
<tr>
<td>Digitized speech</td>
<td>Human speech that is recorded onto an integrated circuit chip and which has the ability to be played back.</td>
</tr>
<tr>
<td>Electronic pointing devices</td>
<td>It allows the user to control the cursor on the screen using ultrasound, an infrared beam, eye movements, nerve signals, or brains waves.</td>
</tr>
<tr>
<td>Joysticks</td>
<td>It may be used as an alternate input device. Joysticks that can be plugged into the computer’s mouse port can control the cursor on the screen.</td>
</tr>
<tr>
<td>Keyboard additions</td>
<td>A variety of accessories have been designed to make keyboards more accessible.</td>
</tr>
<tr>
<td>Onscreen keyboard</td>
<td>These keyboards are software images of a standard or modified keyboard placed on the computer screen by software.</td>
</tr>
<tr>
<td>Optical character recognition (OCR)</td>
<td>OCR software works with a scanner to convert images from a printed page into a standard computer file.</td>
</tr>
<tr>
<td>Pointing and typing aids</td>
<td>A pointing or typing aid is typically a wand or stick used to strike keys on the keyboard.</td>
</tr>
<tr>
<td>Screen reader</td>
<td>A screen reader is a software program that uses synthesized speech to “speak” graphics and text out loud.</td>
</tr>
<tr>
<td>Switches and switch software</td>
<td>Switches offer ways to provide input to a computer when a more direct access method, such as a standard keyboard or mouse, is not possible.</td>
</tr>
<tr>
<td>Talking word processors (TWP)</td>
<td>TWP’s are writing software programs that provide speech feedback as the student writes, echoing each letter as it is typed and each word as the spacebar is pressed.</td>
</tr>
<tr>
<td>Touch screens</td>
<td>This is a device placed on the computer monitor (or built into it) that allows direct selection or activation of the computer by a touch of the screen.</td>
</tr>
<tr>
<td>A telecommunication device for the deaf (TDD)</td>
<td>TDD is a device with a keyboard that sends and receives typed messages over a telephone line.</td>
</tr>
<tr>
<td>Voice recognition</td>
<td>Voice recognition allows the user to speak to the computer instead of using a keyboard or mouse to input data or control computer functions.</td>
</tr>
<tr>
<td>Voice synthesizer</td>
<td>Under control of the screen-reader software, voice-synthesizers can vary the rate, pitch, volume, and language of the information.</td>
</tr>
<tr>
<td>Word prediction programs</td>
<td>They enable the user to select a desired word from an on-screen list located in the prediction window.</td>
</tr>
</tbody>
</table>

*Source: The Family Center on Assistive Services and Technology (n.d.)*
Recently, there has been a strong commitment on the part of audiologists and educators to improve the acoustic environment for all students through the development of national standards that can be used in the construction and remodeling of schools (Marttila, 2004). Any technology that is necessary to aid a student in meeting IEP goals and objectives qualifies as an AT, and students who are entitled to special educational services access AT through the IEP process. The purpose of the IEP is to design an individualized education program to ensure that students with disabilities have adequate educational planning to accommodate their unique instructional

### Table 2. AT Web sites for students with disabilities

<table>
<thead>
<tr>
<th>Website/Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alliance for Technology Access (ATA) (<a href="http://www.ataccess.org/">http://www.ataccess.org/</a>)</td>
<td>This is a national network of 41 technology resource centers which help children/adults with disabilities, parents, teachers, and others to explore computer systems, adaptive devices, and software.</td>
</tr>
<tr>
<td>Assistive Technology for People with Mental Retardation (<a href="http://thearc.org/faqs/assistqa.html">http://thearc.org/faqs/assistqa.html</a>)</td>
<td>This fact sheet describes devices that are used by children/adults with mental retardation and other disabilities to compensate for functional limitations and to enhance learning, independence, mobility, communication, environmental control, and choice.</td>
</tr>
<tr>
<td>Center for Electronic Studying (<a href="http://ces.uoregon.edu/">http://ces.uoregon.edu/</a>)</td>
<td>Funded by the U.S. Department of Education, the Center has launched three projects blending portable computer technology with instruction on computer-based study strategies.</td>
</tr>
<tr>
<td>Closing The Gap (<a href="http://www.closingthegap.com/">http://www.closingthegap.com/</a>)</td>
<td>This is an organization that focuses on computer technology for people with special needs through its bi-monthly newspaper, annual international conference, and extensive Web site.</td>
</tr>
<tr>
<td>Disability &amp; Technology: A Resource Collection (<a href="http://home.nas.net/~galambos/tech.htm">http://home.nas.net/~galambos/tech.htm</a>)</td>
<td>Most sites will refer to assistive/adaptive devices that are computer-based and/or related to computer access.</td>
</tr>
<tr>
<td>DREAMMS for Kids, Inc. (<a href="http://www.dreamms.org/">http://www.dreamms.org/</a>)</td>
<td>DREAMMS (Developmental Research for the Effective Advancement of Memory and Motor Skills) is a non-profit parent and professional service agency, which specializes in AT-related research, development, and information dissemination.</td>
</tr>
<tr>
<td>EASI – Equal Access to Software and Information – K12 Connection (<a href="http://www.rit.edu/~easi/">http://www.rit.edu/~easi/</a>)</td>
<td>The philosophy behind this Information Technology Centre is to ensure that students and professionals with disabilities must have the same access to information and resources as everyone else.</td>
</tr>
<tr>
<td>Early Connections – Technology In Early Childhood Education (<a href="http://www.netc.org/earlyconnections/">http://www.netc.org/earlyconnections/</a>)</td>
<td>Connecting technology with the way young children learn: resources and information for educators and care providers.</td>
</tr>
<tr>
<td>LD Resources (<a href="http://www.ldresources.com/">http://www.ldresources.com/</a>)</td>
<td>This site contains resources for people with learning disabilities, with a focus on the use of AT to help individuals with learning disabilities become successful.</td>
</tr>
<tr>
<td>Literacy Instruction Through Technology (LITT) (<a href="http://edweb.sdsu.edu/SPED/ProjectLitt/LITT">http://edweb.sdsu.edu/SPED/ProjectLitt/LITT</a>)</td>
<td>This is a research project focusing on the use of technology to improve the reading skills of students with learning disabilities. Project LITT is located at San Diego State University.</td>
</tr>
<tr>
<td>Speaking to Write (<a href="http://www.edc.org/spk2wrt/">http://www.edc.org/spk2wrt/</a>)</td>
<td>This is a federally-funded project which explores the use of speech recognition technology by secondary students with disabilities.</td>
</tr>
<tr>
<td>Tools for Understanding (<a href="http://www.ups.edu/community/tofu/">http://www.ups.edu/community/tofu/</a>)</td>
<td>This site is for educators who teach mathematics and are interested in integrating common technologies into their daily instruction.</td>
</tr>
</tbody>
</table>

*Source: The Family Village School (2006)*
needs and that these needs are met in appropriate learning environments; IDEA requires that each student’s IEP be reviewed at least annually by IEP team members including parents (Copenhaver, 2004).

Universal Design

The Americans with Disabilities Act (ADA) of 1990 requires that AT be provided as an accommodation to students with disabilities, and one way to ensure equal access to all students is to utilize a universal design model (Campbell, 2004). Universal design principles and guidelines for AT, which are defined by the World Wide Web Consortium (W3C) that make it possible for people with disabilities to use electronic resources easily make those resources more accessible to a wide variety of devices, such as handhelds (Goddard, 2004).

Universal instructional design is “the design of instructional materials and activities that make the learning goals achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organize, engage, and remember (Burgstahler, cited in Campbell, 2004, p. 167). Colleges should not restrict the use of AT to those students being serviced by disability service providers (Campbell, 2004): “Often there are individuals who benefit from AT that do not have disabilities or have disabilities and have not registered with service providers. Universal design makes room for users of all abilities” (p. 172).

AT Research

Hetzroni and Shrieber (2004) investigated the use of a word processor for enhancing the academic outcomes of students with writing disabilities in high school. Their research indicated the clear difference between handwritten and computer phases. In paper-and-pencil phases, students produced more spelling mistakes, more reading errors, and lower quality of organization and structure in comparison with the phases in which a computer equipped with a word processor was used (the word processor could be considered a writing tool for those students who have writing difficulties where compensation for disabilities becomes more appropriate).

According to Sharpe, Johnson, Izzo, and Murray’s (2005) research, students with disabilities (N = 139) identified the following AT products or devices that they were generally satisfied with: scanner (35%), talking books (20%), portable note taking (17%), text help software (15%), optical character recognition (14%), specialized tape recorders (12%), voice recognition (12%), mouse/switch options (10%), adapted workstation (10%), word prediction software (9%), talking dictionary (8%), screen readers (6%), adapted keyboard (6%), screen magnification-software (5%), real-time captioning (5%), screen magnification-devices (4%), pointer (4%), talking calculators (3%), Braille note takers (3%), assistive listening devices (3%), speaker phones (3%), video captioning (3%), hearing aides (1%), and augmentative communication (1%).

FUTURE TRENDS

Currently, AT is used primarily as an equalizer—a compensatory tool—and on occasion applied universally. As institutions of higher learning become more willing to develop a universal design approach to educating, the need to provide separate accommodations for those individuals with disabilities will diminish (Campbell, 2004). One of the principles with respect to AT that can be applied universally, it is important to develop a technology curriculum that is based on universal design principles (to improve skill areas, such as reading, writing, organization, note-taking, and using the Internet particularly); doing so definitely sets the educational foundation for all learners within the classroom environment (Copenhaver, 2004).

Colleges and universities could develop an interdisciplinary curricula and students from each target audience could attend and learn how interdependent they are in serving the AT needs of students and adults, and, according to Osborn (2006), this would insure that participating students: (1) gain an awareness of AT services and devices, (2) understand the principles of universal design, and (3) know about federal and state laws that impact rights to AT devices and services. In the near future, knowledge of AT may become a requirement for licensing.

Telematic multi-disciplinary AT is essentially ICT or e-learning (video conferencing and the Internet, for example) and offers to many the solution to common obstacles associated with attending educational courses, such as classroom and lecture availability, and lack of adequate transportation. Traditional higher education will increasingly adopt greater components of e-learn-
ing. As Turner-Smith and Devlin (2005) maintain, e-learning has enormous potential for use as a component of AT education; AT will be increasingly recognized as an umbrella term for any device or system that allows individuals to perform a task they would otherwise be unable to do, and that increases the ease and safety with which the task can be performed.

CONCLUSION

Currently there are over 20,000 items classified as “AT devices,” for all disabilities, all ages, and all levels of functioning; AT can help individuals talk, write, move, see, read, and hear for themselves (Center for Innovations in Special Education, 2002). The devices range from low-tech supports (large pencils for writing, and calculators for building math skills) to high-tech supports (specialized software, and voice-output communication devices). Since each student’s technology needs are unique, the support necessary for implementing technology requires a variety of types of AT awareness training for teachers and other educational professionals. Such awareness training could be provided as a staff in-service training under the institution’s comprehensive system of personal development plan under IDEA (Copenhaver, 2004).

In the final analysis, a major challenge is to move decisions about technology applications to the point where they reflect a state of the science; such technology applications must be studied continuously in objective ways so that educators can make informed decisions about their AT selection to best meet the needs of individuals with learning disabilities (Blackhurst, 2005).

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**KEY TERMS**

**Adaptive Technology:** The use of hardware and software to assist individuals who have difficulty accessing information systems using conventional methods. It often refers to assistive technology.

**Early Intervention Services:** A program of activities and services, including assistive technology, required by the Individuals with Disabilities Education Act for children from birth through age two.

**Learning Disabilities:** Conditions that cause people to understand and process information more slowly than average. These individuals may require information to be presented in multiple formats before they completely understand it.

**Multisensory Learning:** An instructional approach that combines auditory, visual, and tactile elements into a learning task. Tracing sandpaper numbers while saying a number fact aloud would be a multisensory learning activity.

**Prereferral Process:** A procedure in which special and regular education teachers develop trial strategies to help a student showing difficulty in learning remain in the regular classroom.

**Special Education:** Specially-designed instruction to meet the unique needs of a student with disabilities including but not limited to instruction conducted in the classroom.

**Universal Design:** Designing programs, services, tools, and facilities so that they are usable, without additional modification, by the widest range of users possible, taking into account a variety of abilities and disabilities.
Asynchronous Online Networking: Cross Cultural Collaboration and the Learning of Foreign Languages

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INTRODUCTION

Computer assisted language learning (CALL) has been at the forefront of foreign language education since the early 1980s. More recently researchers’ and practitioners’ attention has centered on the sociocognitive approaches to CALL, that is, on the classroom practices and the electronic applications that make use of students’ interaction via the computer to promote the foreign language learning potential. This article addresses the issues of cross cultural collaboration and computer mediated communication (CMC) and explores how asynchronous online networking can foster a) the collaboration across partner classes and b) the cooperation of students within partner classrooms with the aim of enhancing the learning of English as a foreign language and in particular the development of language and culture awareness and mediation skills and ultimately intercultural communicative competence.

BACKGROUND

Asynchronous Collaboration and Intercultural Language Learning

Since the 1990s online collaboration has been at the forefront of foreign language education. CALL activities are no longer limited to the students’ interaction with the computer, but include tasks that involve their communication with other students in different parts of the world. It has been proved by researchers that hypertext and hypermedia offer students the opportunity to exchange information in an effective and motivating way and at the same time to expand and broaden their linguistic and cultural experiences (Paramskas, 1993; Warshauer, 1995a, 1995b). However, it has been strongly supported in the literature (e.g., Cummins, 1996; Debski, 1997; Warshauer & Whittaker, 1997) that the simple and random e-mail exchanges among students do not foster students’ communicative skills on a systematic basis. It has been endorsed that CMC activities need to be founded on students’ collaboration, that is, the learning process, which involves exchanging ideas, transmitting and receiving information, sharing experiences, and negotiating meanings, using the foreign language as the means of communication.

Online collaboration is established on the interaction of students’ discourse communities (or else communities of practice), who present information regarding their national culture(s), collect knowledge regarding other cultures, and agree on solutions to common problems (Chapelle, 2000; Cummins, 2000; Vlachos, 2005; Warshauer, 1997a). Asynchronous online collaboration, which is our issue of study in this article, assists the members of these communities in learning and consolidating the target language since they offer them ample opportunities for exposure to authentic linguistic input, which they have the time to reflect on, process, refine, and enrich to produce output that fosters cultural communication and consequently language learning (Kern & Warshauer, 2000; Shetzer & Warshauer, 2000; Vlachos & Athanasiadis, 2005). It has been strongly supported in the literature that in the context of asynchronous online collaboration the members of these communities develop clarity in expression and writing skills in their effort to disclose their cultural identities and to approach and explore life in other social and educational environments (Cooper & Selfe, 1990; Crook, 1994; Cuban, 1993; Cummins & Sayers, 1995; Slaouti, 1997; Warshauer, 1995a, 1995b).
Since communication via the Internet has become a common practice in almost all aspects of everyday life and because applied linguistics have evolved progressively through contemporary pedagogical, psychological, and sociocultural trends and philosophies, a lot of research has been done regarding the learning/teaching practices in the context of online collaboration. Until the late 90s, researchers focused mainly on the interaction between students of a foreign language with native speakers of the specific language. This type of collaboration is defined by Papaefthimiou-Lytra (2004) as “bipolar.” The rationale behind these studies and the “non native-native” or bipolar type of online interaction was based on the assumption of the communicative approach to language learning that native speakers constitute a linguistic and cultural model, which foreign language students should imitate throughout the learning process and against which their receptive and productive language skills can be assessed (Kalliabetsou-Koraka, 2004). Systematic studies of bipolar online collaboration proved that the networking with native speakers helps students to a) appreciate the culture of the people who use the target language as native, b) develop an understanding of what is linguistically and culturally proper in the social context in which the target language is used as a mother tongue, and c) behave and sound more native-like (Kourtis-Kazoullis, 2001; Zahner, Fauverge, & Wong, 2000).

However, with the new millennium, the need for an intercultural perspective in foreign language learning has been emphasized and research has focused towards this direction. The model of the native speaker now tends to be considered as monolithic and monocultural (Dendrinos, 2001; Kramsch, 1998) and has given way to that of intercultural speakers, who need to be able to establish their own culture, mediate across cultures using the target language, and tolerate, understand, and appreciate the cultural “otherness” of their international interlocutors (Byram & Fleming, 1998; Mackay, 1999; Mountford & Wadham-Smith, 2000; Papaefthimiou-Lytra, 1995a, 1995b; Papaefthimiou-Lytra, 1996; Smagorinsky, 2001).

The goal of the intercultural communicative approach is to assist students in developing the construct of the intercultural communicative competence, which is centered on the students’ capacity to use the foreign language(s) to discover and relate to new people from various and diverse social and cultural contexts. CMC provides the means for the realization of this goal. Therefore, from an intercultural perspective, students need to be involved not only in “bipolar” online collaboration but also in “multipolar” (Papaefthimiou-Lytra, 2004). In other words, students need to participate in communicative events in which they exchange their opinions and negotiate meanings not only with native speakers of the target language but also with people whose mother tongue and culture(s) are other than the target one in order that they are catered with opportunities for developing mediation skills and language and culture awareness, which, among other elements, constitute the construct of intercultural communicative competence.

Awareness and Mediation Skills across Languages and Cultures: A Data Driven Discussion

In this section we support that when asynchronous online collaboration is systematically integrated in the foreign language program of a school in the form of a cross cultural networking scheme, students build up awareness across a) their native language and culture, b) the language and culture of the target language, and c) their interlocutors’ mother tongue and culture, as well as the necessary skills to mediate across them. The arguments presented are based on data that were gathered from the implementation of an asynchronous online networking scheme, “The Euro e-pals,” which was created for the purposes of a PhD research (Vlachos, 2006). “The Euro e-pals” lasted for the academic years 2003-2004 and 2004-2005 and involved three classes of primary school learners of English from three different European countries, Greece, Spain, and Finland. The learners of the partner classes exchanged information on specific cultural topics, such as health habits at school and at home, Olympic education, Christmas and Easter traditions, environmental problems, and so forth. The purpose of the exchange of information was to create projects which were published on the Web. The participating networked learners met and collaborated in a Web site that offered them, on the one hand, the facility to exchange electronic messages with the aim of interacting, exchanging information, and negotiating meanings, and on the other hand, the space to publish their projects, that is, the texts and the visual materials the learners collected or produced.
The networking and the cooperation of the three partner classes involved the completion of seven projects, each one of which included two main stages. In the first stage the learners of each class, who worked in groups of 3-4 members, had to collaborate and agree on the information they would transmit to the groups of learners of the partner classes overseas, while in the second stage they had to process the information they had received from their European partners to compose texts which they published in “The Euro e-pals” Web site. For example, during the period February 2005-March 2005, the groups worked on a project named “Providing an ending to a story,” in which the learners of each class selected a folk story from their country, which they narrated in the English language and sent to their European partners overseas. However, they did not include the ending of the story in their narration; they asked from their partners to brainstorm and provide an ending themselves. The Greek learners selected a story titled “The mouse and His Daughter,” the Spanish narrated the story “The Magpie and the Chickens,” and the Finish narrated the story “The Raspberry Worm.” The five groups of Greek learners created five different endings for the Spanish story, the six groups of the Finnish learners created six new endings for the Greek story, and the six groups of the Spanish learners created six endings for the Finnish story.

From the reports of the participating teachers, who observed and documented the learning procedure, we concluded that “The Euro e-pals” learners used both their native language (L1) and the English language (L2), while transferring the folk story of their country from L1 to L2. Furthermore, they used both L1 and L2 while working out the open ended stories they had received from their partners overseas and while putting their ideas in the computer and composing their texts, which were finally written in L2. So far research has shown that students use mainly L1 while collaborating with their fellows in face-to-face interactions within the borders of individual classes on a local level (Legenhäuser & Wolff, 1992; Papaelthimiou-Lytra, 1990; Warschauer, 1997b). The data we collected from our research suggest that “The Euro e-pals” learners used both L1 and L2 to communicate among each other on a local level and L2 to communicate with their partners from the other European schools on a cross cultural level. In other words, they usually went through an L1 and L2 brainstorming stage, which acted as a transition period, before they moved to the L2 production or the text synthesis stage. In the brainstorming stage they resorted to both languages to make semantic and morphological comparisons across L1 and L2. In the text synthesis stage, based on the comparisons they had attempted in the brainstorming stage, they composed texts which mediated and brought into contact their people, language, culture, and civilization with their partners’ cultures, ways of life, and native languages.

Furthermore, analysing the data we collected, we concluded that while collaborating on a local level, “The Euro e-pals” learners took into serious consideration the cultural and linguistic otherness of their interlocutors. Specifically, as all the participating teachers confirm, thanks to systematic online collaboration, their learners soon got used to keeping in mind the fact that the readers of the texts they composed originated from diverse cultural and national backgrounds, had been brought up in dissimilar natural environments, spoke different L1s and, therefore, had disparate perceptions of the world. In the composing and revising phases of the text synthesis stage their learners progressively became aware of the fact that they could make language mistakes, while expressing themselves in L2, and misled by the syntactical patterns, the word order, the notions and the functions of their L1s. The Spanish teacher, who participated in our scheme and research made the following comments, which support the above mentioned arguments:

They (her learners) have realized that they have to be analytic and provide details so that they will be more easily understood. One can understand this if she observes their conversations while they are trying to decide what to include in their texts and how to write it. They wonder whether what they write is enough, or if they would have to add more explanations.

About the language, in some occasions, they ask themselves if, for example the bird (the main character of our tale), the magpie exists in Greece and in Finland.

I have explained to them that the Spanish word order is different from the English and since the Greek and the Finnish learners might not be familiar with our word order, they may not be able to understand the texts we produce if some sentences of our texts follow the Spanish syntactical patterns. ...As a result, my students try to avoid making mistakes of this kind keeping in mind that their European partners might not be able to understand our texts if there are mistakes of this kind.
Focusing our attention to the interrelation between L1 and L2, which in our case was the English language, we can, therefore, support that the learners, who had the role of the “writers” and were composing texts, paid particular attention to expression in L2, keeping always in mind the distinctive characteristics of their L1 and L2. More importantly, it is worth noticing that the writers’ sensitivity towards their accuracy in expression in L2 mainly sprang from the fact that the intended readers spoke a mother tongue other than the writers’ L1. This could confuse the readers further in case the communicating texts, which were written in L2, included grammatical and syntactical patterns that the readers had never met in their mother tongue and the English language (L2).

From the data we collected, it follows that cross cultural online collaboration not only exhorted the participating learners to delve into the linguistic systems of L1 and L2 and observe their functions, but also motivated them to speculate the systems of the native languages of their partners overseas in order that, as writers, they could be effective in intercultural communication. The Greek teacher who participated in our research commented that while selecting a folk story to narrate to their European partners, the Greek learners communicated with their interlocutors abroad and investigated whether in the Finnish language nouns have gender suffixes, as they do in the Greek language.

The Greek learners had chosen to narrate a folk story in which a female mouse was getting married to the sun. However, in the process of the story selection, they were inhibited by the thought that if the noun “the sun” in Finnish was female, then their interlocutors might be confused while decoding the Greek story. In other words, the Greek learners had formed “working hypotheses” (Papaefthimiou-Lytra, 2001) regarding the linguistic system of their interlocutors’ mother tongue. When they communicated with the learners and the teacher of the Finnish class, the Greek children learned that in Finnish nouns do not have gender suffixes, that is to say, they tested their working hypotheses through the act of communication and, therefore, they could proceed with the specific story they had selected. It can, thus, be supported that when cross cultural online collaboration is systematically integrated in the foreign language program of a class, it may create the necessary and appropriate learning conditions which encourage students to develop awareness across their mother tongue and culture, the target language and its culture, and their interlocutors’ native languages and cultures.

In addition, from a sociolinguistic point of view, the teachers’ comments prove that learners formed working hypotheses concerning not only the linguistic systems of their interlocutors’ mother tongues but also the appropriate use of social and linguistic codes and norms that were common and acceptable in the cultures and the communities in which the intended readers belonged to. In the process of cross cultural online collaboration, learners explored these hypotheses and expanded them, forming new ones. Specifically, it has been reported by the participating teachers that their learners wondered what kind of genres, text types, and register they would have to use to facilitate communication, taking into serious consideration the fact that inappropriate selections could cause misunderstandings. They compared genres and linguistic and social codes across L1 and L2 and they wondered what genres and codes would be used in their interlocutors’ mother tongues and languages.

There were instances in the learning process, when the children resorted to texts they had received from their interlocutors in the past and examined factors such as the register, the formality of the language, and the genre. Their aim was to compose texts that would be smoothly decoded and processed by the intended readers. When the texts were published in “The Euro e-pals” Web site and replies were received, learners used to hold discussions in the classroom regarding the suitability of their selections and would make plans as concerns future texts they would compose.

In other words, they used their interlocutors’ replying texts as feedback, which they reflected on to explore their working hypotheses further and create new ones. Hence, it can be asserted that the participating learners established cross cultural mediation skills, which let them take into account the intended readers’ cultural and linguistic background and the specific context in which intercultural interaction took place in order to select the suitable linguistic codes and channels of communication that would facilitate them in their mediation across cultures and languages.

To sum up, in this discussion it has been endorsed that learners’ regular online collaboration across partner classes and systematic cooperation within the borders of each individual class enhance awareness across their mother tongue and culture, the target language, and culture and their interlocutors’ native languages and cultures. It has also been put forward that they foster
Asynchronous Online Networking

Figure 1. Collaboration patterns and outcomes in a cross-cultural CMC learning environment

The development of cross cultural mediation skills, which enable learners to transfer texts and information from their native language into the target one and, consequently, allow their interlocutors to get to know their culture and civilization. As it has already been stated and is diagrammatically represented in Figure 1, awareness across languages and cultures and cross cultural mediation skills, among other elements, constitute the construct of intercultural communicative competence. The specific construct, which is made up of a number of other constituent elements (such as learning skills and strategies that are beyond the scope of this article), constitutes the ultimate goal of the intercultural communicative approach to foreign language teaching/learning.

CONCLUDING REMARKS AND FURTHER RESEARCH

In the context of the expanding European Union, where a European dimension in education has emerged (Byram & Risager, 1999; Papaefthymiou-Lytra, 2004), the intercultural communicative approach in foreign language learning is gaining ground. The compilation of the Common European Framework of Reference for Languages, and the efforts of the Council of Europe to promote foreign language learning have sprung from the need of the European citizens for peaceful coexistence, seminal communication, and commercial conciliation. In this context, intercultural communicative language learning is being developed and continuously expanded in European schools. Our research has proved that through regular online collaboration students from different European countries can use and consolidate a common target language in their effort to exchange cultural elements and learn to appreciate the otherness and the value of other European cultures. We believe that it is worthwhile expanding intercultural foreign language research outside the European borders to embrace cultures and students who have completely different frames of linguistic, social, and religious reference. Extensive research of this type may prove that international languages and information communication technologies are probably meant to bring national languages and cultures in contact since modern communication systems are progressively “shrinking” our world and are bringing people closer to each other.
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KEY TERMS

Applied Linguistics: The scientific field that studies foreign language teaching and learning.

Asynchronous Online Networking: The type of communication between individual learners or groups of learners who use “not simultaneous” modes of communication, such as the e-mail, to share messages and lengthy texts in the context of collaboration and interaction.

Bipolar Online Interaction: The interaction between students of a foreign language and native speakers of the specific language.

Cross Cultural Mediation Skills: The skills which allow learners to take into account a) their interlocutors’ cultural and linguistic backgrounds and b) the specific context of communication in order that they can select the appropriate linguistic codes that will facilitate them in transferring texts and information from their native language into the target one in an effective way.
Cross Cultural Online Networking: The online communication and interaction among discourse communities of learners, each one of which is originated in a discrete cultural and linguistic environment.

Discourse Community of Learners: A group of learners, who communicate with another group via the computer, discuss, and exchange ideas and information on various issues.

Multipolar Online Interaction: The interaction between students of a foreign language not only with native speakers of the target language but also with people whose mother tongue and cultures are other than the target one.

Sociocognitive Perspective in CALL: The perspective according to which students may learn a foreign language through communication via the computer. Proponents of the sociocognitive perspective in CALL propose applications such as the e-mail, the Internet relay chats, the MOOs, audio and video conferencing, and so forth.
Behavior Analysis and ICT Education: Teaching Java™ with Programmed Instruction and Interteaching

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INTRODUCTION

Acquiring skill in computer programming is acknowledged to be valuable for information science students (Forgionne, 1991). Educators in the discipline, however, recognize that students may sometimes select management information systems (MIS) and related academic majors to avoid the programming demands of a computer science curriculum (Gill & Holton, 2006). Although object-oriented software methodologies are included in undergraduate curriculum recommendations for information systems programs (e.g., IS 2002, presented in Gorgone et al., 2002) and information technology programs (e.g., IT 2005, presented in SIGITE, 2005), the complexity and instability of object-oriented languages such as Java1 pose additional burdens on both students and educators alike (Roberts, 2004). Moreover, the diversity challenges of a typical freshman class in computer programming are highlighted by Koen (2005): “Freshman are very diverse with respect to their entering computer skills—some are state computer champions, while others have never touched a computer before” (p. 599). Realizing these challenges and given a course in Java that is intended to be taken by information systems majors, what instructional approach should the teacher adopt to maximize student learning?

Educators have struggled for decades to solve that problem. Instructional recommendations include support to understand logical constructions and flow of control (Papert, 1980), intelligent computer assisted instruction (Anderson & Skwarecki, 1986), approaches to classroom teaching and student learning (Mayer, 1988), emphasis on mathematics and algorithms (Hu, 2006), and other supportive programming environments such as BlueJ (Kolling, Quig, Patterson, & Rosenberg, 2003), DrJava (Hsia, Simpson, Smith, & Cartwright, 2005), Problem-Based Learning (Tsang & Chan, 2004), and the Environment for Learning to Program (Truong, Bancroft, & Roe, 2005). It is not uncommon, moreover, for instructors to avoid responsibility for the outcome of their teaching and to hold the student solely accountable for any failure rather than concluding that the pedagogy might have been flawed (Jenkins, 2001).

The instructional approach taken at the University of Maryland – Baltimore County (UMBC), however, is similar to the intent of many of the above recommendations to assist new learners. Our aim is to expose novitiate students at the outset to a series of instructional events, as the first technical exercise in a Java course, that results in all students being able to write and to understand the JApplet program presented in Table 1, which will display a text string in a browser window on the Web.

The initial learning during the first class, which involves completion of a Web-based tutoring system, is supported by a subsequent lecture on the program during the second class, when the students run the program on the Web. A final elaboration and consolidation event takes place during the third class, when the students engage in dyadic collaborative peer tutoring to test each other’s knowledge and understanding of the program, to raise questions as needed, and to confirm each other’s mastery of the program within a social context. These intensive initial learning experiences are in furtherance of preparing the student to be taught with lecture, demonstrations, and peer collaboration throughout the remaining classes of a semester. The Java code that is mastered in a typical course will produce a final JApplet project that will run on the Web.

From the perspective of teaching computer programming, these techniques together converge on what is increasingly recognized as vital ingredients to facilitate science education, in general (DeHaan, 2005). Among several recommendations of learning principles
to promote retention and transfer of knowledge, for example, are repeated practice with different instructional modalities (Halpern & Hakel, 2003) and with socially supported interactions (Fox & Hackerman, 2003). The remaining sections of this article, then, present the intellectual context and the educational technology to implement behaviorally oriented instructional tactics as a solution to the general problem of effective pedagogy.

**BACKGROUND**

The instructional tactics adopted in the classroom at the start of a semester’s work are based upon programmed instruction (PI), which is a form of structured and optionally automated instruction, and interteaching, which is a form of collaborative peer tutoring. As implemented in the present context, these tactics originated from behavior analysis, and the Cambridge Center for Behavioral Studies3 provides fundamental definitions and a wealth of information regarding the philosophical underpinnings and applications of this approach to science, in general, and education, in particular. The classroom applications under consideration are “atheoretical” in that the causes and explanations for the development of a complex repertoire of programming skill are assumed to rely in a series of systematically crafted interactions as the antecedents to knowledge and skill for the individual student. This orientation contrasts with indirect and metaphorical explanations of behavior, such as intelligence, personality, locus of control, understanding, engaged academic time, and mental models (Emurian & Durham, 2003; Greer & McDonough, 1999).

A general treatment of behavior analysis applications to education, which includes consideration of programmed instruction and personalized collaborations, is presented in Greer (2002). Lockee, Moore, and Burton (2004) present a comprehensive summary of the literature related to the components of PI and to the context of its use, and Feurzeig (2006) provides a historical perspective of educational technology developments that commence with programmed instruction and that conclude with “intelligent” computer-aided instruction. This section will present an overview of the instructional technology associated with programmed instruction and interteaching, and a later section will present the applications to teach Java.

**Programmed Instruction**

Programmed instruction is a technique to structure textual information in small units for the student to study and to master at the level of a unit. Each unit, which is referred to as a “frame,” consists of text along with a test that provides the opportunity to demonstrate learning. The test could require the completion of a partially-spelled word in a sentence or it could require completing a statement by filling in a blank space.

Table 1. Each cell with Java code reflects a learn unit in the tutor

<table>
<thead>
<tr>
<th>Line</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>import javax.swing.JApplet ;</td>
</tr>
<tr>
<td>2</td>
<td>import javax.swing.JLabel ;</td>
</tr>
<tr>
<td>3</td>
<td>import java.awt.Color ;</td>
</tr>
<tr>
<td>4</td>
<td>public class MyProgram extends JApplet {</td>
</tr>
<tr>
<td>5</td>
<td>JLabel myLabel ;</td>
</tr>
<tr>
<td>6</td>
<td>public void init() {</td>
</tr>
<tr>
<td>7</td>
<td>myLabel = new JLabel(&quot;This is my first program.&quot;);</td>
</tr>
<tr>
<td>8</td>
<td>getContentPane().setBackground(Color.yellow) ;</td>
</tr>
<tr>
<td>9</td>
<td>getContentPane().add(myLabel) ;</td>
</tr>
<tr>
<td>10</td>
<td>}</td>
</tr>
<tr>
<td>11</td>
<td>}</td>
</tr>
</tbody>
</table>
Behavior Analysis and ICT Education

with a word or words. The frames are designed so that correct answers are required in one frame before a subsequent frame is presented, and the frames increase in complexity over the course of learning. The design features of programmed instruction, synthesized from the literature, are presented in Emurian (2005), and the intellectual history of this instructional technology, as it relates to behaviorally oriented computer-based tutoring systems, is discussed in Emurian and Durham (2003). The components of PI that are most relevant to the present discussion are as follows: (1) learner constructed responses based on recall, (2) immediate feedback for performance, (3) successive approximations to a final learning objective, and (4) learner-paced progress (Holland, 1960; Scriven, 1969; Skinner, 1958; Vargas & Vargas, 1991). An example of a programmed instruction textbook (Holland & Skinner, 1961) may be freely downloaded from the Cambridge Center for Behavioral Studies.

The origin of programmed instruction is attributable to B.F. Skinner (1904-1990), a behavioral psychologist who spent most of his academic career at Harvard University. In a pioneering paper (Skinner, 1954), the argument was advanced that principles of learning derived from laboratory experimentation could be directly applied to the design of instruction that would manage the countless moment-to-moment interactions between a student and a teacher that might be essential for each and every learner to reach a similar criterion of mastery, which was the objective. Given the complexity and frequency of these interactions, machine support was proposed as a reasonable, if not absolutely essential, requirement for the successful implementation of such a teaching technology (Skinner, 1958). Advanced learners such as college students, however, might be anticipated to follow the process of learning when the instructional frames were presented in the form of a textbook (Holland & Skinner, 1961).

Programmed instruction was not widely adopted by educators, even following the advent of the computer as the “machine” that would implement the interactive information system. Among the reasons given to explain the paucity of PI applications are included the rigidity of the step-like frames and the perhaps questionable assumption that the process for the development of a complex verbal repertoire could never be captured in sufficient detail as to be programmable (McDonald, Yanchar, & Osguthorpe, 2005). Although the impact of automated tutoring systems based on other models of learning is evident in such applications as the Cognitive Tutors, which have been designated as one of five exemplary curricula in K-12 mathematics education by the U.S. Department of Education (Mathan & Koedinger, 2005), behavior analysis of problem solving and similar “cognitive” phenomena has recently been undertaken within the context of computer-interactive learning of the rectangular coordinate system based on a matching-to-sample procedure (Ninness et al., 2005). Finally, an emerging relational-frame theory (Hayes, Barnes-Holmes, & Roche, 2001) shows promise to operationalize language acquisition and use in terms accessible to a behavior analysis.

The emergence of personal computers gave rise to a renewed interest in programmed instruction among researchers and practitioners. One of the first computer-based applications of PI to appear in the behavioral literature was reported by Dube, McDonald, McIlvane, and Mackay (1991). These investigators showed that a computer-based tutoring system, based on a matching-to-sample paradigm, could be used to manage the several developmental steps required to teach two mentally retarded adults to spell. More relevant to the management of text-based learning systems, Tudor and Bostow (1991) reported that a microcomputer PI system that taught PI design achieved the best learning outcome in college students when the frames required overt constructed responses during knowledge acquisition. These results were later confirmed and extended to show that a relatively high density of constructed responses during learning produced superior post-tutor test performance (Kritch & Bostow, 1998). Related research, based upon a microcomputer version of Holland and Skinner (1961), investigated parameters of the temporal transition between successive frames, with a delay of several seconds generally supporting improved response accuracy across the frames (Kelly & Crobie, 1997). With the exception of the PI tutoring system to support the learning of Java, which will be described below, the most recent study in the behavioral literature that used programmed instruction applied the design philosophy to teach preschoolers how to point with the computer mouse (Shimizu & McDonough, 2006). Although many of these studies departed somewhat from the formalism of PI, all are in furtherance of showing the application of behavior principles to computer-based tutoring systems. Finally, as evidenced by the Java tutoring system developed by Truong et al. (2005), which requires constructed responses by a
learner, functional aspects of PI are present in effective tutors even when behavior analysis is not identified as a rationale for the system.

**Interteaching**

Structured collaboration among students is increasingly recognized as a valuable experience to promote learning computer programming (Jehng, 1997; Williams, Wiebe, Yang, Kerzli, & Miller, 2002), to include Java (Beck, Chizhik, & McElroy, 2005). In behavior analysis, one collaborative paradigm is interteaching, defined by Boyce and Hineline (2002) as “a mutually probing, mutually informing conversation between two people” (p. 220). During an interteaching session, two students discuss their answers to questions that are presented in a study manual that is used to prepare for the session. The intent of the session is for both students to reach consensual agreement on the understanding of the material and to move beyond factual recitations into generalizable rules and concepts. The students submit a report of the effectiveness of the session, and the report may contain questions that should be resolved by an instructor. The knowledge gained from the interteaching session is assessed during regularly scheduled tests, which may include objective test items, short answer questions, and essays.

Interteaching is derived from the personalized system of instruction (PSI), which was developed by the behavioral psychologist Fred Keller (Keller, 1968). One aspect of the PSI is to use a student “knowledge expert” to determine, generally within an interpersonal interaction, that a student “knowledge novice” has mastered a unit of material and is prepared to advance to a subsequent unit in a course of study. Student learners may repeat a unit of study until it is passed, with no grade penalty, and progress is determined by the pace set by the learner. The behavioral contingencies are said to optimize learning in all students and to remove the aversive control or coercion that may be prevalent in other instructional techniques.

Research and classroom applications generally support the effectiveness of the “Keller method” and its superiority to lecture courses over a wide range of topics and students (Kulik, Kulik, & Cohen, 1979), and the method’s value in engineering education has been documented (Canelos & Ozbeki, 1983; Haws, 1998). As suggested in the historical and evaluative perspective by Grant and Spencer (2003), however, the absence of widespread use of the method is likely attributable, paradoxically, to its effectiveness, which requires a considerable expenditure of energy by teachers. Importantly, the method requires an orientation to pedagogy that favors overcoming individual differences in student achievement rather than simply documenting differences (Emurian, 2001; Haws, 2000). As stated by Murray Sidman in an address to the Eastern Psychological Association,

*The PSI system of instruction is a behavior analytic contribution that has the potential, like successful public health measures, to exert population-wide effects, but behavior analysis has not yet come up with methods for gaining acceptance of that contribution by either the education establishment or by the general public.* (Sidman, 2006, p. 240)

The advent of the Internet may well help to foster just such an acceptance.

There is growing evidence that the PSI framework is being adopted for Web-based instructional applications. Martin, Pear, and Martin (2002) adopted a computer-aided PSI format for an undergraduate psychology course in which electronic interactions occurred between student “proctors” and student “learners.” Koen (2005) reported the use of Webcams and related synchronous and asynchronous communication media to implement some of the interpersonal proctoring and other social (i.e., “presence”) aspects for a Web-based PSI computer course for freshman, which included Java among other technical topics that were taught. Although behavior principles were not mentioned, Xu, Wang, and Wang (2005) reported a conceptual model of personalized virtual learning environments that convey many of the essential elements of the PSI, to include units of study that meet the level of the individual learner. As suggested by Folkers (2005), moreover, the accelerated movement of educational offerings from the physical “marketplace” to the virtual world of the “marketspace,” through the integration of distance education programs into curriculum models, may provide the occasion for those long sought population-wide effects as a consequence of the implementation and effectiveness of behavior analytic techniques.
TEACHING JAVA WITH PROGRAMMED INSTRUCTION AND INTERTEACHING

For the past several years, the Information Systems Department at UMBC has adopted programmed instruction and interteaching as components of a Java course intended to be taken by information systems undergraduate and graduate students who have minimal programming experience and no prior experience with Java. The PI tutoring system, which takes approximately 3 hours for a student to complete, is a Web-based system that leads the learner to an understanding of the code displayed within each cell of Table 1. When a student exits the tutor, the student has passed online multiple-choice tests on the items and lines of code (i.e., cells and rows), and the student has written the code from memory. This instructional experience is followed by a lecture and finally by an interteaching session, and that latter session is intended to provide the opportunity to solidify and elaborate the prior learning. Several assessments of learning and software self-efficacy are taken throughout these initial classes, as given below for a typical sequence of events.

- Class 1:
  1. Pretutor assessment
     a. Java software self-efficacy
     b. Multiple-choice tests on general programming principles
  2. Java PI tutoring system
  3. Post-tutor assessment
- Class 2:
  1. Lecture on the code while students enter the code into a UNIX™ text editor.
  2. Run the JApplet on the Web.
  3. Post-lecture assessment
- Class 3:
  1. Interteaching session on the Java code
  2. Post-interteaching assessment

The data presented in our reports show that students develop skill and confidence that emerge cumulatively and synergistically over the several learning experiences (Emurian, 2004, 2005, 2006a, 2006b; Emurian & Durham, 2003; Emurian, Wang, & Durham, 2003). The design of the PI tutoring system promotes meaningful learning (Mayer, 2002), as evidenced by the students’ acquired competency to generalize knowledge gained from the tutor frames and constructed response requirements. Students report value in and appreciation of all aspects of these events, and students who were apprehensive at the outset seem to benefit most from having an initially positive experience in a computer programming course, some for the very first time in their student careers. This sets the occasion for the students’ continued involvement in the course with confidence and enthusiasm.

CONCLUSION

Although educators might have the success of their students as a primary goal of teaching, it is less certain that what happens in the classroom is based on empirical evidence of effectiveness: a rational pedagogy. And it is sometimes the case that expecting students prematurely to solve general computer programming problems and to understand complex control structures and algorithms neglects the propaedeutic skills that students must possess to undertake such higher-order learning. In furtherance of providing those skills to our students, techniques derived from behavior analysis have been demonstrably effective in promoting skill, confidence, and meaningful learning by novitiate students regarding an object-oriented programming language. Perhaps overlooked in other models of automated instruction (Anderson, Corbett, Koedinger, & Pelletier, 1995), behavior analysis excels in identifying the ontogenetic instructional learn units (Greer & McDonough, 1999) whose mastery provides the expressive verbal tools for advanced understanding, thinking, and problem solving in the domain of computer programming and beyond (Skinner, 1957). With such a background providing the propaedeutic repertoire, students will progress to more advanced learning of object-oriented programming rules and concepts, with no student left behind.

REFERENCES


Frontiers in Education National Conference, Tempe, Arizona (pp. 280-285).


KEY TERMS

Behavior Analysis: A science and technology of behavior that seeks to understand the causes of behavior in terms of specifiable and directly measurable antecedents that account for and that determine performance at the level of the individual organism.

Interteaching: A dyadic interaction in which two learners come prepared to assess each other’s understanding of a unit of knowledge and to teach each other, as needed, to a mutually informed level of competency.

Learn Unit: A contingency of reinforcement that includes an occasion for learning, a requirement for a learner to respond, and a consequence that confirms response accuracy or that provides remedial action until accuracy occurs.

Personalized System of Instruction: A comprehensive learning environment that permits the individual student to move through a progression of steps to competency at his or her own pace. The written word, rather than a lecture, is emphasized as the medium to transmit information to students. A student proctor “expert” verifies, within the context of an interpersonal interaction, a learning student’s satisfactory completion of a step or recommends that studying continue until mastery of a step is demonstrated.

Programmed Instruction: A method for organizing knowledge for learning in incremental steps or frames of information where progress across successive steps requires demonstrated mastery at the level of the single step or frame.
ENDNOTES

1 Information about Java technology, including the Java programming language, is available at Sun Microsystems, Inc. (http://java.sun.com/).

2 Final project example: http://userpages.umbc.edu/~emurian/learnJava/swing/example/Main-Program.html

3 http://www.behavior.org/index.cfm

4 This book is available online at the Cambridge Center for Behavioral Studies (http://www.behavior.org/education/index.cfm)

5 The tutoring system, together with the source code and all instructional and assessment material, is freely available on the Web at http://nasa1.ifsm.umbc.edu/learnJava/tutorLinks/TutorLinks.html
Behavioral Theories that Guide Online Course Design

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INTRODUCTION

Behaviorism comes from one of three schools of psychology in which theories are categorized. The other two schools are the schools of cognitivism and humanism. It is believed that one school of theory is not better than the other, and individuals are encouraged to apply the theory that is the most appropriate for the student. During the first several decades of the twentieth century, experimental psychologists, William James and his student, Edward L. Thorndike, began to question the use of memorization as a tool for education after their experiments showed that memory was not improved after memorization. Thorndike continued their efforts by promoting the idea of stimulus-response behavioral psychology. It was believed that stimulus-response behavioral patterns could be used by educators to change human behavior and that factors in the environment served as a stimulus for the behavior response. Psychologists would focus on knowledge of how people responded to feedback when performing a task, and they began to think of individuals as self-correcting human beings. Later, other behavioral pioneers such as Ivan Pavlov, B. F. Skinner, Albert Bandura, and Benjamin Bloom would develop additional experimental products to show that the environment had an impact on learning and that all behavior is learned. Because of their beliefs, programs have been developed to help people reduce phobias, learn to read or calculate, develop specific skills, and even increase their ability to relax (Joyce, Weil, & Calhoun, 2000; Pinar, Reynolds, Slatery, & Taubman, 1996).

BEHAVIORAL THEORIES AND ONLINE DESIGN

Theories that embed the work of Ivan Pavlov make use of classical conditioning in that the desirable behavior is stimulated and the result is a conditioned response. Courses that reflect E. L. Thorndike’s use of connectionism, law of effect, and law of exercise are using behaviorism as a tool for learning. Connectionism is the idea of making a connection between a stimulus and a response. Law of effect occurs when a reward is provided after a wanted behavior is produced, and law of exercise refers to a stronger bond being developed between the stimulus and the response, because the connection is made again and again. When positive and negative reinforcements are used as part of the course design, the work of B. F. Skinner is emulated. This is especially true if organization, sequence, and consistency strategies are implemented. The timing in which the reinforcement is enacted is also a deciding factor. According to theories on behavior, an immediate reinforcement is better than a delayed reinforcement. Once social responses are used to illicit certain behavior through a practice called reciprocal determinism, Albert Bandura’s contributions are represented. Examples of behaviorism in the classroom include the use of computer software programs and computer assisted learning tools, providing students with immediate feedback, and behavior rewards (Joyce et al., 2000; Tomei, 2007). Today, instructors make use of behaviorism theory and practice when designing online courses (Buendia, Diaz, & Benloch, 2002). Examples of behaviorist theories used when designing online courses include the social-cultural model of learning, mastery learning, simulations, direct instruction, theory of elaboration, and traditional instructional design theory.

Social-Cultural Model of Learning

An online course that incorporates the social-cultural model of learning, a model that is cognitive in nature, because of how students process information, is reflective of behaviorism, because patterns of communication are utilized. The social-cultural model of learning uses written and oral dialogue. Threaded asynchronous discussions, synchronous discussions, and email are examples of the tools implemented by instructors during the course design process. The pat-
tern of behaviorism begins when the instructor poses a question, students respond to the question, and the instructor responds to the students’ responses with positive or negative reinforcement comments. In this example, the behaviorism is being used in a number of different ways. The reinforcement comments are representative of Thorndike’s ideas of connectionism, law of effect, and law of exercise. It also reminds you of Skinner’s operant conditioning theory. As students see examples of students’ quality responses that receive positive reinforcement from the instructor, they can use those examples as a model to help improve their own responses. When this modeling behavior occurs, Bandura’s practice of reciprocal determinism is being utilized. (Polin, 2004).

**Mastery Learning**

Mastery learning is a practice originally created by John B. Carroll and Benjamin Bloom. John Carroll’s perspective holds that a student’s aptitude correlates with achievement. His view of aptitude considers how long it takes for the learner to learn the material as opposed to the learner’s ability to master the material. According to this view, every learner can learn as long as the appropriate materials and instruction are provided. Benjamin Bloom then alters Carroll’s perspective into an ideal that focuses on organizing the curriculum so that students would have the necessary time and ability to benefit from instruction. The transformed model contains the following characteristics: (a) subjects are defined by major objectives, (b) material is divided into smaller learning units with separate objectives that stem from the larger objectives, (c) learning materials and instructional strategies are selected, (d) formative evaluation is applied, (e) supplementary instruction is provided based on student’s aptitude, and (f) summative evaluation is applied. Benjamin Bloom, James Block, and other mastery learning supporters believe that any traditional instructional unit can be adjusted to meet the ideals of mastery learning once educators ensure that students are provided with the time they need to master the concepts. Now that modern instructional technology has afforded educators with new choices, curriculum developers are encouraged to develop comprehensive curriculum that includes self-administering multimedia units and programmed learning procedures (Joyce et al., 2000; Pinar et al., 1996).

**Direct Instruction**

Direct instruction is referred to by behaviorists as “modeling with reinforced guided performance.” The focus of this model of learning involves dividing performance into goals and tasks, breaking the tasks into smaller tasks, creating training activities that directly target the objectives and ensure mastery of each task, and the inclusion of prerequisites that students have to achieve before they can go on to more advanced concepts. Critics of direct instruction theory note that the application of this theory should be used with caution, because it is not appropriate for all educational objectives and all students. Even though the theory has been criticized, there is an empirical record that shows modest effects when the theory is applied. The direct instruction model has five phases of activity: orientation, presentation, structured practice, guided practice, and independent practice. During the orientation phase, the instructor presents the expectations, the learning task, and the student’s responsibilities needed to complete the task. Phase two of the model is the presentation phase. At this time, the instructor describes the concept or skill and presents demonstrations or examples and identifies whether or not the students understand the new concepts and skills that have been presented. Structured practice, the third phase of the model, is the next step. Students practice, and the instructor will provide feedback as a form of reinforcement. Phase four involves guided practice. Students are given the chance to practice independently with the teacher nearby ready to make assessments and offer more corrective feedback as the need arises. Independent practice is the final phase of the direct instruction theory of learning. Once students reach an accuracy level of 85 to 90% during the guided practice phase, they perform the task independently and receive support from the teacher in the form of feedback after the task has been completed. Any form of technology can be integrated when designing curriculum as long as the direct instruction learning experience contains each of the five phases (Joyce et al., 2000).

**Simulations**

Learning from simulations through training and self-training is another example of a behavioral learning theory. When simulations are utilized, students take on the role of someone from a real life experience. To
succeed when performing the role, students make use of concepts and skills to perform specific tasks. Instructors take the role of explaining, refereeing, coaching, and discussing the simulation experience with the students. They explain the rules, place the students into teams, and they assign roles based on student ability to ensure participation and communication between the students. When coaching, the instructor needs to be supportive, yet avoid interfering with the natural play of the simulation. Students are expected to make mistakes and adjust from those mistakes. Finally, instructors hold a discussion in which students have the opportunity to reflect and identify similarities and differences between the simulation and the real world. Simulations have been used to help students learn about competition, cooperation, empathy, social systems, concepts, skills, efficacy, paying a price for one’s actions, chance, and critical thinking (Joyce et al., 2000; Pinar et al., 1996).

Elaboration Theory

Elaboration theory is a behavioral practice developed by Reigeluth that is concerned with the organization of materials for a course. This theory holds that new learning should be presented first in the simplest form and carefully moved to more complex forms of content and learning. For this reason, online instructors, when applying this theory, will introduce basic content to their students before moving on to more difficult material. When this strategy is utilized instructors tend to begin with knowledge that students are already familiar with. Then, they transition to the exploration of new knowledge which helps students make the appropriate connections to help them understand the content. This theory is based on cognitive psychology, and it holds that in order for a learner to acquire and retain the new knowledge that a sequence of concepts, procedures, and theoretical content has to be in place. Epitome is generally the first level introduced and it usually involves a single form of content. Level 1 is the second step of elaboration theory and it entails a more detailed look at the first concept presented. As the instructor guides the learners to Level 2 of elaboration theory, what is focused on in the first level is further elaborated on in Level 2. As learners move from more basic content to content that is more complex, there is a point at which the entire content has been introduced to the learners (Huang & Liaw, 2004; Ludwig, 2000).

The entire elaboration theory process relies greatly on the summarization and synthesis of everything that has been introduced so that students gain an understanding of the big picture as opposed to only the parts. Theory of elaboration greatly depends on the learner’s cognitive structure. So some learners will transition from the simple to the complex more easily than others mainly because of their own abilities. Elaboration theory, when applied to instructional design processes, targets the organization and sequencing of the content through four trouble areas. These areas are referred to as selection, sequencing, synthesizing, and summarizing. It is the effective use of these four areas among the responsible application of other important theories that can make the difference between a successful and an unsuccessful online course (Huang & Liaw, 2004; Ludwig, 2000).

Traditional Instructional Design

Traditional instructional design involves breaking instruction down into smaller units of knowledge. The units are taught outside of the actual environment in which the behavior actually takes place. Students respond to the stimuli, they listen and take in knowledge, and the relationship between the student and the instructor is hierarchical. Since the learning environment is controlled, the practice has been criticized, because of the lack of authentic interactions and the need for individuals to make adjustments and solve problems to different situations as they occur naturally. Traditional instructional design instructors observe inappropriate behaviors, they present the situation to the students, and they follow by presenting the correct behavior for the situation. Behaviorism holds that by presenting students with correct information that the learners can be controlled and guided to perform in a specific way. When Traditional instructional design theory is used, instructors use the technology tools to convey information and reveal concepts. Students in the behaviorist learning environment based on traditional instructional design use the technology tools to solve classroom-based problems, and when the technology tools are the object of instruction, the use of the tool is taught during an individual lesson. In this type of behaviorist learning environment, the learners carry out...
Behavioral Theories that Guide Online Course Design

the same activities, instructors implement the strategies, students have few choices, and evaluation occurs at the end of the instruction. When learning does not occur, the strategy for teaching is thought to have failed and a different strategy is used to make sure that the correct behavior is learned (Grabinger, 2004).

Teaching Tips

Behavioral technologists indicate that they can design programs that target precise and broad goals (Becker & Gersten, 1982). Other behavioral technologists indicate that to apply effective behavioral theory into instruction when using technology that the techniques should be implemented along with cognitive learning experiences that include interaction between students (Spaulding, 1970). Models of teaching and learning that are based on behaviorism call for the instructor to provide the students with positive and negative reinforcements. When using behavioral theory to manage a classroom that utilizes technology, instructors should provide students with a list of negative behaviors and their negative reinforcements as well as a description of the positive behaviors and the positive reinforcements that students can expect to occur when the occasion arises. As students become off-task, instructors are encouraged to praise the on-task students to get the off-task students back on track. Students who are learning to use a new software program should not be expected to move through each step at the same time, according to behavioral theory. Instead, students should be encouraged to move through each step at their own pace and instructors are advised to make sure that each student masters the concepts and skills that are part of the step before moving on to the next step. Finally, when motivation is involved, instructors are encouraged to allow students to assess or self-score their own work. This type of experience allows the students to analyze mistakes and set new goals for themselves (Joyce et al., 2000).

REFERENCES


KEY WORDS

Behavioral Theory: Behavioral theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of behaviorism hold that the environment has an impact on learning and that all behavior is learned.

Cognitive Theory: Cognitive theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of cognitivism guide students to process information in ways that are meaningful to the student. These theories are based on declarative and procedural learning tasks that are authentic.

Humanistic Theory: Humanistic theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of humanism focus on learner’s affective needs that include their feelings, emotions, values, and attitudes.

Instructional Design Theory: Use of theory by professionals when designing, developing, managing, and evaluating a learning experience.

Online Instructors: Qualified individuals who have had the schooling or training to teach or guide learners to gain new knowledge and abilities in an online learning environment.

Online Learning: A form of learning in which learners interact with each other and the instructor through either asynchronous or synchronous modes of learning.
INTRODUCTION

Blended learning goes by several names, the other major one being hybrids. What is meant by these various terms is that more than one delivery system is being used for one course. And in most cases educators are referring to face-to-face learning and online learning being paired in some combination when they use the term blended learning in a technological context.

In 2007, our world has finally ridden the surge into distance learning, with online learning being the predominant format. While distance learning has deep historical roots to Ancient times when messages were carried by carrier from town to town, 20th Century distance learning has spanned the mail-dependent correspondence course, radio transmitted tutorials, and still familiar public TV courses including not only GED classes but also community college course as well. In business, videoconferencing added an additional educational delivery format surge in the midst of this timeline, but was too expensive to be widely adopted in the 1980s-1990s for home users and their own education (King & Griggs, 2007). Since 2005 we have added formats that include Web 2.0 technologies and more interactive and participatory options for students and teachers alike: blogs, vlogs, podcasts, wikis, and dynamic multimedia of all sorts.

In the first wave of distance learning arriving at the gates of higher education, there was the universal cry of “bricks or clicks?” As is often the case, change was nervously perceived solely as an “either/or” possibility. Universities at first down cried online learning as inferior to face-to-face learning, and then major institutions began to participate in the trend. Fast forward to 2005 and we see some major universities pulling back out of their major investments in online learning (Carlson, 2003). Why? Because they had invested in the either/or perspective when a “both” option was available.

Blended learning can be thought of on a course or programmatic level. That is, a course can be offered partially by distance technologies and partially face to face. In addition, why could not a program of study be offered in a blended format—some courses via distance education and some face to face? At a time in 2007+ when we know students look for options, convenience, and flexibility to adapt their learning to their complex lives, this is a critical point some schools, colleges, and universities continue to by-pass as an option. The details of administering a blended program are not dif-

Figure 1. Blended options

<table>
<thead>
<tr>
<th>Blended Options</th>
<th>Face-to-Face</th>
<th>Synchronous Online and/or Videoconference</th>
<th>Asynchronous Online</th>
<th>Prerecorded Video, DVD, TV, Podcast</th>
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<tbody>
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<td>Blended 9</td>
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</table>
Blended Learning

If you are hosting blended courses; therefore, in the economy of discussion we will focus on blended classes.

Forms of Blended Learning

Perhaps the forms of blended learning might be most easily explained in a chart where you have the variables of technology and time as options and you can see how they can be combined to create all sorts of “blended options.” This chart is only designed to be representative of the principle of blended learning and can never be an exhaustive list as new technologies and capabilities arise each day.

Benefits of Blended Learning

Today you will find blended learning in many more places than you would have just 2 years ago. Indeed, my recent explorations of local colleges have surprised me at the widespread adoption and sophistication of support services for this programs. Given the history of community colleges, their mission, student population, and faculty, it should be no surprise, but given the relative quietness of this blended learning trend in higher education over the last 10 years, it is pleasantly surprising to see the mushrooming development of what has such sound pedagogical and andragogical bases (Baker, Dudziak, & Tyler, 1994).

Among the benefits of blended learning are:

• **Flexible scheduling**: A blended class may meet on campus one day per week and have an online session another day. In this way, students and teachers only have to be at a designated physical location one time per week and can schedule the other time based on their life needs.

• **Decreased classroom space demands**: Related to the flexible scheduling is the fact that blended learning classes meet on campus less frequently per semester, thereby freeing up classroom space for additional course offerings or activities.

• **Academic adjustment strategy**: Blended learning can also be used as a strategy to help students, faculty, and administrators adjust to online and distance learning. Rather than yielding control of classes to an entirely distance delivery, they can start with the combination approach and still maintain a sense of traditional control, “face-time,” personal contact, contact hours, or whatever the issues might be that are of concern.

• **Multiple instructional methods**: Because of the multiple technologies used in these formats, a variety of instructional methods can easily be used in a blended learning class.

• **Multiple learning styles addressed**: With more instructional methods being used and more modes of communications, it stands that a greater span of learning styles will be addressed with blended learning. That is, for example, in many cases not only the auditory learner, but also the text and visual learner would be accommodated.

• **Increased 21st century literacy skills**: As students engage in blended learning courses they use digital media and related 21st Century learning skills in authentic ways. Therefore, in addition to the content of the course, they have opportunities to develop information literacy skills and hone their critical thinking skills among many others. In addition, in a society that is digital information based, they both enhance their advanced academic preparation and valued workplace skills through this learning.

These are a few of the prominent benefits of blended learning at this point in time. The list can be quite extensive when viewed from the possibilities and perspectives of social interaction, global partnerships, interdisciplinary study, collaborations, and further advanced yet emerging technologies.

Future Trends of Blended Learning

As stated, since 2005 Web 2.0 technologies have provided more interactive and participatory options for students and teachers alike to be included in the technological aspects of blended learning. These Web 2.0 technologies include: blogs, vlogs, podcasts, wikis, and dynamic multimedia of all sorts. In addition, the inexpensiveness and ubiquity of technology that used to be high-end has changed options for students at home as well. Therefore, they can now, and will in the future, more fully use desktop (and laptop) videocams, microphones, scanners, digital voice recorders, MP3, and portable video players.

For example, rather than these items only being for the more prosperous students, they will be standard
issue. Much like most textbooks now include CD or DVDs, why could not a foreign language textbook be packaged with a MP3 player/digital voice recorder (average cost in 2007 $30)? Therefore students would have the vocabulary, conversations, and dictation pre-loaded and portable and the means to record responses and upload them to the teacher?

In addition, many schools, colleges, and universities are using distance technologies and blended learning to build global partnerships. It could be that blended learning can be the form that these global partnerships can take more solid forms in the accredited curriculums in a wider representation (King & Griggs, 2007). Such experiences could bring a positive social learning outcome to Web 2.0 technologies through blended learning on a broader basis.

CONCLUSION

More than a “fill-in” strategy, blended learning has emerged in just the last 5 years to be a valued approach for course delivery. Combining many of the benefits of distance learning with traditional face-to-face instruction and support, students and teachers gain greater flexibility of scheduling, variety of instructional methods, and opportunities for interaction. Emerging technologies and public user sophistication and comfort with them together will steer which educational technologies can be best integrated into the vast varieties of blended learning options that can be created. As always, it is important to have frequent communication among teacher and learners to know what works and what does not. Exciting years are ahead as we see what we and our future educators create in this area.

REFERENCES


KEY TERMS

Blog: A web environment which can be easily updated by an individual or organization. Purposes for a blog can range from personal journaling to political persuasion to corporate marketing and anything else. See blogger.com, wordpress.org, and livejournal.com.

Intellectual Property: The intangible property right to protect the intellectual work of the person/s who created it (includes patents, trademarks, designs, and copyright).

Podcast: Combination of the words iPod and broadcast to represent the technology of distributing an audio file over the Internet via an RSSfeed. See entry on Podcasting for more information.

Vlog (video blog): Usually a short video narrative or story created for and posted on the Internet for public viewing. Technical formats dominating in 2007 include Quicktime movie files (*.mov), and MPEG4 files because they are relatively high quality and can be small file size.

Wiki: A universal definition is that a wiki is a Web page that can be easily changed by anyone. A Web-based interface that has been developed to most fully encourage and ease collaboration. More than the collaboration of a Web-based bulletin board, a wiki allows users to add, delete, and edit pages in the environment to name just a few of the fundamental construction functions in which they can participate.
INTRODUCTION

A blog (shortened version of Weblog) is an online journal usually displayed on a Web site that contains entries listed in reverse chronological order. Blogs combine text, images, hyperlinks, and in some cases, audio to provide information on a specific topic. Blogs are used for a variety of purposes, primarily as self-publishing online diaries and Web journals, but they also serve as news sources for social, political, and cultural interests.

BACKGROUND

Debate exists over the genesis of the blog form, but in the late 1980s, the first model for the concept may have been online bulletin boards. Unlike listservs, bulletin boards maintained a series of threaded messages that were later archived. Readers that had access to the bulletin board could post additional messages and comments to the primary message or even threads of the discussions. Individuals seeking previous postings on a given topic could then search through the thread or board archives. Some people believe that these features established the basic structure of a blog. Yet, others believe that blogs evolved from individual personalized Web sites that presented diary-like journals and essay like comments on current events. The rise of self-publishing content on personal Web sites provided Web writers the opportunity to share their musings with an online audience. Tweny (2002) suggests that Justin Hall’s *Links From the Underground* (1994) can be considered one of the earliest blogs whereas Rebecca Blood (2002) cites Mosaic’s “What’s New” page (1993-1996) as the “progenitor” of blogs since it was updated daily and allotted public access. Some of the other early blogs were developed by Jesse James Garnett (*Infosift*), Cameron Barrett (*Camworld*), and Dave Winer (*Scripting News*) which is considered one of the longest running blogs.

The actual term “Weblog” was coined by Jorn Barger (1997) in his blog *Robot Wisdom* and two years later, Cameron Barrett’s article entitled “Anatomy of a Weblog” gave the concept of we-blogging a public forum. Werbach (2001) suggests that the collective use of the word “Weblog” to categorize online journal sites occurred around 1997 and soon thereafter the shortened version “blog” became the mainstream term. Although the first bloggers appeared to be an underground Internet community, *The New York Times* (2001) did a feature on new media for an article about emerging technologies and introduced the blog, *Lemonyellow* to public focus. Soon, as with any other new Internet fad, the list of new blog sites began to expand causing many of the veteran bloggers to distinguish themselves from the novices. To maintain separation, veteran bloggers began to create “blogrolls” and blog neighborhoods which established specific protocols for acceptance into the established community. Even today, blog writers have formed Webring groups around blogging software. In some instances, blog tribes have organized to secure associations and build cooperatives within the community.

Most of the early blogs were individually created by hand and required a good knowledge of programming and Web design. Blood (2002) cites Andrew Smales as the creator of the first open source Web-based tool for public application. Smales’s created an application form template which enabled individuals unfamiliar with blog programming to simply write their entry and post it. Soon, more and more novices began to create blogs on a wide range of topics. The “blogosphere” expanded even more when Pyra produced Blogger in 1999 to provide even greater ease for public users to create blog sites. By 2000, there were over 100,000 blogs. Additional software applications for blogging appeared (for example, User Radioland, Moveable Type, Live Journal) and continue to emerge. By 2003, blog software and blogging-related peripheral tools had generated an entire new market for the tech industry.
Since blogs were now being viewed as valuable resources for gathering current information, they began to rival other traditional news sources. As a result, traditional press services began to investigate how to integrate blogs into their reporting. In 2000, Editor Chris Alden of the British *Guardian* was the first journalist to integrate the blog form to expand distribution of news reports and related information. The success of the Alden’s venture, in turn, positioned the blog as a “must-use” tool for journalists and other press corps. Blogging directories such as Brigitte Eaton’s Eatonweb Portal and indexes such as Blogdex were developed in an attempt to organize the increasing number of blogs. Beebo’s Weblog Ratings examined blog traffic and rated the most common links referenced in blogs. Reference sites on blogging tools were developed to decipher the differences between applications and by 2003, several blogging search engines began to appear to help online readers locate blogs by topic area. As blogs entered into mainstream culture, an entire dictionary of terms associated with this communication tool gave credibility to blogger jargon. In response to the blogging trend, publishing houses began marketing books on how to create blogs and how to use blogs at work and in education. Even libraries joined into blogging using the tool for increasing the outreach of book chats and other user services. The popularity of blogging was reinforced when in 2004 (Wikinews, 2004), *Merriam-Webster’s Dictionary* cited “blog” as the word of the year.

**FOCUS**

Perhaps the primary success of the blog as an Internet tool has grown out of its ease of design and use. Most blogs are set up as an electronic journal and include the title of the page, the main content (or body of the post), the post date, and a permalink that provides future access when the link is placed in the archives. The sidebar section on most blogs which lists various links to Web sites and other blog sites was first introduced by Cam Barrett who had integrated the feature to alert his readers about new blogs he was reading. Permalinks provide a unique URL to each post on the blog so that when the post is transferred to the archive, it can still be accessed. This feature avoids the problem of broken links and helps maintain an active archive. The dated postings, the sidebar section of links, and permalinks are the most standard features of every blog. Newer features include blogrolls and trackback (or pingback) functions. Blogrolls are listings of other blogs read by the author of the primary blog. Often bloggers try to provide links to other blogs related to the topics of their blog. Political blogs will link to individuals that support or promote their platform. The trackback feature is a system tool that lets one blogger know if another blogger has linked to a posting. Pings serve as search tools that locate recent posts of offsite blogs to help gather information on a topic or updates on information related to the subject of the blog. Some commercial blogs provide post scheduling to let readers know when posts will be written. Other blogs make use of news aggregators or RSS feeds which allow the blogger to pull in additional links and information for updates as well.

Since blogs have gone commercial, a number of providers have developed systems to eliminate the need for users to know how to do programming and Web design. Web applications allow new bloggers to use the software without having to maintain a server. Open source and free Web-hosted sites enabling anyone to set up a basic blog has also contributed to expanding the blogging community. Fee-based blogging sites offer more security and additional features as well as technical support. Security features such as captchas require people to register to the blog site so that the blogger can identify who is posting to the site. The blog owner can then moderate who has access to post or read on the site. In addition, individually purchased applications allow individuals to establish their own blogging communities. In 2003, Dave Winer established a blog project at Harvard (*Weblogs at Harvard Law*) with the Berkmen Canter for Internet and Society to establish an intellectual community for bloggers at the university. Students and faculty have access to set up blogging sites to discuss topics of learning. Winer’s venture brought rise to the idea of blogging as an educational tool. Soon, blogging would venture into the corporate sector as well.

The varied use of blogging tools dictates their form. As with any application, blogs can take on several different formats. *Blood* (2002) cites three basic forms of blogs: basic blogs (short form journals), notebooks (longer posts that resemble short stories and provide more focused content), and filter blogs (short quips or links that serve as feeds for information). Some blogs resemble combinations of these three forms, but most
Blogs

appear to adhere to the short journal format. Blogs are usually accessible, but some software tools have built in password protection features to limit access to the author and selected readers. Some blogs are set up as read only sites whereas others encourage collaborative posting. Blogs can be hosted on a free or fee-based server depending upon the features and extras the blog owner selects. Some individuals opt to host their own blog site and install the software on their own server. In both cases, blogs are controlled by a database that organizes the posts (for later searching and archival storage). Blog types are also often defined by the type of content they deliver. For example, a blog solely comprised of videos is called a vlog, a blog that is used for project development is often referred to as a blog, and one comprised just of photos is called a photoblog. Blogs that are written by mobile devices (such as a mobile phone or PDA) are often referred to as moblogs. Clyde (2004) considers moblogging or m-blogging to become more prevalent because of its “24/7 anywhere anytime” capabilities. Individuals needing to update or check on the postings of their blogs can do so with immediate access.

Although the majority of blogs are controlled and developed by one individual, some blogs are managed by a group of people or blogging collaborative. Political or educational blog sites are often organized as collaborative spaces to allow group members to update the primary site with a discussion of events and other important group information. Educators using blogs as supplemental texts for students are finding ways to create full online courses with the application. Blogs have also been applied in business and industry sectors, government agencies, and even in Hollywood. Many celebrities have begun blog sites for publicity and for communicating with fans. Radio stations and other music venues have established blogs for listeners and fan clubs. The ability to provide updates to information quickly is viewed as a highly effective means of communication. The simplicity in using the tool to disseminate information has only increased its popularity.

Perhaps the first greatest historical impact blogs made grew out of their use in presidential politics. In the 2004 Democratic primary, Howard Dean’s use of the blog for his political campaign made such an impact with young voters that other campaign managers took notice. Now blogs are used in nearly every facet of the political arena for outreach and fundraising. Candidates have now had to hire blog managers to make certain their site is updated and secured. Blogrolls on these sites include blog listings of campaign supporters and links to endorsements. Candidates can respond to the posts or distribute their messages about campaign issues to a much larger audience through use of a blog.

However, blogging in politics and in public media has had its negative impact as well. Hewitt’s Blog (2005) details how the “open source journalism” of blogs has contributed greatly to finding out information on topics not often covered by the traditional press. Bloggers were credited with publicizing Trent Lott’s support of Strom Thurmon’s anti-civil rights voting record, exposing the truth about Dan Rather’s use of unauthorized documents in a news report about President Bush, and revealing the truth about Senator Kerry’s activities in Cambodia. Blogs generated by political parties often perpetuate misinformation about opposing candidates and attempt to lobby public opinion for or against issues. In turn, the speed at which blogs can deliver information that influences public opinion has raised concerns from those in the public eye. There is even specific blog watch sites designed to get the story of the moment out before the traditional press has had time to confirm it. To manage the information from blogs, some television news shows have begun to use blogs for public opinion commentary and interactive communication with their viewers. Blogs written by objective authors are given more media attention and often cited in reports. People are also invited to post their views on a given topic related to the news and then their comments are integrated into the journalist’s report. Attempts to verify the credibility of some bloggers have begun to create a series of “blog-wars” in which individual bloggers face off at who has posted the most accurate information on a given subject.

It is no doubt that the access and dissemination of blog commentaries has concerned many people in terms of both legal and social issues. The public nature of blogging has led to several legal issues involving privacy, copyright, and fair use. In some instances where content has not been properly cited, there have been concerns that writers are manipulating commentary as their own musings, improperly quoting sources for information, and taking lines out of context to illicit a response. Since bloggers essentially “cut and paste” reports into their own site, the material that gets transferred may not always credit its original source. The social element of blogging has also concerned
many parents. Since bloggers are able to express their comments freely on their site, children and teenagers can gain access to discussions of topics that are often restricted in other venues.

Blog content has also stirred great controversy in the workplace. Several individuals have been fired for misrepresentation of their employers or for writing about topics that contradicted their employer’s values. Other individuals have been fired for blogging simply because they hosted their blog on an employer’s Web server. Most instances of termination have resulted from issues regarding confidentiality, defamation, and libel. In turn, numerous court cases and penalties have also been initiated over comments made in a blog. Mark Cuban, the owner of the Dallas Mavericks was fined during the 2006 playoffs for comments he made on his blog against several NBA officials. Several professors have been fired for comments made about their institutions and for violating the privacy of their students. In response, perhaps as a fair warning, The Papal Bull (2006) has begun collecting a list of everyone who has been fired for blogging.

FUTURE TRENDS

Future blog features may include more improved research and end-user capabilities. Blogs will be able to search not only the archives of the parent blog, but perhaps blogs that are directly linked to it. Elements to modify and share posts will be improved for those who engage in moblogging. Combinations of blogging tools and wiki tools (blickis) will yield even greater interactivity for group work and collaborative writing. Blogs with multiple layers of access built in may offer password protected areas or limited access to features hosted on the site. Custom blogging systems may include streaming video and audio features that permit direct access to concerts and other live performances. Future features may even transform the blog form into an even greater interactive tool. Inevitably, new laws will also be passed to manage the legal issues of the blogosphere. As blogging for public sectors becomes more widespread, there will be more lawsuits over libel and violations of privacy. It is likely that industries will revise employee handbooks to include the rules and regulations for blogging. Universities will also have to address the issues of pedagogy if instructors use blogs to teach their courses. Students may have to adhere to specific guidelines to manage a blog on a university server. Acceptance use policies will have to address blogging. Blogging may generate an entire industry of its own.

As blogging software becomes more sophisticated, it is likely that the blog will be used for additional communication applications. The tools for audio and video blogging have improved to further increase interactivity such that blogs are now rivaling existing courseware platforms. Since educators have found many innovative ways to integrate blogging in their instructions, more enhancements for teaching and learning with blogs will be built in to foster collaborative networking and information sharing. As more universities attempt to connect with entering students and exiting alumni, expect more university blogging communities such as Weblogs at Harvard Law to develop. Business and industry will also make greater use of the blog forms for marketing, project management, and strategic planning. It is likely that almost every major corporate organization will outfit a blogging aspect to their Web site. Blogs will become integrated into additional service industries as a means for customers to communicate with vendors. Companies that want to keep their clients updated on new product lines may use blogs to provide quick access to information of updates and sales. Government agencies, health care organizations, and other non-profit organizations will rely upon blogs to share and provide timely information. Libraries will continue to include blogs to expand outreach and services to those home bound. Nearly every print news publication will have an associated blog tool for correspondence. And just as the digital camera became a household tool, blog applications will also be used for families to interact with each other when they are apart.

CONCLUSION

As a Web-based tool, blogs have made a definite impact on communication media because of their potential applications. The popularity of blogs will continue as long as there are no regulated restrictions placed upon the blogosphere. However, as more social, political, and personal liabilities issues occur as a result of blogging, it is possible that new legislation may be introduced to protect educational, corporate, and government entities. Hewitt (2005) believes that blogging will be “an essential part” of any effort to communicate ideas and
influence public opinion. He sees blogging as the start of a revolution of information sharing and seeking that will inevitably impact the ways in which decisions will be made. In turn, blogging may be valued so highly simply because it reinforces the idealistic notion of having a voice that can be heard, or in this case, one that can be read.

REFERENCES


KEY TERMS

Archives: A collection of all the blog’s posts on one page.

Audioblog: Blogging using audio instead of text.

Blog: Short form for Weblog.

Blogosphere: The Internet blogging community.

Blogroll: List of links to other blogs in your sidebar. Also see blogrolling.com.

Captcha: Short for “Completely Automated Public Turing test to tell Computers and Humans Apart”. Those word and letter verification images you need to type in to show you are human and not a machine.

Dashboard: The first screen with all controls, tools, and functions that one sees when they set up their blog.

Feedburner: A professional feed management system.

Moblog: A blog posted and maintained via mobile phone.

Permalink: A permanent link to a specific article.

Photoblogging: A blog predominantly using and focusing on photographs and images.

Ping: Short for Packet Internet Grouper. Blog and ping helps to notify other blog tracking tools for updates, changes, and trackbacks.

RSS: A family of Web feed formats used for Web syndication. Short form for Really Simple Syndication (RSS 2.0), Rich Site Summary (RSS 0.91, RSS 1.0), RDF Site Summary (RSS 0.9 and 1.0).

Sidebar: One or more columns along one or both sides of most blogs main page.

Technorati: A real-time search engine that keeps track of what is going on in the blogosphere.

Trackback: A system by which a ping is sent to another blog to notify that their article has been mentioned by you.

Vlogging: Blogging using video instead of text.

Weblog: An online dated diary listing your periodic thoughts on a specific topic, often in reverse chronological order.

Wiki: A collaborative online software that allows readers to add and edit content.
Chat as New Pedagogy: The Emerging Communities of Learners in Higher Education

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INTRODUCTION

There is a new pedagogy in which college professors use computer information technology as a means to enhance effective collaboration. The World Wide Web, e-mail, discussion boards, chat rooms, and Instant Messaging are services offered on the Internet. As a new medium of communication, this emerging technology offers educators unprecedented opportunities to augment or fully devote courses to innovative formats. Chat provides a venue for communities of learners to communicate in real time. A chat room is a Web application that allows two or more people to type messages to each other at the same time. There are many types of chat rooms used by online learning communities via the Internet.

Communication is integral to the overall process of collaboration (Brown, Mittan, & Roen, 1997). The most common place for chat activity is on Web sites or computer programs. The virtual classroom is basically a chat application offered by the university with access privileges extended to students enrolled in a class. Chat activity can be further defined as Web-based communication in real-time. It is interactive, allowing individuals to communicate on any number of Web-based discussion channels. Chat is synchronous, providing users with highly desirable real-time networking abilities. While general chat rooms are a popular phenomenon, there is also a burgeoning market for topic-driven chats in which participants can talk, ask questions, and interact with people. These chat rooms are online gathering places and in certain contexts become virtual learning communities. Information in a chat room can be obtained by simply reading the continuous conversation on screen. Chatters can also request information by posting questions and comments. The chat room participants can dispense information by posting conversation in response to another participant’s post or by beginning a new topic.

Synchronous and asynchronous communications provide an opportunity for student interaction that further enhances the learning process (Murray, 1999). Chat is still in a refining process as this form of collaborative learning continues to evolve in academia. The new chat-collaborative paradigm is changing the way pedagogies are implemented. Advancements in information technology provide an augmentation that college students consider a natural part of their communication culture. The amelioration of chat is allowing creative collaborations to take place across distant sites. Chat’s enculturation process provides the community of learners’ unprecedented interaction that probes new depths of understanding, problem-solving, and learning.

BACKGROUND

The educational community is beginning to realize possibilities made available through the chat medium. Chat is considered a contemporary mode of communication that is gradually being implemented in online educational networks. The Forum on Technology in Education (Dnkauth, 1999) notes, “How we use technology in the classroom is more important than if we use it at all” (p. 1). Chat is an excellent resource for building a community online, but more specifically, it can be an effective pedagogy. The chat format is an essential component of distance education, where students do not communicate face-to-face. Chat, as a communication resource, helps facilitate online conferencing to support collaborative activities. The process of creating an online community requires participants to be tech savvy, collaborative, and reflective. Summarizing their research on chat, Russell and Halcomb (2002) note,

This single classroom activity produced two behavioral products: (1) first, the virtual group discussion
Chat as New Pedagogy

Chat as a mode of instruction provides interactive learning, meaningful instruction, enhanced communication and collaboration, and a more timely assessment of the learning effectiveness in comparison with traditional methods. Bonk (2002) states:

In terms of collaboration, the chat tools nurture learner brainstorming and questioning, presenter clarifications and explanations, role-play and private one-to-one mentoring. They can foster the collection of immediate responses to an idea from learners around the globe. (p. 5)

From an instructional standpoint, teacher/facilitator training should establish and advance quality experiences in the online chat format. The capacity for professional development to advance experimentation, innovation, and implementation of effective communication technologies should be continuous. Chat requires universities to establish technologies with strong infrastructures and a commitment to provide ongoing training. Also, in an increasingly competitive market, administrators are compelled to know the generational characteristics of potential students. Generation Y’ers, or the Millennium Generation, are ages 12 to 29 and “have spent one-third of their life on the Internet…are very tech savvy…totally plugged in… and variety to them isn’t lots of things; it is a few things that change frequently” (Chico State Inside, 2006, ¶ 6). Generational characteristics are not merely a matter of young vs. old. Rather, it is a transitioning process from one generation to another in which values are determined.

The Collaborative Paradigm

“There is no mistaking the shift in society’s focus from thriving on competition to the need for collaboration. Therefore, education must prepare workers for these environments” (Bonk, 2002, ¶ 3). Brown and Gray (1995) observe, “When a company acknowledges the power of community, and adopts elegantly minimal processes that allow communities to emerge, it is taking a giant step toward the 21st century” (p. 1). The advent of computer technology coupled with a growing accessibility of communication channels have caused collaborative learning to undergo a metamorphose of sorts. New and promising technology-based collaborations are being designed and implemented in universities.

Nichols (2002), states, “Communities of Practice are groups of people in organizations that form to share what they know, to learn from one another regarding some aspects of their work and to provide a social context for that work” (¶ 8). Communities of practice serve a valuable purpose in business by transferring knowledge and expertise from one individual to another in a socially engaging format beneficial to all. These communities are unlike a task force, which is given a specific duty or function to be performed and upon completion of the task the group has no other purpose. They are disparate from the concept of team. Teams operate with contingencies for the varied personalities and roles that evolve in team processes. The community of practice concept is an innovative idea, another seminal training notion that higher education has borrowed from business. The challenge for higher education is to take this concept and ultimately make it an adaptive pedagogy. Chat communities in an educational environment can facilitate, nurture, and enhance learning. Faculty portals developed to teach these concepts may prove to be visionary.

The Collaborative Nature of Online Chat

The collaborative perspective recognizes that students are active participants in the process of constructing their own knowledge (Kafai & Resnick, 1996). Therefore, it is essential that higher education faculty contemplating the use of chat understand the issue of
Chat as New Pedagogy

real time collaborations. They have a critical role as facilitators of the collaborative process. Establishing a common and meaningful purpose for collaboration is an initial challenge. Sustaining this purpose within the richest context of learning is an ongoing process. Faculty-facilitators affirm the contributions of individuals expressed in written language as a valued and esteemed commentary. Feedback, reinforcement, and sensitivity are all part of the nurturing process to develop a proper context for learning (Kerr, 1986). Online communication tools enable students to interact with subject matter, the instructor, and their peers outside of the classroom. In the truest sense of collaboration, students negotiate the meaning of course content through interactions with others in a specially created community of learners. Frequently, sharing problematic scenarios in a real world context is a catalyst for getting students involved. The interaction of individuals through relevant and meaningful conversation provides a unique learning experience. Therein, the student is “involved in constructing knowledge through a process of discussion and interaction with learning peers and experts” (Harasim, 1989, p. 51). There is a unifying aspect in presenting a well-related, feasible, and timely problem to a community of online learners, which causes them to collectively reflect upon a solution.

Kanter (1999) identifies three qualities of leadership pertinent to the discussion of collaboration, “The imagination to innovate…the professionalism to perform…and the openness to collaborate. Leaders make connections with partners who can extend the organization’s reach, enhance its offerings, or energize its practices” (¶ 2). Community building is an on-going task of information technology as McDermott (1999) observes,

They often need to share knowledge that is neither obvious nor easy to document, knowledge that requires a human relationship to think about, understand, share, and appropriately apply. Ironically, while information technology has inspired the knowledge revolution, it takes building human communities to realize it. (p. 3)

An online learning community provides a level of support, sharing, and trust among its participants. The successful online chat has a synergistic effect in which students build on one another’s perspectives to gain a deeper understanding of the materials.

An Emerging Pedagogy

Pedagogy is how teachers orchestrate classroom learning and the implication of this orchestration is significant in light of technology’s rapid ascent. Effective teachers acquire a broad spectrum of skills and abilities that foster a rich learning environment. This continual process of honing pedagogical skills and abilities manifests itself in a disposition to teach at the highest levels. An integral part of this process is for the teacher/facilitator to probe his or her understanding of the learner and learning environment. Every student has a unique learning style. Students known for their passive nature can flourish with a greater sense of empowerment when placed in an online chat format. While some students are visual learners, others learn by doing, which emphasizes a more hands-on approach. Online learning environments enable the teacher/facilitator to develop one course, yet offer a variety of learning resources. Students are then able to adapt a learning style that helps them. Chat’s quick feedback, interaction, and reflection are highly desirable. Chat, when implemented in a pedagogically sound context, becomes a forum where academic and personal growth can be nurtured. The extent to which pedagogy fosters a sense of community between participants is critical. An important role is played by the teacher/facilitator whose responsibility it is to assure quality subject content balanced with participation.

McMahon (1997) identifies learning as a social process. While constructivism itself does not advocate a specific pedagogy, it emphasizes the contribution of culture in a societal context and the construction of knowledge based on that perception (Derry, 1999). Chats allow students to become active participants in a learning experience that is both individual and group-oriented. Interpersonal communication through conversation and collaboration is facilitated by a teacher whose skillful expertise brings an added dimension. Properly implemented online chats are pedagogically sound. Students enlist constructivist learning principles permitting them to create their own understandings based on their chat experience. This unique interaction between students, teacher, knowledge, and technology results in an emerging pedagogy. Instructional models engaging this pedagogy are varied but focus on the concept of knowledge as a social construct. The collaborative learning model utilizing chat in education is currently being retooled as innovative communication technologies are developed.
Berge (1998) identifies potential hindrances to communication technology as situational, epistemological, philosophical, psychological, pedagogical, technical, social, and/or cultural. It is incumbent upon the teacher/facilitator to establish a pedagogical foundation upon which the community of learners can build appropriate context, philosophical bent and cultural appreciation.

The role of the moderator in an online conference is as complex as any teacher or trainer in a face-to-face situation. Issues of educational philosophy, relationships with learners, power and control, the nature of knowledge and learning and so on are as important and problematic in [online environments] as they are in face-to-face meetings. (McConnell, 1994, p. 55)

The teacher/facilitator utilizing online communication technologies such as chat must be sensitive to inherent factors that can impede the progress of online learning communities (Hillesheim, 1998). It is therefore essential that teachers experience the emerging technologies as learners so that they can empathize with their students in a chat environment.

The primary reason for skepticism of chat as an emerging pedagogy is due to improperly designed courses that lack the support needed to sustain them. Nachmias, Mioduser, Oren, and Ram (2000) note

A common practice is to push the technology into the class expecting that this by itself will make a difference in educational processes. Experience shows that without the creation of an appropriate technology/ pedagogy composite, no educational impact should be expected. (p. 2)

A lack of attention to pedagogy can account for why some communication technologies have failed to reach their potential. The evolving nature of technology has produced various communication tools. Each medium has its own unique characteristics, which makes pedagogical decisions more complex.

Concerns of collaborative environments in the past as well as today involve the technical problems that tend to frustrate collaborative efforts. Computer hardware and software problems, poor typing skills, and lack of motivation can all be factors. It is prudent to know the technology barriers that may or may not exist with potential online students. The necessary high speed equipment and connection may not be available to all chatters. The online learning experience may vary for users when technology is dissimilar. Universities should take accessibility into account when developing programs for a community of learners.

Ethical Concerns of the Chat Environment

Chat is text-based; consequently, it is more difficult to fully understand the nonverbal communication taking place in real time. Communication in this context is void of observable mannerism or gesture, which helps identify and communicate an individual’s intent when the interaction is face-to-face. Also, the dual meaning of words, a lack of response, abbreviated expressions, slang, and other intended or unintended written language can create an environment of misunderstanding, distrust, or superficiality. Words frequently serve as prompts for action. It is convenient for chatters to create an identity to protect, project an image, or achieve some purpose other than simply being who they really are. This merits a constant reminder that in a chat environment people may present themselves as being different from who they are in reality. This is less a factor in educational online chats that are closely monitored by a teacher/facilitator. In a university setting, the chat environment is tailored for pedagogical purposes but not so structured as to usurp group consensus. In these environments, the tendency is for a community of learners to decide rules and netiquette in collaborative fashion. Inherent in the evolving structure must be an ethical underpinning that protects the online learning community.

Young (2001) suggests that “ethical warning labels be prominently displayed in public chat rooms to alert users that their comments are on display” (p. 1). It has become increasingly common for teachers/facilitators to post their class chats allowing participants to gain a holistic perspective on the evening’s chat session. Meshing ethical principles with ever-evolving technology tools has spawned new dilemmas for educators. This uncharted territory requires chatters to reflect, establish, and enforce the values of their online culture. Adherence to a collaborative code of conduct eventually takes place in chat rooms, online bulletin boards, and discussion lists because their interactive nature requires some general rules.
CONCLUSION

A meaningful pedagogy should help students understand people and cultures beyond their own. Chat within an educational context provides a medium for students to learn both content and culture in real time. In having students create their own culture, they become gatekeepers of a process that nurtures learning, collaboration, and innovation. This process requires communication and critical thinking skills, tech saviness, and the ability to work collaboratively. A successful online community applies technology effectively to enhance learning and develops opportunities for a variety of learning experiences. These experiences can give rise to learning strategies that can be implemented and advanced by the community of learners.

The new collaborative paradigm in education has forged an interesting and integral association with technology. Online learning communities can nurture a synergistic relationship that not only achieves course objectives but benefits the entire university community through pedagogy. Shifting traditional teaching/learning paradigms into this new medium holds great promise. That being said, educational chat rooms present many challenges for which there are no precedents. Chat as an emerging pedagogy must evolve along a continuum ranging from course content to axiological ethics. The following initiatives will determine the extent to which institutions of higher learning are able to understand and implement new pedagogical schemas applicable to the emerging characteristics and qualities of Web technology:

1. Increased expertise and efficiency in systems of course delivery that do not compromise institutional integrity or quality.
2. The progress of faculty portals developed to enhance the role of teacher/facilitator in technology mediated courses.
3. The identification and implementation of resources that contribute to the enculturation processes of online learning communities.
4. A perpetual system for collecting, analyzing, and interpreting information about the generational characteristics of students in order to formulate policy and pedagogy.
5. An institutional adeptness for implementing change in the way information is exchanged through information technologies.

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Chat as New Pedagogy


**KEY WORDS**

**Adaptive Pedagogy:** The development of adaptive pedagogically-driven e-learning where the pedagogy is central to the learning experience.

**Asynchronous Communication:** Communication that is not synchronized, it includes computer-based technologies for which the participants need not be available or online at the same time. Examples include e-mail, blogs, threaded discussion, and text messaging.

**Collaboration:** Collaboration enables communities of learners to share information by working together cooperatively. It is both a process and end result.

**Communities of Learners:** Participants together construct a culture that values the strengths of all participants.

**Online Chat:** A tool that allows participants to create and enter online rooms within which to communicate in real time.

**Real Time:** Refers to sensing and responding to external events nearly simultaneously with their occurrence.

**Synchronous Chat:** A communication that is computer-related and happens in real-time; involves having the learners’ communication conveyed to other participants for immediate response.
INTRODUCTION

Today the global education community has become the buzz term in the realm of education and training. Learners in every location around the globe must acquire new skills, be literate, and understand constantly changing dynamics in globalization (Schrum, 2000, p. 91). College courses taught in the United States of America can be taken by students in Asia. Likewise, courses taught in Europe can be taken by learners in North America. Although younger learners like to travel to a different university in a different country in order to obtain a much-desired degree and to get cultural immersion in order to learn a different language, nontraditional learners prefer taking courses offered by foreign universities or corporations in foreign countries via distance education technologies in their home countries. This is not to say that nontraditional learners do not like to travel to foreign countries. Rather, they have multiple work and family responsibilities (Wang, 2006) that prevent them from being away from home for a long time. Obtaining a college degree is a several years long endeavor to anyone.

Today, people live in what could be termed a knowledge society (Jarvis, 2001). In a knowledge society, lifelong learning is a must. People learn at every waking minute (Gagne, Wager, Golas & Keller, 2005). Distance education has been viewed as a way in which to offer lifelong learning to those who are geographically separated from traditional institutions, have obligations that limit their ability to attend regular courses, or have other exceptional challenges (Schrum, 2000). Distance education has evolved from passive media (paper, audio, and video broadcast) to Internet network and communication technologies. And it has the capability to deliver courses to large numbers of learners anywhere anytime (King, 2006). Regarding the omnipotent nature of distance education, King (2006, p. 16) has this to say:

- The working mother in rural Nebraska completing her bachelor’s degree online through her local state university while her children sleep at night.
- The single young man in New York City studying for the GED exam via public television and telephone tutoring.
- The mid-career business woman executive pursuing her doctorate in education via hybrid online and residency program in order to change careers.
- The retired bus driver engaged in a collaborative Webinar for his class through a University of Beijing class on the Eastern perspective of global issues.

Indeed, King’s description indicates that today’s classroom is without borders. Distance education technologies have broken down the four walls of a traditional classroom. Not only is distance education asynchronous, but also it is synchronous. Courses are delivered via chat rooms and videoconferencing and these are considered synchronous formats of distance education. Distance education technologies, especially the Internet communication technologies, have created a shift in focus from our traditional four-walled classroom to a classroom without borders. Distance education is seen as a viable alternative for a myriad of “just in time” professional development and lifelong learning opportunities for learners in just about any location around the globe.

BACKGROUND

Traditional course offerings using a variety of distance education technologies are normally electronic mail, computer conferencing, two-way audio/video, and satellite delivery (Harasim, 1993; Hiltz, 1990; Rice-Lively, 1994; Schrum, 1992; Sproull & Kiesler, 1991). Numerous studies have concluded that this form of education is not only expensive, but also effective for well-motivated learners. The growth in the practice of lifelong learning has attracted a large number of nontraditional learners to turn to online learning. These learners frequently must overcome concerns about
time, distance, and money that traditional students do not have (Shrum, 2000). As the demand to take more online courses on the part of nontraditional learners grows, many educational institutions have expanded their programs to include traditional and nontraditional courses, partially or entirely online. And other entities such as military, business, and nontraditional educational providers have begun to consider doing the same thing for their employees.

The demand comes not only from domestic learners; the demand also comes from overseas. Most people in developing countries yearn for a middle-class living in developed countries such as the United States and Western Europe. Since these learners are from low-income societies, there is no way that they can afford to travel to developed countries to take college courses. Most leading universities have seen this potential education market overseas and have begun to develop and offer online courses to these learners. To date, giant online universities have delivered courses for learners around the globe. Mention Phoenix University and most people in other countries know that it is an online university located in the United States. Yet, learners from around the world can take its courses anywhere anytime. The university has created classrooms without borders. As Bash (2003) noted, “in 2002, the University of Phoenix, part of the Apollo Group, saw its enrollment surpass 100,000 students—making it the largest institution of higher learning in the United States.” No need to say that this enrollment figure must include students from overseas. Other universities do not want to lag behind in this regard. As Wang (2006, p. 47) noted, “California State University, Long Beach, University of California, Irvine and Online University of America demonstrated Western instructional methods to deliver their graduate programs to leading universities in China, the Middle East and West Europe via Internet technologies in 2004.” Increased communication, interactivity among participants, and incorporation of collaborative pedagogical models are made possible by recent developments in technology. A classroom without borders indeed has many advantages over the traditional four walled-classrooms:

- Instantaneous (synchronous) and delayed (asynchronous) communication modes.
- Access to and from geographically isolated communities around the globe.
- Multiple and collaborative among widely dispersed individuals.
- Ultimate convenience, when and where you choose.
- Interaction with and among individuals from diverse cultures, and
- Ability to focus on participants’ ideas, without knowledge of age, race, gender, or background. (Shrum, 2000)

The classroom without borders has come a long way and taken many steps from traditional classrooms. The classroom without borders would not be possible without distance learning technologies. It was the distance-learning technologies that brought revolution to the traditional classroom. To convert a traditional classroom to a classroom without borders, there are important issues for educators and practitioners to consider. The next section delves into these prominent issues associated with the classroom without borders.

**ISSUES TO CONSIDER IN CLASSROOM WITHOUT BORDERS**

Although distance learning technologies have the capability to reach beyond the traditional classroom learners, this is not to say that instructors can just go ahead and dump their course onto the computer screens. To implement successful teaching and learning in a classroom without borders, instructors need to take into consideration first of all pedagogical and cultural issues. Shrum (2000) reminds instructors to ask these questions, “What are the instructional and personal goals of this course for all students?” “What is the purpose of this course?” To add to Shrum’s questions, questions that should be asked can be “Where do my students come from?” “Do they prefer Western instructional methods or Eastern instructional methods?” “What kind of prior experience do they bring to this classroom without borders?” “What are my instructional strategies to accommodate their learning needs?” “If my instructional methods do not work with this group of learners from a particular region in the world, do I have alternative instructional methods that I can fall back on?” “What are the political issues that I should always avoid when teaching a particular group of learners?”

Writing in 1996-1997, Duchastel suggests that an instructor rethink the traditional classroom model to
one more fitting the electronic processes and global resources:

- Static content to specifying goals to pursue;
- One answer to accepting a diversity of outcomes;
- Representing knowledge to requesting production of knowledge;
- Evaluating at the product level to looking to the task level;
- Individual efforts to building learning teams;
- One classroom to encouraging global communities. (p. 224)

Further, adult learning theory, such as authentic learning, relevant materials, and negotiating assignments, is required to ensure participation and involvement necessary to meet course objectives. However, keep this in mind: these instructional strategies may not work in authoritarian cultures where a teacher-dominated mode of instruction is highly valued (Wang & Bott, 2003-2004). Thinking only in the universal terms of adult learning theory makes it difficult for instructors to adapt to local social contexts in which particular situations contradict our beautifully reasoned analysis of adult learning theory (Brookfield, 1986, 1995). “When in Rome, do as the Romans do” is not a bad strategy when teaching in a classroom without borders. “One size fits all theory” may not work with learners with different social and cultural backgrounds. It is also a truism that learners from different countries may have different learning styles. For example, learners from authoritarian cultures may prefer rote learning and memorization skills. Learners from democratic countries may prefer problem-solving and critical-thinking skills. Whereas learners in Western countries enjoy learner-centered learning, learners in authoritarian countries require their teachers to be knowledge dictators. In a nutshell, instructors need to switch from adult learning theory to pedagogy (the art and science of teaching children) if a particular teaching situation requires them to do so. Although a helping relationship with learners in a classroom without borders fits learners from Western countries, a directing relationship may best fit learners from authoritarian countries.

Once pedagogical questions are answered, the instructors can turn to the organizational questions. It is a common rule that courses should be arranged from simple to complex. Assignments must be aligned with interaction. Synchronous activities must be arranged in advance. Group size may influence the communications patterns. The challenge to most instructors is to create interaction within the course. It is easy to consider how learners can interact with course content. However, it is hard to determine active learning online. The instructors might want to require discussion on topics of the course, or have students post comments upon various readings for others and provide immediate feedback about global resources that have been investigated. Laurillard (1993) describes four ways of supporting interaction with learners in the classroom without borders:

1. A need for discursive language in order to understand each other’s conceptions.
2. Adopting an adaptive perspective, so that the focus shifts as each student’s needs shifts.
3. Authentic activities for students to demonstrate their understandings, and
4. Reflection on the student’s work.

Once the organizational question is answered, it is necessary to consider institutional issues. An important question to ask is “Does my institution support the classroom without borders?” In other words, does this have to do with my promotion and tenure process? Will I be offered release time and assistance? What credit will I get for teaching in a classroom without borders? In case I need to travel to foreign countries, will I get support from the department? How will I deal with prejudice coming from senior faculty who do not want to touch technology? If these issues are not solved, there may be stumbling blocks for instructors in a classroom without borders. Last but not least, does my institution offer support necessary for learners in different locations?

In a nutshell, these are foremost issues that instructors must consider in order to be successful in a classroom without borders. Of course, there may be other outstanding issues to consider in addition to the foremost issues. Unless support is generated from the entire global educational community as well as individual stakeholders, instructors who teach in classrooms without borders will experience some kind of difficulty.
CONCLUSION

To create a classroom without borders depends on not only distance-learning technologies, but also the global education community and institutional and individual stakeholders. The growth in the practice of lifelong learning requires institutions of higher learning and some non-educational providers to develop classrooms without borders. Salient issues such as pedagogical issues, organizational issues, and institutional issues must be solved before launching a successful classroom without borders. As Shrum (2000, p. 103) suggested, “as a community of scholars and educators, we must create more avenues for sharing of experiences and research among all the international players, be willing to describe difficulties, and take feedback from learners. The challenges are substantial, but the potential rewards are worth the efforts.”

REFERENCES


KEY TERMS

Asynchronous: Merriam-Webster Online Dictionary defines the word as of, used in, or being digital communication (as between computers) in which there is no timing requirement for transmission and in which the start of each character is individually signaled by the transmitting device. The term asynchronous is usually used to describe communications in which data can be transmitted intermittently rather than in a steady stream. Teaching and learning anytime anywhere is the typical asynchronous nature of distance education.

Border: Newbury House Dictionary of American English defines the word border as the legal line separating two states or countries. For example, we crossed the Mexican border into the USA. The word border can also be used as a verb. For example, the trees border the road on both sides. In this article, the word Border also means the legal line separating two states or countries. Although the legal line exists, it
no longer separates a learner from a teacher because distance learning technologies have broken down this legal line. Learners may have their citizenship and passport. However, when they join the global education community via distance learning technologies, the legal line as defined by the word border no longer exists to some degree.

**Computer Conferencing:** This refers to an approach to distance teaching using a computer(s) to assist in the presentation of teaching materials or to assistant learners to work through an already prepared learning program. The term computer conferencing has the following meanings:

1. Teleconferencing supported by one or more computers.
2. An arrangement in which access, by multiple users, to a common database is mediated by a controlling computer.
3. The interconnection of two or more computers working in a distributed manner on a common application process. Instant Messaging and chat systems are multicasting approaches for computer conferencing.

**Distance Education:** Distance education can be defined as any form of education in which the teacher and the learner are separated in either time or space. Distance education was formerly called home study, and then correspondence education. Later, distance education was delivered via radio and TV broadcast in different countries. Currently, more distance education is delivered via Internet and computer communications technologies.

**Lifelong Learning:** Until recently, there has been a tendency to treat this term as being synonymous with lifelong education. In fact, lifelong learning and lifelong education are totally different terms. Lifelong learning can be defined as follows: 1. The process of learning that occurs throughout the life span. 2. The learning that occurs variously in formal institutions or education and training, and informally, at home, at work, or in the wider community. Learning emphasizes the person in whom the change occurs or expected to occur. Learning is the act or process by which behavioral change, knowledge, skills, and attitudes are acquired whereas education is an activity undertaken or initiated by one or more agents that is designed to effect changes in the knowledge, skill, and attitudes of individuals, groups, or communities. Once the difference between learning and education is clarified, the meanings of lifelong learning and lifelong education become self-explanatory.

**Pedagogy:** This word is an uncountable noun, meaning the theory and method of teaching. As different fields develop, this word has taken on new meanings. For example, in the field of adult education, pedagogy means the art and science of teaching children. Others may just define the word as an activity involving the purposeful creation of learning experiences. In recent years, the word pedagogy refers to teaching children. Adult pedagogy means andragogy, which means the art and science of helping adults learn.

**Synchronous:** Merriam-Webster Online Dictionary defines the word as happening, existing, or arising at precisely the same time. To achieve synchronous teaching and learning via the Internet technologies, teachers and learners can chat with each other or do videoconferencing.
Cognitive Informatics

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INTRODUCTION

Cognitive informatics (CI) is an emerging discipline that studies the natural intelligence and internal information processing mechanisms of the brain, as well as the processes involved in perception and cognition. CI provides a coherent set of fundamental theories and contemporary mathematics that form the foundation for most information- and knowledge-based science and engineering disciplines, such as computer science, cognitive science, neuropsychology, systems science, cybernetics, software engineering, and knowledge engineering.

The development of classical and contemporary informatics, the cross-fertilization between computer science, systems science, cybernetics, computer/software engineering, cognitive science, neuropsychology, knowledge engineering, and life science has led to an entire range of the extremely interesting new research field known as CI (Chan, Kinsner, Wang, & Miller, 2004; Kinsner, Zhang, Wang, & Tsai, 2005; Patel, Patel, Wang, 2003; Wang, 2002a, 2003, 2004, 2006a, 2006b, 2007b; Wang, Johnston, & Smith, 2002; Wang & Kinsner, 2006; Yao, Shi., Wang, & Kinsner, 2006). CI is a transdisciplinary study of cognitive and information sciences that investigates the internal information processing mechanisms and processes of the natural intelligence generated by the human brain. CI is a cutting-edge and profound interdisciplinary research area that tackles the fundamental problems shared among aforementioned disciplines. Almost all of the hard problems yet to be solved in these areas can be deduced onto the common root for understanding the mechanisms of natural intelligence and cognitive processes of the brain.

COGNITIVE INFORMATICS: A NEW TRANSDISCIPLINARY RESEARCH FIELD

CI is a new transdisciplinary field of research that investigates into the most common problems of how the brain processes information shared by almost all science and engineering disciplines. This section examines the nature of information and the historical development of the three-generation informatics that lead to the establishment of CI.

Informatics: A study on the third essence of the world. The basic characteristic of the human brain is information processing. Therefore, information is recognized as the third essence supplementing matter and energy to model the natural world (Wang, 2002a, 2003, 2007b).

Definition 1. Information is any property or attribute of the natural world that can be distinctly elicited, generally abstracted, quantitatively represented, and mentally processed by the brain.

Definition 2. Informatics is the science of information that studies the nature of information, its processing, and ways of transformation between information, matter and energy.

Theorem 1. A generic world view known as the Information-Matter-Energy (IME) model (Wang, 2007a, 2007b) states that the natural world (NW), which forms the context of human cognitive activities and the natural intelligence, is a dual world. One aspect of it is the physical or the concrete world (PW); the other is the abstract or the perceptive world (AW), where matter (M) and energy (E) are used to model the former, and information (I) to the latter.
Theorem 1 can be illustrated in Figure 1. According to the IME model, information plays a vital role in connecting the physical world and the abstract world. Models of the natural world have been well studied in physics and other natural sciences. However, the modeling of the abstract world is still a fundamental issue yet to be explored in cognitive informatics, computing, software science, cognitive science, and brain sciences. Especially, the relationships between I-M-E and their transformations are perceived as one of the fundamental questions in CI.

From conventional information theory to CI. The theories of informatics and their perceptions on the object of information have evolved from the conventional information theory, to modern informatics, and to cognitive informatics in the last 6 decades. Conventional information theories (Bell, 1953; Shannon, 1948), particularly Shannon’s information theory (Shannon, 1948), known as the first-generation informatics, study signals and channel behaviors, and they are statistics and probability based. Modern informatics (Wang, 2007a) known as the second-generation informatics studies information as properties or attributes of the natural world that can be generally abstracted, quantitatively represented, and mentally processed. The first- and second-generation informatics put emphases on external information processing that overlook the fundamental fact that human brains are the original sources and final destinations of information, and any information must be cognized by human beings before it is understood. This observation leads to the establishment of the third-generation informatics, a term coined as CI by Wang in 2002 (Wang, 2002a, 2003, 2007b).

Definition 3. CI is the transdisciplinary enquiry of cognitive and information sciences that investigates into the internal information processing mechanisms and processes of the brain and natural intelligence, and their engineering applications via an interdisciplinary approach.

The definitions of information and their measurement in the three-generation informatics are summarized in Table 1. It is noteworthy that the bit in the 2nd- and 3rd-generation definitions has been shifted from a weighted sum of probability of signals to a more concrete and deterministic entity, and it is no longer probability-based as that of the conventional information theory. It is recognized in CI that cognitive information and knowledge being processing in the brain can be divided into five abstract levels, such as the levels of analogue objects, diagrams, natural languages, professional notation systems, and mathematics (philosophy) from the button-up.

THE THEORETICAL FRAMEWORK OF CI

In many disciplines of human knowledge, almost all of the hard problems yet to be solved share a common root in the understanding of the mechanisms of natural intelligence and the cognitive processes of the brain. Therefore, CI is a discipline that forges links between a number of natural science and life science disciplines with informatics and computing science. The structure of the theoretical framework of CI is described in Figure 2, which encompasses the fundamental theories of CI, descriptive mathematics for CI, and the key application areas of CI.

The fundamental theories of CI. The fundamental theories of CI have been developed in 10 aspects
resulted in the basic and transdisciplinary research in CI (Wang, 2007b) that encompass the Information-Matter-Energy (IME) model, the Layered Reference Model of the Brain (LRMB) (Wang, Wang, Patel, & Patel, 2006), the Object-Attribute-Relation (OAR) model (Wang, 2007c) of information representation in the brain, the cognitive informatics model of the brain, Natural Intelligence (NI), Neural Intelligence (NeI) (Wang, 2007b), the CI laws of software, the mechanism of human perception processes, the cognitive processes of formal inferences, and the formal knowledge system (Wang, 2007a).

**Denotational mathematics for CI.** Three new types of denotational mathematics, Concept Algebra (CA) (Wang, 2006d), Real-Time Process Algebra (RTPA) (Wang, 2002b), and System Algebra (SA) (Wang, 2006c), are created for CI to enable rigorous treatment of knowledge representation and manipulation in a formal and coherent framework. The new structures of contemporary mathematics have extended the abstract objects under study in mathematics to a higher level, that is, concepts, behavioral processes, and systems. A wide range of applications of the descriptive mathematics in the context of CI has been identified (Wang, 2006b).

**The key application areas of CI.** The key application areas of CI can be divided into two categories (Wang, 2007b). The first category of applications, A2, A4, and A5, as shown in Figure 2, uses informatics and computing techniques to investigate cognitive science problems, such as memory, learning, and reasoning. The second category including the remainder areas uses cognitive theories to investigate problems

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### Table 1. Taxonomy of the Three-Generation Informatics

<table>
<thead>
<tr>
<th>Generation</th>
<th>Description</th>
<th>Object under Study</th>
<th>Definition of Information</th>
<th>Mathematical Model of Information</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conventional information theory</td>
<td>External information in communication</td>
<td>A weighted probabilistic measure of the variability of messages (signals) that is expected from a source via a transmission channel</td>
<td>[ I = \sum_{i=1}^{n} p_i \cdot \log_2 \left( \frac{1}{p_i} \right) ]</td>
<td>Information is perceived as entropy of signals on the basis of probability. The subjective nature of entropy deems there is no information if the probability of a sign in a message is 1. When the probability of signals is indeterminate or 0, their entropy or information is undefined.</td>
</tr>
<tr>
<td>2</td>
<td>Modern informatics</td>
<td>External information for machine processing</td>
<td>Any property or attribute of the natural world that can be generally abstracted, quantitatively represented, and mentally processed</td>
<td>[ I_k = f: M \rightarrow S_k ] [ = \log_k M ] [ = \log_k M ] [ = \text{[k-based digits]} ] [ = \text{[bit, } k = 2 ]</td>
<td>[ I_k ] is the content of information in a ( k )-based digital system, ( M ) is the size of message, and ( S_k ) the measurement scale based on ( k ). The unit of ( I_k ) is the number of ( k )-based digits, when ( k = b = 2 ), the unit is ( \text{bit} ).</td>
</tr>
<tr>
<td>3</td>
<td>Cognitive informatics</td>
<td>Internal information in the brain</td>
<td>Abstract artifacts and their relations that can be elicited, modeled, represented, stored, and processed by human brains</td>
<td>[ I_k = f: M \rightarrow S_k ] [ = \log_k M ] [ = \text{[k-based digits]} ] [ = \text{[bit, } k = 2 ]</td>
<td>The most fundamental form of information that can be represented and processed is binary digit where ( k = b = 2 ). Any form of information in the physical (natural) and abstract (mental) worlds can be unified on the basis of binary data. Both internal and external information share the same basic type in information representation.</td>
</tr>
</tbody>
</table>
in informatics, computing, and software/knowledge engineering. CI focuses on the nature of information processing in the brain, such as information acquisition, representation, memory, retrieve, generation, and communication. Through the interdisciplinary approach and with the support of modern information and neuroscience technologies, mechanisms of the brain and the mind may be systematically explored within the framework of CI.

**APPLICATIONS OF CI**

A wide range of applications of CI has been identified in multidisciplinary and transdisciplinary areas, such as: (1) The architecture of future generation computers; (2) Estimation the capacity of human memory; (3) Autonomic computing; (4) Simulation of human cognitive behaviors using denotational mathematics.

**The architecture of future generation computers.** Conventional machines are invented to extend human physical capability, while modern information processing machines, such as computers, communication networks, and robots, are developed for extending human intelligence, memory, and the capacity for information processing (Wang, 2004). Recent advances in CI provide formal description of an entire set of cognitive processes of the brain (Wang et al., 2006). The fundamental research in CI also creates an enriched set of contemporary denotational mathematics (Wang,
programmable digital computers.

The theory and philosophy behind the next generation computers and computing methodologies are CI (Wang, 2004). It is commonly believed that the future-generation computers, known as the cognitive computers, will adopt non-von Neumann (von Neumann, 1946) architectures. The key requirements for implementing a conventional stored-program controlled computer are the generalization of common computing architectures, and the computer is able to interpret the data loaded in memory as computing instructions. The essences and the computer is able to interpret the data loaded in memory as computing instructions. The essences of stored-program controlled computers known as the von Neumann architecture, which encompasses five essential components to implement general-purpose programmable digital computers.

Definition 4. A von Neumann Architecture (VNA) of computers is a 5-tuple that consists of the components: (a) the arithmetic-logic unit (ALU), (b) the control unit (CU) with a program counter (PC), (c) a memory (M), (d) a set of input/output (I/O) devices, and (e) a bus (B) that provides the data path between these components.

Definition 5. Conventional computers with VNA are aimed at stored-program-controlled data processing based on mathematical logic and Boolean algebra.

A VNA computer is centric by the CPU and characterized by the all-purpose memory for both data and instructions. A VNA machine is an extended Turing machine (TM), where the power and functionality of all components of TM, including the control unit (with wired instructions), the tape (memory), and the head of I/O, are greatly enhanced and extended with more powerful instructions and I/O capacity.

Definition 6. A Wang Architecture (WA) of computers, known as the Cognitive Computers is a parallel structure encompassing an Inference Engine (IE) and a Perception Engine (PE) (Wang, 2006a).

The future generation cognitive computers based on WA are not centered by a CPU for data manipulation as the VNA computers do. The WA computers are centered by the concurrent IE and PE for cognitive learning and autonomic perception based on abstract concept inferences and empirical stimuli perception. The IE is designed for concept/knowledge manipulation according to concept algebra (Wang, 2006d), particularly the nine concept operations for knowledge acquisition, creation, and manipulation. The PE is designed for sensory and perception processing according to RTPA (Wang, 2002b), and the formally described cognitive process models of the perception layers as defined in the LRMB model (Wang et al., 2006).

Definition 7. Cognitive computers with WA are aimed at cognitive and perceptive concept/knowledge processing based on contemporary denotational mathematics, that is, concept algebra, Real-Time Process Algebra (RTPA), and system algebra.

As that of mathematical logic and Boolean algebra are the mathematical foundations of VNA computers, the mathematical foundations of WA computers are based on denotational mathematics (Wang, 2006b, 2006c). As described in the LRMB reference model (Wang et al., 2006), since all the 39 fundamental cognitive processes of human brains can be formally described in CA and RTPA (Wang, 2002b, 2006e), they are simulating and executable by the WA-based cognitive computers.

Estimation the capacity of human memory. Despite the fact that the number of neurons in the brain has been identified in cognitive and neural sciences, the magnitude of human memory capacity is still unknown. According to the Object-Attribute-Relation (OAR) model (Wang, 2007c), a recent discovery in CI is that the upper bound of memory capacity of the human brain is in the order of 10^{8,432} bits (Wang, Liu, Wang, 2003). The determination of the magnitude of human memory capacity is not only theoretically significant in CI, but also practically useful to explain the human potential, as well as the gaps between the natural and machine intelligence. This work indicates that the next generation computer memory systems may be built according to the OAR model rather than the traditional container metaphor, because the former is more powerful, flexible, and efficient to generate a tremendous memory capacity by using limited number of neurons in the brain or hardware cells in the next generation computers.

Autonomic computing. The approaches to implement intelligent systems can be classified into those of biological organisms, silicon automata, and computing systems. Based on CI studies, autonomic computing (Wang, 2004) is proposed as a new and advanced computing technique built upon the routine, algorithmic, and adaptive systems. The approaches to computing can be classified into two categories known as imperative
and autonomic computing. Corresponding to these, computing systems may be implemented as imperative or autonomic computing systems.

**Definition 8.** An imperative computing system is a passive system that implements deterministic, context-free, and stored-program controlled behaviors.

**Definition 9.** An autonomic computing system is an intelligent system that autonomously carries out robotic and interactive actions based on goal- and event-driven mechanisms.

The imperative computing system is a traditional passive system that implements deterministic, context-free, and stored-program controlled behaviors, where a behavior is defined as a set of observable actions of a given computing system. The autonomic computing system is an active system that implements nondeterministic, context-dependent, and adaptive behaviors that do not rely on instructive and procedural information, but are dependent on internal status and willingness that formed by long-term historical events and current rational or emotional goals.

The first three categories of computing techniques are imperative. In contrast, the autonomic computing systems are an active system that implements nondeterministic, context-sensitive, and adaptive behaviors. Autonomic computing does not rely on imperative and procedural instructions, but are dependent on perceptions and inferences based on internal goals as revealed in CI.

**Simulation of human cognitive behaviors using the denotational mathematics.** The contemporary denotational mathematics for CI, particularly concept algebra and RTPA, may be used to simulate the cognitive processes of the brain as modeled in LRMB (Wang et al., 2006). Most of the 39 cognitive processes identified in LRMB, such as the learning (Wang, 2007d), inference (Wang, 2007e), and decision-making (Wang and Ruhe, 2007) processes, have been rigorously modeled and described in RTPA and cognitive algebra. Based on the fundamental work, the inference engine and perception engine of a virtual brain can be implemented on cognitive computers or be simulated on conventional computers. In the former case, a working prototype of a fully autonomic computer will be realized on the basis of CI theories.

**CONCLUSION**

Cognitive informatics (CI) has been recognized as a new frontier that studies internal information processing mechanisms and processes of the brain, and their applications in computing and the IT industry. This paper has provided an insightful perspective on the past, present, and future of CI, which reviews the development of informatics from the classical information theory, contemporary informatics, to cognitive informatics. Based on this, the foundations of cognitive informatics and its potential applications have been explored. Cognitive informatics has been described as a profound interdisciplinary research area that tackles the common root problems of modern informatics, computation, software engineering, AI, cognitive science, neuropsychology, and life sciences. The future generation computers, such as cognitive computers, will be developed on the basis of cognitive informatics theories and models.

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KEY TERMS

Autonomic Computing System: An intelligent system that autonomously carries out robotic and interactive actions based on goal- and event-driven mechanisms.

Cognitive Computers: Cognitive computers are aimed at cognitive and perceptive concept/knowledge processing based on contemporary denotational mathematics, that is, concept algebra, Real-Time Process Algebra (RTPA), and system algebra.

Cognitive Informatics: The transdisciplinary enquiry of cognitive and information sciences that investigates into the internal information processing mechanisms and processes of the brain and natural intelligence, and their engineering applications via an interdisciplinary approach.

Conventional Computers: Conventional computers with VNA are aimed at stored-program-controlled data processing based on mathematical logic and Boolean algebra.

Imperative Computing System: A passive system that implements deterministic, context-free, and stored-program controlled behaviors.

Information-Matter-Energy (IME) Model: The natural world (NW), which forms the context of human cognitive activities and the natural intelligence, is a dual world: one aspect of it is the physical or the concrete world (PW); the other is the abstract or the perceptive world (AW), where matter (M) and energy (E) are used to model the former, and information (I) to the latter.

Informatics: The science of information that studies the nature of information, its processing, and ways of transformation between information, matter and energy.
Cognitive Theories that Guide Online Course Design

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INTRODUCTION

Cognitivism comes from one of three schools of psychology in which theories are categorized. The other two schools are the schools of behaviorism and humanism. It is believed that one school of theory is not better than the other, and individuals are encouraged to apply the theory that is the most appropriate for the student. Theories from the school of cognitivism guide students to process information in ways that are meaningful to the student. One of the most important goals of cognitive theories is for students to become independent learners. Struggling learners are guided through the learning process with learning strategies, and the lessons are based on declarative and procedural learning tasks in authentic learning environments (Grabinger, 2004; Tomei, 2007).

COGNITIVE THEORIES AND ONLINE DESIGN

In the past, theorists such as Jean Piaget, Lev Vygotsky, Erik Erikson, and David Ausubel developed theories that not only became widely accepted, but they brought other professionals from the field to develop other cognitive theories. Piaget is known for his work on schemes of knowledge. He presents two ways in which individuals adapt new knowledge. They either use assimilation theory by taking the new knowledge and making sense of it with schemes of knowledge that they already know, or they use accommodation theory by taking their existing schemes of knowledge and adjusting them so that the new knowledge can fit into a scheme. Piaget is also remembered for the stages of cognitive development. The four stages, sensorimotor, preoperational, concrete operational, and formal operations, take place during certain years of an individual’s life. Educators are encouraged to keep these stages in mind when designing instruction (Joyce, Weil, & Calhoun, 2000; Tomei, 2007).

Lev Vygotsky is known for zone of proximal development theory. His theory guides instructors to guide students to work in the developmental zone in which they are capable of learning. Erik Erikson’s work presents the stages of psychosocial development through which individuals develop as they grow older. This theory guides educators to focus on a student’s needs based on the society in which they are growing. David Ausubel shows us how to use his theory on advanced organizers. The organizers are supposed to serve as a conceptual bridge between the current and new knowledge. He believes that people acquire knowledge through reception, not discovery (Joyce et al., 2000; Tomei, 2007). The work of these accomplished theorists is being used in learner-centered theory and practice in various distance education programs. Other forms of theory from the school of cognitivism that are being used by instructors include theory of multiple representations, cognitive flexibility theory, Bruner’s three-form theory, dual-coding theory, Gagne’s conditions of learning, Merrill’s instructional transaction theory, and Moore’s theory of transactional distance.

Theory of Multiple Representations

Applying multiple representations that connect to content of subject matter is thought to be a valuable practice, because students can build mental representations with the information. They can make the information meaningful to themselves by assigning different representations to the information. Web environments and computer mediated discussions are said to be conducive to the application of multiple representations during course design (Huang & Liaw, 2004). Researchers provide support and they raise cautions when it comes to using multiple representations during instruction (Gfeller, Niess, & Lederman, 1999; Huang & Liaw, 2004; Moreno, 2002; Ying-Shao & Fu-Kwun, 2002). Cognitive psychologist Allan Paivio states that this is a difficult concept, because there are two coding approaches to the concept. It is not easy, because

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individuals are required to figure out how to represent the information mentally, and they have to find ways to apply the information in the real world. It is also a difficult theory to utilize, because the information that needs to be represented can be concrete and abstract. Instructors who use this theory when designing curriculum need to remember that individuals have their own internal representations of information which can cause the message that the instructor is trying to get across to come out differently as the information becomes externalized (Paivio, 1990).

**Cognitive Flexibility Theory**

Jonassen (2003) explains that much research looks at the presentation of problems to learners and identifies two conflicts with how problems that need to be solved are presented. First, the problems are presented as structured problems. Real life problems are ill-structured. Second, students do not transfer problem solving skills very well. Research considers the role of tools that can be used to help externalize students’ internal representations. Semantic networks, expert systems, and systems modeling tools are three types of cognitive tools that this researcher uses to study the efficacy of using them to externalize internal representations. Learning how to represent the problems being solved is vital when it comes to transferring skills so structured and ill-structured problems can be solved. According to Jonassen, problem representation is the main factor. Students must be helped by the instructor to learn to build problem representations that integrate their internal representations with knowledge domains. The better a student is at externalizing representations the better the student is at solving problems. Jonassen writes that there are three ways learners can go about building representations: through the development of mental representations, making internal maps of problems, and using tools to externalize problem representations. An example of a cognitive tool is a concept or semantic map. These maps or graphs help students build spatial representations of concepts that help them see connections between abstract concepts and reality so they can solve a problem more realistically.

**Bruner’s Three-Form Theory**

Bruner (1990) states that there are three ways from which individuals see the world: through action, through icons, and through symbols. They use action to perform or demonstrate what it is they see about the world from their perspective. Icons or mental images are used to present a path, summary, or pattern. Symbolism which is an abstract way of visualizing reality through the use of words and numbers is the third form that individuals use. According to Bruner, these three forms of representation are founded on the theory that development must be effectively related to theories of knowledge and instruction.

Vacca and Vacca (1998) discuss Bruner’s work on scaffolding and the development of categories. They refer to scaffolds as a form of support and compare it to the scaffolds used by construction workers to lift themselves up so they can make achievements that they could not make without the support. Instructors are to provide all learners with support. Helping students recognize what they know, what is new, and building new categories makes the environment less complex and more constant. According to Bruner (1990), how learners make meaning relies greatly on cultural connections with their own convictions, objectives, aspirations, and dedication to the learning. Eisner (1991) extends this thought by saying that students’ whose interests are ignored lack motivation to learn. Vacca and Vacca (1998) find that building schemes of knowledge with categories is linked with the need to be motivated. Learners need to be emotionally involved, and instructors need to identify what the students know, what they need to know, and how well the learners already know so learners have an opportunity to be emotionally motivated to become active learners.

**Dual-Coding Theory**

Another strategy used by online instructors when designing and implementing courses is to apply dual-coding theory. Through this theory, the systems of verbal and imagery processing can be used independently or simultaneously through the support of verbal and imagery subsystems. The verbal subsystems help with the presentation and processing of information. Imagery subsystems aid in the development of images, sounds, actions, and responses of emotion that are not always available when nonverbal cues cannot be shared (Huang & Liaw, 2004).

Conditions of this construct hold that we use both aural and visual paths to process information and make meaning. The aural and visual modalities that we each
have differ by their representational system depending on our own experiences. For some of us the visual modality is stronger and for others the aural modality is used more to process information, but they both have an influence on how information is perceived by an individual. It is suggested that the visual and aural stimuli are combined to make remembering the messages easier. Using multiple stereotypes as stimuli is one strategy that instructors can use to make a concept more understandable and obvious to the learners (Paivio, 1979, 1990; Simpson, 1995).

**Gagne’s Conditions of Learning**

Gagne’s conditions of learning is a form of instructional theory, and he is credited for the beginning of the infusion of instructional psychology into the instructional technology and design field. Instructional theory involves the integration of principle sets that are based on learning theories and empirical research that allow for predictions of instructional conditions on cognitive processes and new learning (Richey, 1996; Smith & Ragan, 1996). Huang and Liaw (2004) identify Gagne’s condition as an instructional learning process that is methodical and logical. Gagne’s conditions of learning are a descriptive theory of knowledge that contain five separate categories of outcomes labeled as intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes. Having the ability and knowledge to categorize and use materials are characteristics of intellectual skills. Abilities that allow individuals to show “what” something is or means are verbal information abilities. Cognitive strategies have to do with the learning skills that individuals own. Simple and complex movements make up an individual’s motor skills, and attitudes are the feelings that we develop as a result of interactions that are either constructive or unconstructive. Researchers note that Gagne’s work has grown into a system of nine practices: gaining attention, informing learners of the objective at hand, stimulating recall of prior learning, presenting the content, providing learning guidance, eliciting performance, providing feedback, assessing performance, and finally, enhancing retention and transfer (Gagne, 1985; Gagne, Wager, Golas, & Keller, 2005; Molenda, 2002; Smith & Ragan, 1996).

Smith and Ragan (1996) write about the influence that Gagne’s theory has had on instructional design models that are conditions-based. Conditions-based models theory holds that learning can be placed into categories according to cognitive learning processes. In order for these categories of learning to take place in an instructional design instructional supports are needed. The categories are so clear that when the theory is applied researchers argue that you can look at a lesson and point out which parts of the lesson can be linked with the different categories. According to Richey (1996), Gagne’s work serves as the root of other known instructional theories including Merrill’s instructional transaction theory and Reigeluth’s elaboration theory. In addition, the researcher states that Gagne’s work can be related to positions on trends in learner-centered instruction and design as well as context-centered instruction and design. It looks as though Gagne’s work, states Richey, will continue to be expanded upon as long as the positions of the theorists, researchers, and practitioners still support principles of cognitive learning.

**Merrill’s Instructional Transaction Theory**

This theory holds that learners can be motivated by processes of transactions that help them make connections. It has a set of conventions to which objects of knowledge are selected and sequenced (Huang & Liaw, 2004). Identifying relationships between educational and technical factors are possible with instructional transaction theory. Instructional transaction theory consists of two facets: schemes of knowledge and procedures for applying the knowledge. Merrill’s position states that for learning to take place, the learner needs to have more than one knowledge structure illustrated for anything to make sense. According to the researchers, instructional transaction theory learning consists of the object that is to be learned or the content that is to be taught. It is possible to combine the different facets of content that need to be taught and group them into one structure of knowledge. Individuals have internal representations of knowledge and structures of knowledge are external. The theory utilizes transactions as a way to categorize the content that is to be taught (Buendia, Diaz, & Benlloch, 2002).

Instructional transaction theory can reduce problems that learners have when using computer simulations. It is believed that there are three data types used when a transaction of knowledge takes place. There is a knowledge base, a resource base, and there are instruc-
Cognitive Theories that Guide Online Course Design

These three facets of instructional transaction are then subdivided into more descriptive categories. A knowledge base is, for example, divided by entities, activities, and processes. Resource databases among other possibilities are subdivided by mediated representations of the knowledge field, presentation techniques, and communication techniques. Instructional boundaries, of which vary by situation, can be divided according to population, learning task, and the environmental situations. So when an online instructor applies instructional transaction theory to course design, empirical research is used to help set the categories in a knowledge base, build resource database classes, and define the parameters that are used to set the boundaries. This practice is meant to reduce difficulties that can occur when simulations, for example, are being used as the form of delivery (Zwart, 1992).

Moore’s Theory of Transactional Distance

Moore’s theory of transactional distance, unlike the Web-based theories already presented, is a distance theory. Many online instructors have applied this theory because its three dimensions have an affective influence on teaching procedures. Those three dimensions are referred to as interaction, course structure, and learner autonomy (Huang & Liaw, 2004). Two key factors of independent learning, structure and dialogue, are identified by Moore in the early part of the 1970s. The distance aspect of this theory has less to do with physical separation and much more to do with pedagogical distance. When a course is highly structured, there is less distance between the instructor and the learner because the interaction is higher between the two as well. Thus, there is a perception that the distance between the two is not as great as it would be if the course were low structured with less interaction (Chen, 2001; Jung, 2001; Kanuka, Collett, & Caswell, 2002; Lally & Barrett, 1999; Moore, 1973; Moore & Kearsley, 1996).

Several types of interaction have an impact on the effectiveness of online courses, and there are specific variables that influence interaction. Students, the instructor, mediums used for communication, course organization, and delivery method are all influential variables (Stow, 2005). Distance educators are concerned with and want to identify students’ perceptions of these variables. Huang states that learners should not only be surveyed on interaction to learn what they think about online course, but questions should also be asked about learner autonomy, course structure, and the system used for delivering the course (Huang, 2002).

Interaction, the first of Moore’s three dimensions, includes interaction between the learner and the content, the learner and the instructor, and the learner with another learner. Course structure, the second of Moore’s three dimensions, includes learning objectives, educational strategies, and methods for evaluation. Learner autonomy, the third of Moore’s dimensions, requires students to take responsibility for their own experience due to the distance between instructors and students in online courses. Eventually, Moore introduces a fourth dimension that he calls interface. Learners must have technology skills or expect to attain those skills in conjunction with fulfilling course requirements in order to be able to act as a participant in an online course (Chen, 2001; Huang, 2002; Moore, 1989, 1991; Kanuka et al., 2002; Stow, 2005). Blending the right amount of the dimensions into the course design, according to Kanuka et al. (2002), is vital to transactions in an online environment.

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Cognitive Theories that Guide Online Course Design


KEY WORDS

Behavioral Theory: Behavioral theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of behaviorism hold that the environment has an impact on learning and that all behavior is learned.

Cognitive Theory: Cognitive theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of cognitivism guide students to process information in ways that are meaningful to the student. These theories are based on declarative and procedural learning tasks that are authentic.

Humanistic Theory: Humanistic theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of humanism focus on learner’s affective needs that include their feelings, emotions, values, and attitudes.

Instructional Design Theory: Use of theory by professionals when designing, developing, managing, and evaluating a learning experience.

Online Instructors: Qualified individuals who have had the schooling or training to teach or guide learners to gain new knowledge and abilities in an online learning environment.

Online Learning: A form of learning in which learners interact with each other and the instructor through either asynchronous or synchronous modes of learning.
INTRODUCTION

Money is to be made with computer fraud. While this statement seems to be shocking, it is nonetheless a very real indication of the seriousness of the nature. As we are becoming more dependent on technology for our information and convenience, and the lack of process being made in stopping computer fraud, we are increasing the risk we place on ourselves. Computer fraud is often perpetuated by computer professionals who have an understanding of information technology. They have an advantage over the normal computer user, and due to the anonymous nature of the Internet, it is often difficult to catch and try suspects (Lynch, 2003).

What is still interesting is that corporate America is usually reluctant to bring criminal charges, even though Romney (1995) reported that the average loss due to computer fraud was $109,000.00 and 90% of companies have reported they were a victim of computer fraud. Further, the Federal Bureau of Investigation has reported that reports of computer fraud have been declining (Hanna, 2005).

One of the main reasons Hanna (2005) and Romney (1995) report on the decline of incident reporting is the possibility of bad publicity. During this span of 10 years, some of the reasons for not reporting incidents, that is, fear of bad publicity, remain the same. This could suggest that criminals are not worried about repercussions and feel the chances of getting caught are slim. Another reason might be that organizations are so dependent on their information systems that the main goal is simply to get back up online and in business (Cronan, Foltz, & Jones, 2006).

TYPES OF COMPUTER FRAUD

Organizations are under constant bombardment, and it is not uncommon for an organization to be attacked by “thousands of scans, probes, pings, and viruses” (Hanna, 2005, p. 34) on a daily basis. Computer fraud is not always a one-way attack; a newer type of attack called phishing, actually relies on the individual to initiate some action and give some information. According to the Anti-Phishing Working Group (APWG), 5% of individuals who receive an e-mail will respond with personal information; it is actually the victim helping the criminal. It can then be seen that the scope of this type of fraud is only limited by the size of the population the attacker wishes to contact (Knight, 2005).

Computer fraud can take on different activities; it can be internal or external. It can be employees stealing data, faking data entry input, management editing and/or altering financial information, or so-called fraudulent financial reporting where the National Commission on Fraudulent Financial Reporting (NCFFR) defines it as “intentional or reckless conduct, whether by act or omission, that results in materially misleading financial statement” (1987, p. 2).

Who commits computer fraud, and why would someone engage in this type of criminal activity? There are several possible reasons for this type of conduct. The term perpetrator is used to describe two sets of individuals, those who are authorized and those who are unauthorized users (Davis & Braun, 2004). Authorized users are those users who at one time have been granted access to a system for a legitimate purpose, where unauthorized users are those who neither have a legitimate purpose, or their authorized use was revoked. Davis and Braun (2004) reported that the largest group of perpetrators were those who were unauthorized users, but had somehow gained access, for example, breaking into a system. The motivation for authorized users was those who may have been laid off or terminated and used their authorizations to conduct criminal activity.

Some research suggests that it is people with low ethical standards that commit fraud (Ford, 1988). However, Cronan, Foltz, and Jones (2006) reported that in a survey of university students, 34% admitted to copying software. Does this mean that 34% of those who responded to the survey have low ethical standards, or are they simply not aware that copying software is considered a form of computer fraud?
Combating Computer Fraud

Espionage is also a possibility, Lenard (2005) reports on a case where an employee of one company was hired away by another company, but not before this employee was able to e-mail hundreds of important documents to his home account, where he was able to access them at a later time.

Computer fraud typically falls into one of several categories, which include:

- **Altering Input:** This is typically the simple process of altering data to show some change in quantity. For example, changing inventory levels so that it does not appear that inventory was in fact stolen. Altering data could also include the changing of someone’s salaries, creating fictitious employees, and/or altering grade point averages for students (Rommey, 1995).

- **Copying Input:** This is the condition where computer data has been copied, for example, credit card numbers, social security numbers, and other personal or financial information was copied with a legitimate purpose (Davis & Braun, 2004).

- **Theft of Computer Time:** This involves using a computer for unauthorized processing. This would include the use of a company’s computing system for other activities, like running a personal software program for his or her own purpose. This can lead to serious consequences, for example, if the system is needed for legitimate business purposes, or the unauthorized programs allows a malicious program to run that might be used later for further illegal activity (Rommey, 1995).

- **Software Modifications:** Modifying, deleting, and/or copying company software is a serious offense and costly to the organization. The Software Business Alliance, the trade group representing the commercial software groups, warns organizations that illegal copying of software can cost them in penalties from $150,000 to $250,000 per illegal copy (Rommey, 1995).

- **Phishing:** A social engineering attack, where e-mails and/or other correspondence directs users to Web sites, where individuals divulge some of their personal information, for example, banking information, user names, passwords, and so forth (Knight, 2005). A new form of phishing, termed vishing, is now taking place. Instead of e-mails, it is tricking individuals to offer up personal information by giving a user a telephone number to dial instead of visiting Web sites. E-mails and even personal phone calls direct unsuspecting individuals to a telephone number of the supposedly real financial institution. This is facilitated by the new Internet protocol voice over Internet protocol (VOIP) which allows criminals to quickly set-up telephone numbers from any area code, and set-up automated voice dialers duplicating a legitimate financial institutions’ automated voice response system. These criminals will be gone, and the telephone number disconnected by the time the individual realized it was an attack (Hunt, 2006).

- **Pharming:** A new term is identified, or what Knight (2005) refers to, as “fishing without a lure” (p. 29). It is the use of a specialized hostile code, such as Trojans or key loggers, which copy an individual’s keystrokes as he or she types. Poisoning is another type of pharming, where an individual believes they are surfing to a legitimate Web site, but end up at fraudulent Web site, offering up their valuable personal information.

- **Identity Theft:** Identity theft can be considered a form of pharming, where perpetrators use social engineering techniques and other forms of collection to obtain personal and financial information from individuals without their knowledge or consent. With identify theft, there are two victims: the individual, who must now try to repair the damage done to their credit rating; and the financial institution, where that information was stolen (Krause, 2006; Lynch, 2003). According to Lynch (2003), identity theft is one of the fastest growing crimes, and in 2002, it impacted at least 9.9 million Americans, and cost businesses $47.6 billion and consumers $5.0 billion.

**COMPUTER FRAUD PROTECTION**

Since computer fraud can have a huge financial impact, is it possible for organizations to put in place a comprehensive policy to eliminate, or at least reduce computer fraud? In the case of corporate or management fraud, some legislators and regulators believe that preventing fraud may be best done in the hands of auditors, and that in the normal course of their work, they are in the best position to detect fraud (Casabona & Yu, 1998). To also assist in this effort, the Auditing
Standards Board of the American Institute of Certified Public Accountants has adopted the standard, *Statement on Auditing Standards (SAS 099): Consideration of Fraud in a Financial Statement Audit*. Key provisions of this standard call for: (a) the increased emphasis on professional skepticism, remove any feelings they have about management, and discuss how fraud could occur; (b) engage management discussions to inquire about the risk of potential fraud in the organization and if they know of any; (c) unpredictable audit tests, in that auditors should test for fraud in areas not considered; and (d) management override of controls, since management is often in a position to override controls that would allow fraudulent activity to occur, auditors must test that these override procedures are valid (AICPA, 2002).

The Computer Fraud and Abuse Act (CFAA) (1986)—amended in 1994, 1996, and 2001—was designed to reduce the incidence of hacking into computer systems. Courts have been mixed on the application of the CFAA to civil action on computer damages. Krause (2005) has identified problems with the CFAA, and that critics contain that the law is too vague. For example, the law cites as unauthorized access as intentionally accessing a computer system without the right authorization, however that could be interpreted as any computer interaction. Further, courts are not designed to understand some of a perpetrator’s activity, like hacking, cracking, virus writhing, and so forth, and because of Congress’s zeal of making it too easy to convict due to the rising wave of computer crimes, and the complexity of these types of crimes, there are fewer successful prosecutions.

Congress has passed the Sarbanes-Oxley Act of 2002, and is again considering helping with passage of the Personal Data Privacy and Security Act, which imposes new penalties and enforces organizations to ensure security, and new regulations for privacy and notification requirements when handling personal data (Jason, 2006). States are passing their own laws on notifications and disclosure laws when it comes to personal information being stolen. There are laws in 21 states and several proposals in Congress to protect individuals from identity theft, and enforcing companies to “design, implement, and maintain safeguards to protect customer information” (Krause, 2006, p.40).

Lenard (2005) does report that in some cases, the Computer Fraud and Abuse Act can help an employer. Lenard states that it is not in the law itself, but rather “the CFAA typically does not stand alone but serves as an adjunct to more conventional causes of actions, such as breach of covenant not to compete, breach of confidentiality agreement, trade secret misappropriations, tortuous interference with contract or business expectancy, and breach of fiduciary duty” (p. 15). The CFAA also has a clause that any reasonable cost to a victim over $5,000.00 could be recovered, including loss of data, restoring data, even bringing action against an individual. In today’s environment, it would be rather easy to justify $5,000.00 in losses. The CFAA even allows for loss suffering from loss of business goodwill (Lenard, 2005).

Since computer fraud takes on many forms, protection against computer fraud should be done on a layered approach. There are a number of things both organizations and individuals can do as a line of defense. Hanna (2005) reports on some of these:

- **Firewall**: A firewall is a device that protects an organization’s internal network from external networks like the Internet. It is often considered a first line of defense. It is a barrier between the inside and outside worlds. Administrators try to balance the incoming and outgoing data traffic and maintain security while not impacting organizations’ productivity.

- **Authentication**: Resources on a network are necessary in order to conduct business, and authentication is the mechanism that allows the access to these resources. This is where authentication techniques are required, for example, secure tokens, RADIUS, and even passwords. Whether traffic is allowed through the firewall to internal resources, or if the original data request originated on the internal network, a good authentication model is essential.

- **Virus Software**: A firewall is a front line type of defense, but it is also like the front door. You need to open the front door to conduct business, but now you have to guard what comes in that front door. Virus protection software can be loaded on a firewall where it will attempt to stop viruses. Each computer on the network also needs to be loaded with anti-virus software, and users need to be trained that even though an e-mail has made it through the first line of defense, it still can contain viruses, and that these viruses usually use some medium to spread, that is, attaching to the e-mail...
as an attachment, for example, files with extensions such as .exe, .bat, .zip, can all be potential viruses, so they need to understand the potential consequences of opening up attachments.

- **Spyware**: One of the latest vulnerabilities is spyware. Spyware is sometimes considered more of a problem than viruses, since spyware does not want to do damage to a system. Spyware is software that is loaded into a user’s system, normally when other software is loaded. There are two types of spyware: one is legitimate software—it is often buried in the license agreement that many users do not read. There is the other brand of spyware that is much more troublesome—it can take control of the system, and/or report back keystrokes to the author of the program. This has the potential to allow others to see a person’s banking activity and to capture user names and passwords. Similar to virus protection, systems need to be loaded with anti-spyware software and kept up-to-date.

There are some additional recommendations that Rommey (1995) advances, such as:

- **Hiring and Firing Practices**: Security checks are needed to be run on potential employees, with the employee consent. When employees are terminated, all access must be immediately removed and escorted from the place of business if they are in secure positions.

- **Employee Training**: Employees are needed to be made aware, and trained that security is everyone business. They should be taught on their responsibility to report fraud, how fraud can occur, and that the organization monitors all activity. It is important to stress ethical behavior and consequences of not following company policies.

- **Designing Against Fraud**: It is easier to build protection at the beginning, then to adjust to vulnerabilities later. It is important to examine the risks and threats, evaluate them on a probability level, estimate the loss or exposure, identify controls to protect against these losses, and determine the threat value against the potential for loss. Several options are available to design against fraud, and they include:
  - **Enforce Segregation of Duties**: Make sure that an individual in charge of an asset cannot conceal the threat of that asset.
  - **Enforce Vacations and Rotation of Duties**: Fraud takes time; forced vacations and rotation of duties will enable others to spot fraud quicker if perpetuators are forced to relinquish control for a time.
  - **Restrict Access**: Make sure individuals are allowed access to do their jobs and are only allowed access to areas of an organization that their job entails.
  - **Encrypt Data**: Use encryption whenever there is confidential data being passed over unsecured networks, including internal networks.

**CONCLUSION**

While corporations are improving security and increasing awareness, computer fraud will continue. Due to the amount of money that can be gained by criminals, and as this paper stated, money can be made in computer fraud. However, there are ways to mitigate the risk and offer protection. User education is helping, but education and awareness must be increased. These computer fraud attacks, whether internal or external, being socially engineered or simply a disgruntled employee causing financial stress to the organization need to be understood. There is no single type of computer fraud attack, and therefore no one possible solution. In Cronan et al.’s (2006) study of university students and computer misuse, one startling result was reported that those students who actually read and understood the university’s policy on computer misuse actually committed more misuse. While different reasons were explored for this phenomena, the result is clear—challenges are ahead, not just for the normal everyday criminal, but all society.

The impact of personal identity losses and their financial impact are staggering. However, even with computer fraud on the rise, there are some good reports available, for example, once a criminal case is brought forth, the vast majority (81%) plead guilty (Davis & Braun, 2004). The average prison time has risen to 23
months, followed by probation and the average fine levied was $401,000.00 with the mean being $46,000.00. This increase as suggested by Davis and Braun (2004) may be due to increased training and collaboration between the FBI and the Department of Justice. Penalties are also on the rise for companies that do not enforce security. According to Jason (2006), the Federal Trade Commission fined one large discount wholesale club for not utilizing appropriate security practices to protect its customer database. This company must now submit to third-party audits, and while some security experts believe it is a good idea for companies to allow audits to check their security, many companies may see this as an unwelcome intrusion on their business.

The U.S. Patriot Act has also helped in this fight to stop computer fraud. The definition of loss has been expanded to any reasonable cost, even including the cost to report the loss. Previously, only a successful attempt was counted, now even failed attempts are taken into an account, and the law now recognizes and goes after users who are not located in the United States (Davis & Braun, 2004). This may be a signal in a new era of corporation, enforcement, and sentencing of this type of activity.

In any of these conditions and/or events, training must continue and either the penalties must be increased or the seriousness of the nature of computer fraud be understood by all.

REFERENCES


KEY TERMS

Computer Fraud: An activity conducted for financial gain by an individual. Computer fraud can be a malicious attack to steal data, or a type of social engineering where the goal is to gain someone’s personal information. Computer fraud can be considered an inside or outside threat. Identify loss, data modifications, and data theft are all forms of computer fraud.

Computer Fraud Activities: An activity where an individual would gain knowledge of someone’s personal information, for example, phishing and pharming. Ac-
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Activities are also directed at the corporations, for example, theft of computer time, theft of computer resources, and software modifications or copying of software. It is typically considered an act where a computer is used to commit fraud.

**Computer Fraud and Abuse Act:** The federal Computer Fraud and Abuse Act, 18, (USC1030) (CFAA) of 1986, created and passed by Congress to reduce the hacking incidence of computer systems. It was last updated as part of the Patriot Act in 2001, raising penalties, increasing jail time, expanding the definition of loss, and making it easier to show damage Organizations can make use of CFAA against employees who wrongfully use data that was on their computer systems, for example, to give to competitors, or start a business. The CFAA is a federal statute which authorizes penalties, terms of imprisonment, and civil actions.

**Identity Theft:** An activity where a perpetrator uses someone else’s personal information without their permission for financial gain. Examples could be credit card and mortgage fraud, where credit is issued to the perpetrator based upon the financial rating of the victim. Perpetrators steal identities in numerous ways: e-mails, key loggers, impersonations, phone calls, and stealing trash from an individual’s home.

**Phishing:** An activity based upon social engineering, where perpetuators or phishers attempt to exploit the trustworthiness of individuals to reveal personal information, such as user name, passwords, credit card numbers, banking information, and so forth. Communications is attempted by several means—e-mail, phone, letters—but most often carried out by e-mail due to the ease and relative ease in which phishers can obtain mailing lists with thousands of e-mail addresses. Phishing techniques are varied and often very business looking stating that your financial institution needs you to update your records immediately or your account will be locked. Phishers do not really know your banking institution, but after they send out 10,000 e-mails, the chances are good that some of those e-mail addresses actually conduct business with the named institution in the e-mail. It is the unsuspected individual who does not identify this as such, and instead of calling his or her financial institution, offers their valuable information, often at a Web site that looks identical to their main institution.

**Social Engineering:** An activity that is conducted by perpetrators on individuals in the hopes of gaining some personal information, such as credit card numbers, banking information, user names, passwords, and so forth. Social engineering can take the form of e-mails, mail, and phone calls. The authors of social engineering activities exploit individuals willing to trust, often with bad consequences. It often relies on non-technical means and involves tricking individuals to give up personal information. Social engineering perpetrators often rely on the goodness and natural tendency of people to help others.

**U.S. Patriot Act:** The Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism Act of 2001, also known as the U.S. Patriot Act, was passed by Congress and signed into law by President George W. Bush in October of 2001. It was designed after the September 11, 2001 attacks to allow law enforcement quicker access to information and to share information in the hopes of stopping future attacks. It expanded and clarified rules regarding the seizure of digital evidence and the authority to intercept electronic, oral, and wire communications when it relates to computer fraud and abuse offenses, and expanded on the use of search warrants for electronic data.
Communities of Practice

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INTRODUCTION

Basic social-learning theory presupposes that students and instructors function within community; they share common context, goals, and expectations and, thus, actively work to help one another learn. Instructional environments that reflect this understanding that all participants contribute to the learning process exemplify what is generally called a “community of practice” or a “community of learners” (Ormrod, 2004). Communities of practice involve situations in which teachers structure realistic problems or tasks and then facilitate learners to activate previous understandings, to interact collegially with others, and to apply combined knowledge to work towards a process-based solution. It is important to recognize that communities of practice can extend beyond traditional educational settings (such as school) into family dynamics, corporations, or any other social context.

BACKGROUND

Research has focused on the changing roles of learner and instructors in technology-assisted educational settings. Kettner-Polley (1998) presented an autobiographical case study describing the metamorphosis that occurs when a traditional educator fully adopts a technology-mediated teaching style; “…this is only one person’s story. On another level, it is a sign of the times. Traditional academia is rapidly falling apart, and it is the quiet transformation of traditional (teachers) into virtual (teachers) that tells the true story behind this revolution” (¶ 1). In describing the changing role of the instructor, Kettner-Polley’s report also detailed the common principles that guide twenty-first century learning: community, accountability, and flexibility.

Smith, Ferguson, and Caris (2001) interviewed twenty-one educators familiar with both traditional and technology-assisted teaching strategies. This study indicated that, not only were computer-mediated activities at least as interpersonal as face-to-face classes, one-to-one relationships could actually be enhanced by the increased use of technology-based learning strategies. Additionally, these researchers concluded that teaching and learning that integrates technology elicits higher-order thinking and increased instructor-student equality.

Fowler (2005) proposed that technology-enhanced coursework may actually prove to be more academically challenging and pedagogically sound than traditional face-to-face activities. “Despite the fact that online learning is a pretty well-established learning modality, there are those who continue to discuss and debate whether online is ‘equivalent’ to onsite…. In fact, a recent experience of simultaneously teaching online and onsite has me asking quite the opposite question: Are onsite courses as effective as online?” (p. 8).

Beam and Zamora (2002) recommended that, before educators attempt to teach with technology, they ought to be well-versed in the experience of being online learners, themselves. This case study documented elements perceived to connote successful technology-based teaching and learning as an intentionally designed reflective and supportive learning environment; flexible course design; real-world opportunities for application of skills being learned; collaboration with peers; and asynchronicity.

Modern students generally express a preference for collaborative and authentic learning activities over lectures, projects, and discussions (Stein, 1998). Kish (2004) utilized teacher vignettes as part of a technology-assisted course and discerned that interactive teaching practices increased academic achievement and higher-order thinking skills. Other authentic learning experiences, including online case-based approaches, have been demonstrated to improve students’ reflective and critical-thinking abilities (Kim, Hannafin, & Kim, 2004). Alomyan and Au (2004) concluded that the nature of teaching and learning with technology, particularly the use of collaboration and hypermedia, actually reduces academic performance differences between students with differing cognitive styles.
Much of the educational design that integrates technology incorporates ideas of “communities of practice” suggested by Lave and Wegner (1991). This model of situated learning defines community as a set of relationships rather than as a fixed social or temporal construct (Smith, 2005). Duncan and Leander (n.d.) maintain that learning by means of intentionally-structured experiences with technology exemplifies communities of practice; “…it is productive for the study of Internet community and learning possibilities to consider the particular kinds of social-material spaces that the Internet constructs, including the increasingly fuzzy conceptions of public and private space” (¶ 3). Electronic mail (e-mail), use of the World Wide Web, and Internet course delivery have been found to be particularly effective uses of situated learning that foster communities of practice, and positively affect learners’ affect and achievement (Bhalla, Chu, Currier, Curtis, Dehash, Eick, et al., 1996; Veal, Brantley, & Zulli, 2004).

Owen (n.d.) explained professional development in terms of induction to a community of practice and detailed situated learning as it is applied to teacher education. Because they utilize flexible distance education techniques, courses that integrate technology assist support professional development (Johnstone, 2002), particularly when they are “…based on practitioners’ reflection of their work and collaborations with their colleagues” (Owen, n.d., ¶ 30). Crawford (2002) proposed an educational model in which technology-integration strategies (including participation in online courses) was deemed to be essential in producing new understandings. Specifically, Crawford rates learner-centered (rather than teacher-centered) instruction, Internet access and integration, professional modeling opportunities, and interactive or collaborative activities as those elements most effective for promoting engaged learning.

USA Today reported that schools tend to integrate technology less frequently and effectively than does much of society in general (Feller, 2005). Several studies have reasoned that this is due to the fact that technology is not appropriately integrated within educational programs (Goetze & Stansberry, 2003; Sahin, 2003; Wepner, Tao, & Ziomek, 2003). Researchers advocate constructivist practices, a full integration of technology that takes the sociocultural context of teaching into account, when designing instruction (Bhalla, et al., 1996; Crawford, 2002; Duncan & Leander, n.d.; Polloff & Pratt, 2003; Slowinski, Anderson, & Reinhard, 2001; Walker, 2001). Teachers, preservice and in-service, should utilize technology to begin to structure learning activities within communities of practice.

Lara and Malveaux (2002) describe an educational program redesigned around the theme of teaching and learning with technology; learning communities, collaborative learning, and hybrid courses are foundational to it. The design of whole courses or specific activities that integrate technology with more traditional teaching strategies can afford educators the flexibility to incorporate modeled behavior, collaboration, technology skills, student-centered learning design, and additional time into their courses (Polloff & Pratt, 2003) A study by Vonderwell and Turner (2005) indicated that educators who effectively utilize technology as a tool for situated learning take student expectations and motivations into consideration, redefine student and instructor roles, and reconstruct traditional learning activities and available instructor support. “Students must be prepared for their roles as active learners. Learner autonomy, as well as collaborative strategies, need to be negotiated for the effectiveness of learning” (Vonderwell & Turner, 2005, p.82).

Walker (2001) echoed these ideas in terms of a situated learning environment proposed for teachers’ professional development. Educators were motivated to participate in online courses/workshops or to use technology tools, if they were provided with continual access to instructional technology, could model their technology use on that of knowledgeable peers, and were aware of the technology goals of their districts or schools (Johnstone, 2002). In short, learners embrace technology-mediated instructional practices if they can identify and relate to the communities of practice in which to do so.

**COMMUNITIES OF PRACTICE APPLIED**

Learning environments considered as exemplifying communities of practice tend to share certain traits (Brown & Campione, 1994; Ormrod, 2005; Rogoff & Lave, 1984; Rogoff, 1994; Tam, 2000), and to make use of particular interactive instructional strategies (Brown & Campione, 1994; Conway, 1997; Tam, 2000). This is particularly true of technology-mediated teaching and learning situations.
Changing roles. In a community of learners, the role of teacher is shared between learners and instructors. The teacher transitions from the traditional role of “the sage on the stage” to a more participatory “guide on the side.” Communities of practice are characterized by: teachers and students who share knowledge, authority, and responsibility; by the various heterogeneous groupings within them; and by the teacher’s evolving role from instructor to facilitator.

Within communities of practice, the role of the teacher has been modified from a deliverer of information to that of creator and supporter of a collaborative environment. The teacher guides the learners in a process whereby they construct their own knowledge in a collaborative way. The student’s role has changed from that of passive recipient of information to that of active and participatory learner. He/she defines goals, evaluates progress, and is responsible for his/her own learning.

The changing nature of student-teacher interactions has created opportunities and challenges for technology-mediated instruction. Course management software, such as Blackboard, provides instructors with a Web-based framework for instruction. Various sequences of experiences can be intentionally created whereby the instructor prompts students to participate in their own learning and to discover new information, but does not absolutely dictate the manner in which they are to do so. Electronic communication technologies, like e-mail or instant messaging, enable teachers to scaffold instruction for various students, and to customize the ways in which individuals or groups approach learning tasks. Discussion boards, podcasts, or Web logs provide opportunities for students and instructors to move between learning and teaching roles, and to work together to negotiate meaning within a community of practice. Distance-learning strategies, including online or hybrid classes, have transformed the traditional relationship between teacher and student. Learning is now possible anytime, anyplace, and in a variety of ways, very few of which are linear.

Process vs. product. Learning goals for participants in communities of practice vary from those of “traditional” educational environments. Products that demonstrate mastery assume less importance than activities reflecting the process of learning. Students must be able to work as a community to build learning processes rather than just to acquire knowledge. In particular, learning within a community of practice becomes meaningful when it is active, authentic, cooperative, constructive, and intentional. Learners who have a stake in the process of learning establish demonstrate understandings more fully.

Knapp and Associates (1995) describe the process-based ways in which communities of practice negotiate meaning as being especially meaningful. They cite three reasons why learners thrive within a learning community that values process over product. “First... they are encouraged to be meaning makers. Second, they derive meaning from seeing the relationship of parts to the whole, rather than being left with only parts. Third, they find meaning by connecting new learning experiences to their existing body of knowledge, assumptions, and meanings...” (¶ 2). When designing a community of practice, the goal is to provide a scenario in which new understandings emerge from the process of social learning within the community.

There are numerous technology resources in which the process of learning takes precedence over or, at the very least, blends seamlessly with an integrated product. The creation of various multimedia products such as PowerPoint presentations or digital stories require that students evaluate content to determine the most relevant subideas, synthesize disparate elements into a cohesive whole, and then decide how best to present new understandings. For example, when an elementary student decides to create a series of Web pages presenting research about personal ethnicity, he/she must make a series of value decisions regarding what factual elements to include or exclude, assumptions regarding the audience for which the product will be geared, determinations about the voice and sophistication of the content, a selection of an appropriate technology application and how to operate it, conceptual judgments about layout and design, and communication strategies regarding ways in which the Web pages can be accessed.

Process-based learning also allows for effective differentiation of instruction. Learning communities foster diversity and help learners to construct shared meaning based upon the strengths of individuals within the whole. Learners actively work to establish strategies that build on personal strengths and allow them to compensate for individual weaknesses. The flexible nature of shared process-based learning ensures equitable and interactive work where tasks may be customized within groups or for various individuals. In particular, technology-assisted activities involving multimedia
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allow learners with different learning styles, varying cognitive abilities or processing speeds, and multiple socioeconomic backgrounds to construct meaning from disparate experiences and to identify personally relevant learning experiences.

**Collaboration.** Collaboration between members of a community of learners is essential for the creation of new understandings. Not only do communities of learners allow participants to share their accumulated knowledge, they also allow for the presentation of multiple perspectives. Working between diverse points of view affords learners the opportunity to compare, to appreciate, and, ultimately, to synthesize multiple perspectives about an issue. Students with varying backgrounds, from differing cultures, and across ability levels, are encouraged to make valuable and valued contributions to the learning process, and, in a community of practice, they feel comfortable doing so.

However, collaboration in a community of practice transcends the basic division of labor associated with typical “group work.” Bednar, Cunningham, Duffy, & Perry (1992) insist that it involves “...the rigorous process of developing and evaluating the arguments that is the goal in collaborative learning” (as cited in Tam, 2000).

There are many types of technology that support collaboration. Tools such as word processors (i.e., Microsoft Word), drawing programs (i.e., KidPix), desktop publishing programs (i.e., Microsoft Publisher), multimedia presentation tools (i.e., PowerPoint), photo editors (i.e., iPhoto or Adobe Photoshop), movie-makers (i.e., iMovie), and sound editing applications (i.e., Garage Band) allow learners to work collaboratively as they make decisions about what information to convey and how to convey it to the world-at-large. Additionally, various technology communications resources, like e-mail, instant messaging, or discussion forums, provide opportunities for learners to communicate across time and distance as they work together. Search engines (i.e., Google) and data bases (i.e., multimedia encyclopedias like Encarta or Wikipedia) serve as rich repositories for various information utilized in collaborative learning projects.

**Participatory learning.** All learners have the potential to be resources for others. Reflective practices and collegial debates/critiques are encouraged. Discussions, cooperative learning activities, peer tutoring, reciprocal teaching, and cognitive apprenticeships are types of educational strategies often demonstrated within communities of practice. As learners carry out authentic tasks, they actively determine how and when to use various knowledge to solve problems (Hannafin, Hannafin, Land, & Oliver, 1997). Thus, they participate in generating their own understandings. Learners use higher-order thinking skills as they read, write, discuss, and intentionally engage with one another to solve problems. They may also model their learning after expert members of their learning community.

Learning is also not limited to the acquisition of information. Students in a learning community are disavowed of a single “right” answer or sole schema. Instead, they engage in participatory activities that enable them to connect new information to prior knowledge, to test multiple perspectives, to reject or to accept various strategies, and, ultimately, to create understandings that are meaningful for a particular case at a particular place and time. In a community of practice, problems are never neat and tidy; instead they are changeable, require multistep inquiry and reflection, and have no formulaic solution. Learners are motivated to participate in and are engaged by learning when problems mimic real-life situations and spark curiosity.

Using a variety of technologies, learners increasingly assume responsibility for their own learning. Simulations, video conferencing, e-pals, e-portfolios, virtual field trips, and a variety of other technology applications allow students to learn through guided experience. A teacher might create a podcast in which he/she reads a text aloud and verbalizes the reading strategies used to process the content. A student could then download the podcast, listen to the reading, and model the processes being demonstrated. Video conferencing or textual discussion provides students the means to participate in an exchange of information with one another or with an instructor, and to negotiate meaning from it. Communication via e-mail or other telecommunications with other students or with individuals perceived as experts connects learners to both the process of learning and the resources necessary to glean knowledge.

Participatory learning is also encouraged in various virtual learning environments. Simulations (i.e., The Sims) allow students to manipulate a variety of factors in ways that would not be possible in real life. Virtual field trips, Web quests, or virtual environments, such as participatory and exploratory Websites (i.e., The
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White House or The Metropolitan Museum of Art), offer students almost unlimited access to places, people, and things.

**Authentic tasks.** Instruction within communities of practice emphasizes learning within meaningful contexts. In order to formulate process-based understandings, learners must construct personal understandings within a context that is relevant for them. In fact, Jonassen (1991) argues that the knowledge base associated with learning is inextricably linked to the context in which it occurs. Conway (1997) contrasts such instructional practices with more traditional product-based ones; “...they tend to focus on projects that require solutions to problems rather than on instructional sequences that require learning of certain content skills” (p. 2).

This is not to say that learners are not held accountable for learning basic skills or concepts. However, such skills are not taught in isolation. Rather, skills are embedded within tasks that mimic real-world problems. Learners must disassemble a broad-based authentic problem into its various components, determine the skills and logic necessary to solve each portion, and then reassemble the disparate knowledge into an integrated understanding of the concept as a whole. Authentic tasks prompt learners to use what they already know to determine what they need to find out. Thinking analytically in this way also instigates students to locate and use appropriate learning resources.

Authentic learning experiences require that students become problem-solvers. They must first frame the questions that define the problems that they aim to resolve, and then devise methods for solution and means by which to communicate the answers. Computer-mediated resources and telecommunication technologies fit this paradigm perfectly. There is no more “authentic” definition of tasks than of those created for a realistic purpose, that are personally meaningful, and that are accessible to a world-wide audience. Integrating technology into communities of practice enhances authentic experiences at a personal level as well as in terms of social learning. “On the one side, one can see even more individualized learning in a student sitting in front of his or her computer. But, on the other hand, the technology allows for much more diversified and socially rich learning contexts; peer tutoring via computer; computer networks, e-mail, telecommunications” (Tam, 2000, p. 11).

**CONCLUSION**

“Back in the day,” educational models were didactic. Learning was perceived to be a function of direct instruction and understanding could be measured in observable behaviors or in quantifiable reports. However, twenty-first century learning is far less rigidly defined. In order to be successful lifelong learners who effectively process the diverse information with which they will be bombarded daily, students need to be able to function within communities of practice. Increasingly, educators recognize that these same learning communities can provide effective instructional strategies and reflect more constructivist notions of best practice. In short, communities of practice define a modern paradigm for teaching and learning.

One that involves students working together toward common goals, teachers serving as ‘experts’ and coaches, and facilitators, and sometimes just plain getting out of the way and letting students discover things for themselves. What is technology’s role in this movement? It is supporting the choices that teachers make every step of the way by providing the environment, the content, the experiment, and the place for students to ‘put it all together; to share with other students, parents, and the world (Conway, 1997, p. 7).

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Communities of Practice


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**KEY TERMS**

Communities of Practice: Communities of practice are those instructional environments reflecting an understanding that all participants contribute to the learning process and involve situations in which teachers structure realistic problems or tasks and then facilitate learners to activate previous understandings, to interact collegially with others, and to apply combined knowledge to work towards a process-based solution.
INTRODUCTION

Computer-based assessment (CBA) is gaining popularity in higher learning institutions to replace traditional written tests with computerized versions. Some reasons that have encouraged instructors to develop and adopt CBA include the increased number of students and the corresponding increase in time spent by instructors on assessment. The primary objective of a CBA is to save the instructor time by leaving the computer software to mark and give feedback on the test.

As information technology has become ever more important for teaching engineering, so computers have become an established means of student assessment. CBA is not just an alternative method for delivering tests; it represents an important qualitative shift away from traditional methods such as paper-based tests. In this paper we describe a computer coach-based assessment model for engineering mechanics dynamics course.

BACKGROUND

Computers are now regularly used to deliver, mark, and analyze student assessments. A common traditional assessment is where candidates fill in their responses on a paper form, which is fed into a computer optical mark reader. This reads the form, scores the paper, and may even report on test reliability. In general computer-

| Area Type Brief Description                                                                 |
| Summative Exam An assessment solely for grading purposes such as an exam at the end of a unit of study (Callear & King, 1997; Zakrzewski & Bull, 1998) |
| Formative/Summative Grading test An assessment for grading but which also provides feedback intended to direct future studies such as a small test, or weekly problem sets (Callear & King, 1997) |
| Formative Open access test A grading test where students are allowed to practice before sitting the test (Thelwall, 1998). |
| Formative Self-test An assessment designed to provide feedback to students on their progress (Zakrzewski & Bull, 1998) |
| Formative Exercises A problem set designed to consolidate learning on a section of a unit of study (Thoenessen & Harrison, 1996; Whiting, 1985) |
| Formative Programmed Learning tool A linear computer-aided learning (CAL) package based upon a question and answer session as pioneered by Skinner (1968) |
| Formative CAL quiz A marked exercise integrated into a CAL package, for example a MCQ presented after a slide show containing new information (Kelly, Maunder, & Cheng, 1996) |
| Formative Adapted CAL quiz A marked exercise integrated into a CAL package used to test the students but also used to adapt the teaching of the package to student weaknesses (Laurillard, 1993) |
| Formative Diagnostic test An assessment of prior learning taken before a unit of study test (Appleby, Samuels, & Treasure-Jones, 1997) |
based assessment has been used since the 1960s to test knowledge and problem-solving skills. The earliest versions were text-based and typically consisted of factual questions for which they were definite right and wrong answers. However today, computer-based assessment is used in many different contexts, and to perform different functions. There are generally two basic types of assessment, that is, formative and summative (Thelwall, 2000) as briefly described in Table 1. Formative assessment is designed to help students to gain understanding and to develop their good learning habits. Typically, this type of assessment will be represented by activities integrated into the course and may include:

- Feedback within study materials;
- Self-assessments tests or quizzes;
- Feedback from assignments;
- Dialogue with peers, colleagues, and department; and
- Un-graded tests (“mock exams”).

On the other hand, summative assessment attempts to measure the extent and quality of the students learning through:

- Examinations;
- Course work/assignments/mini projects; and
- Practical demonstrations/oral presentation.

A commonly used format that operationally combines the two is continuous assessment, that is, summative assessments are integrated into the course alongside any formative assessment. Such an assessment is beneficial to vocational courses where a written summative assessment may itself be inappropriate. Continuous assessment is easy to manage and provides a source of material that allows dialogue, reflection, and motivation to develop.

**GENERAL PRACTICE**

Before looking at ways in which assessments might be implemented using computing software, it might be best to look at the needs and concerns of the students, department, educational, and institutions. Students generally have mixed feelings about assessment. On the one hand, the resulting qualifications are seen as being highly desirable, often necessary to acquiring a desired job or promotion. Students typically fear the standard summative examination process, often feeling it to be unfair that a whole year’s work can depend upon their performance in the allotted two or three hours (Morgan & O’Reilly, 1999).

For the department, the principle function of formative assessments should clearly be to monitor the learning of the student. The assessment process would provide the instructor with useful feedback about the effectiveness of the course. Summative assessment should then be able to provide an accurate representation of the level achieved by a student. For the educational establishment itself, assessment has two important functions; it allows staff and program performance to be monitored, and allows the achievement of the establishment be known to the public through publications, advertisements, and so forth.

With the rapid expansion of educational opportunities, the number of candidates sitting for a particular test has become very large and this calls for an alternative method for effective assessment. In addition, there is a great demand by the candidates, parents, sponsors, and the university to release the results of the examination as quickly as possible. In order to cope with this scenario, computers are increasingly being used in assessing student’s knowledge. However, the techniques employed for this purpose depends on pertinent factors such as the number of candidates, the number of questions, and the available man-hours to mark the answer sheet to prepare the result sheet on the computer.

In general, there are a variety of commercial computer-based assessment tools available on the market such as Question Mark Designer for Windows, Question Mark, Quiz Please, WinAsk Professional, and EQL Interactive Assessor. On the other hand, authoring tools such as ToolBook II Instructor could be used to design and implement customized CBA tools. The following section describes an innovative in-house developed engineering coach-based CBA tool that not only marks and grades the student but additionally coach the student in solving the problem.

**THE ASSESSMENT MODEL**

The assessment model is a dynamic model of the student’s knowledge and capabilities, maintained and constantly updated by the computer-based tool. Its
Computer-Based Assessment

purpose is to evaluate and account for the student’s actions and responses. Human tutors do excellent work on moderating student’s answers in the context of their assumed level of understanding and past learning behavior, thus effectively adapting their instruction to the student’s competence and abilities. Although adaptation to the student is almost second nature for human tutors, it is an extremely difficult characteristic to implement in this CBA model.

The function of the assessment model is to provide the student with feedback from comparing the student’s actions with those prescribed by the computer-based assessment tool. This feedback is used to inform the student which actions are correct and which are incorrect. In this way, the student receives tuition while interacting with the CBA tool.

Conventional (classroom) assessment could occur through a variety of methods, for example, quizzes, exams, oral test, or homework. However, the most common technique to be used for assessing the student in a computer-based tutoring tool is the assessment of the number of correct and incorrect answers upon completion of a course topic. Adaptation to the student level of understanding is usually limited to the presentation of a pre-specified course material, based on the student’s response to the questions of the test. Most available conventional computer tutoring tools do not have the ability to keep track of the student’s insufficient knowledge, except at a very basic level. For current tutoring tools, the assessment model will have to be greatly simplified so that it may be practically realized.

Requirements for Assessment Modeling

The student assessment model represents an overview of the student’s capability level. There are a number of fundamental rules that should be adhered to when developing an assessment model in this CBA tool. These can be summarized as follows:

• The model must be able to represent knowledge, concepts, and skills.
• The model must include the knowledge that the student has acquired, and that which the student has been exposed to and shown some understanding.
• The model must be able to represent the student’s misconceptions.
• The model must be able to include a history of the student’s problem-solving performance.

Student Diagnosis

Student analysis plays an important role in assessing and correcting the student’s misunderstandings. It is important that whenever a student makes a mistake, the computer tutor points out the error, offers an explanation to clarify, and guides the student effectively in solving the problem. If the computer tutor only tells the student that s/he is incorrect, it has not performed its teaching task, but instead shifted the problem back to the student.

The aforementioned types of misconceptions in a student’s knowledge that may be analyzed are dependent on the knowledge represented in the tutoring package. Because each tutoring tool has a limited domain and pedagogical knowledge component, an extensive student analysis is a difficult facility to incorporate into a CBA tool. There are occasions where the student has the correct answer but expresses it in a different way to that recognized by the tutoring package. Similarly, a student may appear to be missing certain skills when instead, s/he is employing a totally different strategy that is not programmed in the assessment model.

Misconceptions in Students’ Understanding

The assessment model describes what a student should know and do in a particular situation. When the student actions do not match those suggested by the assessment model, the reasons can be attributed to a number of causes, for example, the lack of knowledge stored in the assessment model, the use of inappropriate knowledge to tutor the student, a student’s inability to apply this knowledge to the present scenario, or an incorrectly defined model (Sleeman, 1982). Evaluating a student’s misconceptions involves determining the probable cause for the student’s incorrect behavior or action.

After evaluating a student’s misconceptions, a computer-based tutoring tool will provide instructions for correcting these misconceptions and improve the student’s problem-solving skills. The selection of the appropriate instructions is guided by the domain knowledge tutoring strategies (Sleeman, 1982).
**Tutoring Strategies**

There are two areas of tutoring strategies that affect the assessment model directly. These include the adaptation of the tutoring tool to the student and the limitation of the number of interrupts allowed to the student.

**Adaptation to the Student**

One of the most important aspects of assessment modeling is the ability of the computer to adapt to the requirements of the student. The following strategies offer useful guidelines to the successful adaptation in response to the behavior of the students (Galdes & Smith, 1990).

- It is useful to look at the cause of a definite error in addition to the type of error made. Before correcting the student, it is important to assess whether the error was one of a careless nature, or whether it resulted from misconceptions in the student’s understanding.
- When a student appears to be struggling with the concept or problem and has not specifically asked for help, it is advisable to allow the student extra time before interrupting. The student’s attitude should determine some of the parameters in the tutoring process.
- In specific cases, where the student’s error is fundamental, it is useful to teach procedures for error detection instead of just correcting the error.

**Limit the Number of Interrupts to the Student**

An important tutoring strategy is to ensure that the student is not offered excessive assistance on a topic, unless it is required. The CBA tool should function as a passive observer, offering guidance only where necessary/requested. This method is essential to ensure that the student discovers knowledge through experimentation. The following strategies could be adopted (Galdes & Smith, 1990).

- The computer tool should apply a “pause” strategy whenever possible for correcting errors that arise when a student is performing a task.
- It is not recommended to interrupt the student for every action that cannot be fully explained, especially if the student is likely to return to the correct solution path at a later stage.
- If the student appears generally confused and is likely to request assistance in the near future, it is advisable to wait for the student to initiate the dialogue, as the student’s initiative may give insight into the specific problem.

**THE COACH-BASED ENGINEERING ASSESSMENT TOOL**

The coach-based CBA tool implemented for assessing the student’s understanding of the problem presented in the assessment tool has a user-friendly environment that builds on eight major modules: the action interpreter, the assessor, the interface, the help, the calculator, the glossary of commands table, graphs to show $v-t$ and $s-t$ curves, and a database to store the student progress score. The system environment consists of the given conditions of a problem and a problem-solving engine. The problem-solving engine comprised of decision-making rules. The given conditions of a problem are used as input to the problem-solving engine. Outputs from the problem-solving engine consist of all the equations necessary to solve the problem. These equations are then used by the action interpreter and assessor to provide appropriate hints.

When solving engineering problems, students need to use and input special characters that are unavailable on the standard keyboard such as the power of two. Thus a character map table has been included in the tool whereby students can click the character map button, as that will display all the characters available for editing. Once the required character is selected, the student can copy and paste into the text input box where appropriate. Similarly, a calculator, notepad, and glossary of commands are included because these features are considered as essential components of the tool.

The action interpreter module interprets the student’s problem-solving action in the context of the current problem and determines the type of feedback to provide. For example, if the student enters an equation, this is compared to the set of equations produced by the problem-solving engine, and if a match occurs, a message informing that the equation is correct is displayed as
Figure 1. Screen caption of the engineering problem being solved by user

shown in Figure 1. When the student has reached an impasse and has no idea how to proceed, he can click the hint button for help. Some of these buttons are enabled when it is necessary or appropriate and disabled when not required in the problem-solving step.

On the other hand, if the student has input the wrong formula, the student will be asked if s/he needs a hint. If the answer is wrong again, a solve button will be visible as shown in Figure 2. The student can then allow the tool to solve the problem. The solution will be shown in a step-by-step animated form. If the answer given by student is correct, he can then proceed to the next step. If a complete solution has been accomplished, except for numerical substitution, the user can choose the solve button for the tool to do the appropriate substitution.

During these actions, the student progress database is also updated accordingly. The progress of the student is shown at the end of each complete attempt to solve the problem as typically shown in Figure 3.

As the student solves the problem, s/he is required to input numeric values in text boxes where appropriate, select the right symbolic calculator from a drop list item, and make a choice from a multiple list of answers. The student can activate the calculator to perform simple calculations, and the calculated answers can be copied and pasted in the text input box.

If the student correctly solves a step, the screen will display the subsequent step. The steps are iterated until the last step is completed. High quality color graphics were used extensively and design features, such as
interactivity, animation, and a hypertext facility were employed with the intention to enhance student learning. Interactivity is promoted in several ways. For example, students are required to:

- Input numeric values in text boxes.
- Interpret time graphs of a car journey.
- Perform calculation to compute the distance the car travel.
Computer-Based Assessment

CONCLUSIONS

In summary, computer-based assessment offers many educational and practical advantages over paper-based tests. However, the implementation of a computer-based assessment can be challenging and lengthy to be successfully integrated. In this paper, we proposed an innovative method via coach-based assessment tool that can be used for marking engineering problem being solved by the student. The proposed method is suitable to be used if there are a large number of candidates. The proposed method can therefore make the marking process of CBA practically easier and provide both the student and lecturer instant feedback.

REFERENCES


KEY TERMS

Coach-Based Tool: Computer software to coach students on deciding the appropriate actions to be taken, that is, the actions ensuring that a given goal is reached in solving a given problem by a step-by-step approach.

Computer-Based Assessment (CBA): An assessment that is built around the use of a computer; the use of a computer is always intrinsic to this type of assessment. This can relate to assessment of IT practical skills or more commonly the on-screen presentation of knowledge tests. The defining factor is that the computer is marking or assessing the responses provided from candidates.

Formative Assessment: Designed to help students to gain understanding and to develop their good learning habits. Additonally it intends to promote student attainment.

Summative Assessment: Refers to the assessment of the learning and summarises the development of learners at a particular time.
Computer Supported Collaborative Learning Scenarios: And External Representations for Promoting Them

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INTRODUCTION

There are many ways in which information technology (IT) can be integrated into the curriculum. IT can, for example, enable access to learning material and resources, it can feature learners’ communication, and also provide instructional elements for the learners. The exact method by which IT is applied to the learning situation is however dependent upon the scenario in which it is required. This article is about computer-supported collaborative learning scenarios. These are characterised by the fact that two or more learners work together to acquire knowledge about a particular topic. Learners may sit together in front of the same computer screen and work in a learning environment, or they may be spatially or temporally separated and use IT for their communication as well as for access to the learning environment. This communication may use chatrooms, newsgroups, or one of the forms of audio-visual communication, such as videoconferencing. The method of communication should be adapted to best fit the learning scenario for which it is being applied (Ertl, Kopp, & Mandl, 2007). Whether or not the collaboration partners are in the same place, the computer screen and its contents are always the central element in the computer supported learning environment. The information displayed on the screen is used to focus the collaborative learning process on particular aspects of the learning task, for example, on ontologies and argumentation moves (Ertl, Fischer, & Mandl, 2006; Suthers & Hundhausen, 2003). This structure can be seen as an external representation of the instructor’s knowledge about the topic at hand, and is given to the learners as instructional support.

BACKGROUND

The term ‘external representations’ is very broad and can be described as knowledge and structure which are displayed by physical symbols, objects, or dimensions (Zhang, 1997). External representations comprise of text information, such as a book, visualisations, or structure and guidelines (e.g. in the style of templates) (Löhner & van Joolingen, 2001; Zhang, 1997). External representations offer different features for varying scenarios of collaborative learning. They provide a permanent display of knowledge and structures (Larkin, 1989; Pächtter, 1996) and allow learners a permanent access to contents (Dennis & Valacich, 1999).

External representations may also guide the learning process if they provide an instructional prestructure to the learners; for example, verbal guidelines or visual structure for aspects that are of particular importance to their task. This representational structure focuses learners’ attention on aspects that might otherwise be neglected. Suthers and Hundhausen (2003) call this ‘representational guidance.’ The creator of the structure or guideline decides upon which aspects the learners should focus. The existence of this kind of structure may influence learners’ perception of a task (Zhang & Norman, 1994), and this may in turn influence the learners’ ability to solve the task. When provided with a beneficial representation, learners may perceive the problem in a different manner, enabling them to deal
with its content more swiftly (Zhang & Norman, 1994). Their studies showed that learners experience benefits to learning if they receive a supportive task structure (Zhang, 1997; Zhang & Norman, 1994). This mechanism can be used for providing instructional support for the learners.

INSTRUCTIONAL SUPPORT BY EXTERNAL REPRESENTATIONS

When external representations are applied as a means of instructional support, they are mainly directed towards the conceptual level of a task. They aim at facilitating learners’ understanding of a particular problem. For this purpose, content specific facilitation highlights central characteristics of the learning material by representing important content structures. Such prestructuring of the shared screen can make important task characteristics salient and can thereby function as a representational guide to learners’ content specific negotiations (Suthers & Hundhausen, 2003). The broad variety of structures for external representation (Löhner & van Joulingen, 2001) lead to a wide variety of facilitation methods, differing in the degree of freedom that learners have, and in the degree of support they receive when working with them. In general, one can distinguish between three different classes of support: simulations, conceptualisation tools, and templates. All three classes have the fact that learners interact with the external representations and that external representations guide the learning processes in common.

Simulations (e.g., Roschelle & Teasley, 1995) allow learners to simulate scientific processes; learners work with simulation software, which models the respective processes dependent on specific parameters. Roschelle and Teasley (1995), for example, provided learners an ‘envisioning machine’. This machine simulated Newton’s Law in respect to the concepts of velocity and acceleration. Learners were able to modify the vectors of velocity and acceleration in the Newtonian world and could directly see the effects of their changes within the simulation. Thus, the general principle of simulations is that an external representation provides parameters for learners to modify. Based on these modifications, the learners get direct feedback on this change within the simulation. In this way, simulations aim at understanding the influence of particular factors on a whole (simulated) system.

In contrast to simulations, conceptualisation tools allow the modeling of relations by the learners. In this case, the tool provides objects of different styles and different relations important for the content area and the learners can create their own representation of the structure of a particular content (Fischer et al., 2002; Suthers & Hundhausen, 2003). Fischer et al. (2002) presented a tool for structured visualisation. Learners were given the assignment to make a lesson plan for a class and to take different motivational issues into consideration. The tool provided cards for the learners to visualise lesson elements and other cards to visualise motivational aspects. Furthermore, they had different kind of lines to visualise relations between the lesson elements and the motivational issues. The tool enabled learners to get an image of the pros and cons of different lesson elements and to decide which lesson elements to use. Thus, conceptualisation tools aim at deeper understanding of structures within particular content area.

Templates prestructure a content domain (Brooks & Dansereau, 1983; Ertl et al., 2006; Suthers & Hundhausen, 2003). They are mainly in the style of tables and provide categories, which are particularly important for content specific negotiation. Learners fill the empty spaces in the template and thereby focus on important categories (see Table 1). However, learners cannot change the structure of the template and model new relations. Therefore, templates aim to help learners to understand important aspects of a content area. In the following, this article provides an example of a content scheme, which is related to the class of templates, to illustrate the possible application of external representations for computer supported collaborative learning.

CONTENT SCHEMES

Content schemes provide templates for learners that comprise of placeholders for important aspects. They often provide tabular structures (e.g., Brooks & Dansereau, 1983; Ertl, Reiserer, & Mandl, 2005; Suthers & Hundhausen, 2003). This structure of the scheme remains salient during collaboration and focuses learners on the aspects introduced by the placeholders (Suthers & Hundhausen, 2003). This style of guidance can be important for promoting important aspects of a task implicitly, which means that learners use this structure without being directly told to do so. Therefore, such
structures are particularly suited for distance education because there is usually little direct contact between instructors and learners. Until recently, the effects of such representational structures were often studied within the context of individuals (Brooks & Dansereau, 1983; Kotovsky & Fallside, 1989; Kotovsky, Hayes, & Simon, 1985; Larkin, 1989; Zhang, 1997; Zhang & Norman, 1994). However, during the last decade studies emerged about the use of representational guidance in computer supported collaborative learning (Ertl et al., 2006; Fischer et al., 2002; Suthers & Hundhausen, 2003). Results of these studies show that content schemes also have beneficial effects in collaboration.

Ertl et al. (2005) presented learners with a content scheme for collaborative theory teaching. It comprised of the categories of theory, evidence, and elaboration (see table 1). In their study, two learners acquired knowledge about different theories individually so that each learner had detailed knowledge about one particular theory. The learners’ collaborative task was to mutually teach the learning partner the theory that they had previously learned. During their collaboration, they worked with the content scheme (see Table 1) which guided them through the process of theory teaching. They used it for dealing with the aspects of theory, evidence, and personal elaboration (which comprised of the consequences of the theory and the individual opinion).

Ertl et al. (2005) could show that the scheme focused learners particularly on the categories of evidence and elaborations. These were neglected by learners without scheme (Ertl et al., 2005). In a further study, they were able to show effects of a content scheme for collaborative problem solving (Ertl, Kopp, & Mandl, 2006). Also this content scheme focused learners on categories, which were overlooked without, and encouraged them to take these categories into consideration. Suthers and Hundhausen (2003) reported similar results with respect to a tabular template. In their study, learners with a template provided more concepts between theoretical concepts and evidence.

### FACILITATION AND LEARNERS’ PREREQUISITES

External representations have proven to be beneficial for computer supported collaborative learning in several studies. They offer quite a lot of possibilities and opportunities for learners’ facilitation. However, not all of the opportunities that facilitation methods offer may have the desired effects (Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005). They may be dependent upon learners’ individual prerequisites, for example, prior knowledge (Ertl & Mandl, 2006; Shapiro, 2004), their cognitive abilities (Sweller, van Merrienboer, & Paas, 1998), or motivational aspects of the learning scenario (Deci & Ryan, 1992). This is particularly important for support methods using external representations as they may offer complex tools. These may require quite skilled learners with a high amount of prior knowledge. If such facilitation methods offer many freedoms to the learners, they may be too complex for beneficial activities (Dobson, 1999). When applying such complex facilitation methods, they may exceed learners’ cognitive abilities and result in cognitive overload (Sweller et al., 1998). Such effects may negate the benefits of facilitation. Consequently, complex methods, which have a high degree of freedom, may be best suited for highly experienced learners, while rather restricted,
highly structured methods may provide most benefits for inexperienced beginners.

Yet if facilitation methods are simplifying a task too much, this could result in a reduction of learners’ mental activities. In such situations, learners may also have lower learning outcomes (e.g., Salomon, 1984) because learners’ cognitive activities are the key to understanding. Therefore, facilitation methods should aim for the evocation of beneficial mental activities. It may be advantageous for complex tasks to make them easier and to reduce complexity for the learners to increase their understanding of the subject. In contrast, it may be more suited for simple tasks that facilitation methods make these tasks more difficult to evoke increased mental activity in order to improve learning outcomes (Reiser, 2002).

CONCLUSIONS

External representations can be a suitable means for the facilitation of computer supported collaborative learning. They offer a broad variety of styles and can be applied to several different content domains because they are content-specific. However, this has the consequence that the results may be difficult to generalise. A simulation about Newton’s Law is hardly applicable to thermodynamics and a tool for structured visualisation may have peculiarities for different content domains. De Jong, Ainsworth, Dobson, van der Hulst, Levonen, Reimann, et al. (1998) describe this as the specificity of external representations. External representations which have a high degree of specificity may lack in generalisability and rather unspecific and generalisable tools may have the advantage of being broadly applicable. However, learners may have the skills to adapt them to their particular needs and this may require highly skilled learners (Dobson, 1999).

The main advantage of external representations for the facilitation of computer supported collaborative learning lies in their power to guide learners with their permanent display through their learning process (Ertl et al., 2006; Suthers & Hundhausen, 2003). This offers the chance to improve collaborative learning outcomes using a particular information technology implementation. Consequently, external representations can show their power particularly in distance learning scenarios, which usually have quite restricted instructor-learner contact.

REFERENCES


KEY TERMS

Cognitive Overload: Caused by excessive demands on a learner’s mental abilities and can limit their capacity to learn and apply knowledge.

Collaboration: Tight working together with a strong commitment of collaboration partners.

Collaborative Learning: Method of learning by which a group of learners collaborate to achieve improved learning results.

Content Scheme: A content-specific representation of the structure of a particular topic.

External Representation: A material display of knowledge and information which may include facts but also procedures and structures.

Instructional Design: The didactical rationale for a learning scenario which includes instructional elements as well.

Prior Knowledge: Knowledge that the learner possesses about the relevant topic before the collaborative learning phase begins.

Videoconferencing: Users use Web cams and headsets to have audio-visual conversation via Internet. Videoconferencing is often combined with the use of a shared application to enable users to work collaboratively with the same software tool.
Computer Technologies in Logic Education

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INTRODUCTION

The recent truly revolutionary changes in information technology triggered the rapid proliferation of educational software supporting introductory as well as advanced college-level logic courses. At the same time, many commercial software packages represent a more or less explicit implementation of logic-based programming paradigm. For example, sequential query language (SQL), designed for such popular database management products as Microsoft Access, Microsoft SQL Server, Oracle, and free-source MySQL, is based on logical query language called relational calculus. From this perspective, it seems not only desirable, but also imperative to introduce carefully selected industrial software packages into the standard Logic and Critical Thinking courses, thus, explicitly linking logical theory with existing as well as emerging applications in information technology. Some of such applications would include database systems, data mining, logic programming, and Web ontologies, among others. Artificial intelligence is still another multidisciplinary area where logic plays an especially prominent role. In this paper, we intend to show how logic-based industrial software can be used in conjunction with specialized as well as broad-based logic courses.

BACKGROUND: SOFTWARE IN LOGIC EDUCATION

Logic courses are currently an intrinsic part of practically any college curriculum. The departments of Philosophy as well as Humanities typically offer Introduction to Logic, Symbolic Logic, and Critical Thinking courses at different levels. Often a course in (mathematical) logic is offered for Mathematics majors, while those majoring in Computer Science have to study logic at least as a module in Discrete Structures course.

The use of computer software for logic courses can be traced to 1950, when “Patrick Suppes introduced his program Valid into...Stanford’s elementary logic course” (Barwise & Etchemendy, 1996). Since then, a variety of software programs have been developed, assisting instructors and students in introductory and advanced logic courses. Modern educational logic software helps students in such areas as natural deduction in propositional and predicate calculus, syllogistic logic, visual argument representation, various techniques in modal logic, and so forth (Logic Software).

Among the most popular programs: Tarski's World for teaching first-order logic, natural deduction based Fitch, truth-table checking tool Bool, and computability theory software Turing's World. We should also mention Gateway to Logic, a European collection of elementary as well as advanced logic programs (European Software). In particular, Tarski's World, Fitch, and Boole are bundled with a popular logic textbook Language, Truth, and Logic (Barwise & Etchemendy, 2003); all aforementioned programs can be also successfully used with any standard introductory logic textbook.

While many logic software packages function as standalone tools, one can also find multiple Internet-based programs. Usually such programs are implemented in JAVA (for portability) and share user-friendly interface. We can mention Causal and Statistical Reasoning System by Carnegie Mellon University (CSRS), Power of Logic for Stephen Layman’s textbook, natural deduction tool Pier, and The Logics Workbench (Layman, 2004; Logic Software). Some tools provide just a convenient self-test and grading facility, while others (like Pier) boast a full-fledged editor.

Logic software seems to be especially useful for those who are interested either in self-study or in pursuing the growingly popular online degree. The growing community of online learners can benefit not only from the automated grading facilities but also from a variety of visualization tools, making the study of logic ever more enjoyable and intuitive. In particular, the already mentioned Tarski’s World program represents a good example of an intuitive approach to the study of logic, allowing testing first order calculus statements on “three-dimensional worlds inhabited by geometric

LOGIC AND RELATIONAL DATABASES

Practically all currently available logic software can be used only for the purpose of teaching logic; the links to possible application areas are rather distant. In this paper we propose a completely novel computer-assisted approach to teaching Logic and Critical Thinking courses. This approach by no means is intended to substitute the already existing practice in this area. Our objective is to consider how logic-based industrial software can be explicitly introduced into standard logic courses taught at virtually every university around the world, thus, providing students with the practical skills they could use pursuing a career outside the academia. Our study is intended as a brief introduction to a new teaching methodology rather than a detailed treatment of the vast area of logic software in education. Among the relevant industrial information technology fields are database management, logic programming, and data mining.

As our first example, we consider quantification, the standard topic for any introductory course in formal logic (Copi & Cohen, 1998; Hurley, 2005). The discussion of quantification theory in logic courses can be integrated with, or even taught in, a framework of (tuple) relational calculus, proposed originally by Codd in 1972 as a logical query language for increasingly popular type of industrial software-relational database management system.

Tuple relational calculus is based on the standard first-order calculus, and intended to query industrial databases implementing the relational data model; among them are such widely used products as Oracle, Microsoft SQL Server, and the dominant microcomputer database management system Microsoft Access, a part of Microsoft Office software package installed on practically any PC.

Relational calculus could be integrated into the standard logic course in the following way. First, the students should be taught the standard predicate calculus and only then introduced to its applied modification, tuple relational calculus. Consequently, students may be asked to design (or to be provided with) a sample database, using one of the available commercial products. Once the database is in place, students can practice data manipulation queries using first the natural language queries, and then translating them into the relational calculus queries. At the next, more practical, phase, students may be required to express calculus queries in the standard industrial query language SQL. The order as well as specific details of this process can vary and are up to a logic instructor.

Let us consider a simple example. Assume the following database schema:

\[\text{Bank (bankName, bankNo, location)}\]
\[\text{Account (accountNo, bankNo, accountType, yield)}\]

Here “Bank” and “Account” are names of the tables created in any familiar-to-the-student relational database system such as Microsoft Access. It is instructive to understand that in the logical context of a relational data model, a table is actually a name of a relation, while a column represents an attribute of a relation. The structure of a relation is often called by the familiar logical term intension; a set of all rows or tuples of any table represents an extension of a relation.

These somewhat technical logical terms of intension and extension could be linked to the standard discussion of Socrates’ contribution to philosophy. Socrates, as reported by his contemporaries, used to walk around Athens asking its citizens pointed questions like “What is beauty?” or “What is piety?” Usually all he could get in response was a definition by example: his opponents would simply give him a list of entities they would consider beautiful or a list of actions they would call pious. Now, such a list represents what we denote in logic by the term extension. However, it is not what Socrates wanted. He used his famous ironic criticism to show the listeners the inadequacy of the proposed definitions by extension; Socratic criticism was intended to demonstrate that such definitions, in modern logical terms, were either incomplete or inconsistent. What Socrates really insisted upon was an essential definition or a definition by intension, so that for each object presented, we could tell whether an object possesses a certain property such as beauty or piety. (Copi & Cohen, 1998, pp. 137-148)

The point we want to make here is a methodological one. In a standard Introduction to Philosophy course, especially one taught to technology or business majors, it may be instructive to show the connection between the moral inquiries of the old Athenian and the issues discussed in Logic or/and in the professionally oriented
database management courses. By the same token, Logic students could appreciate an unexpected leap from the “dry” logic material to the poisoning moral deliberations in ancient Athens. In general, such teaching methodology could contribute into filling the widening gap between professional and academic education.

Let us return to our database schema. Following the outlined methodology, we can ask students to perform a sequence of queries on our database. Let us consider as an example the following query:

*Show the banks with yield more than 5%*

The students could be asked to translate such a query into the relational calculus query using logic notation. The corresponding calculus query would look like:

\[ \{B.\text{bankName} \mid \text{Bank}(B) \land (\exists A (\text{Account}(A) \land (B.\text{bankNo} = A.\text{bankNo}) \land (A.\text{yield} > 5))}\]  

Here “A” and “S” are tuple relational variables, “∃” is an existential quantifier, and “\&” stands for logical “and.” As a reverse exercise, the students could be also presented with the calculus query and asked to restate it in an ordinary language.

The next important task, to present the query as a so-called JOINT statement written in the commercial relational query language SQL:

```sql
SELECT bankName
FROM Bank B, Account A
Where B.bankNo=A.bankNo AND yield > 5
```

The last step is important for our methodology because the SQL queries could be consequently run using Microsoft Access or another relational database management product. To do so, students would have, first, to implement the suggested database schema and, second, to create the schema extension. In practice, this procedure implies creation of the database as a file in Microsoft Access, creation of the tables within such a file, and finally requires populating the newly created tables. What is at stake here is an ability of an instructor to demonstrate the intrinsic connection between logical theory and information technology practice.

Following the outlined learning procedure, philosophy majors would be able to “feel” how the somewhat abstract logical constructions, which may be used by the philosophers in ontological discourse, play, at the same time, a significant role in the development and use of cutting-edge information technology products. Whereas information technology or business majors would be able to see how the seemingly hands-on information technology tools are based on deep logical results.

**LOGIC IN DATA MINING APPLICATIONS**

Another related area of interest for logic instructors is data mining, a technique for finding hidden and unexpected patterns and relationships in sets of data. As an example, manual data mining may be used to illustrate the notions of necessary and sufficient conditions in logical reasoning, or to demonstrate how

<table>
<thead>
<tr>
<th>Patient ID#</th>
<th>Sore Throat</th>
<th>Fever</th>
<th>Swollen Glands</th>
<th>Congestion</th>
<th>Headache</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Strep throat</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Allergy</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Cold</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Strep throat</td>
</tr>
<tr>
<td>5</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Cold</td>
</tr>
<tr>
<td>6</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Allergy</td>
</tr>
<tr>
<td>7</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Strep throat</td>
</tr>
<tr>
<td>8</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Allergy</td>
</tr>
<tr>
<td>9</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Cold</td>
</tr>
<tr>
<td>10</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Cold</td>
</tr>
</tbody>
</table>
logical operators can be used in query languages like relational calculus/SQL to discover implicit relationships in a data set.

Let us consider a brief example (Table 1) representing the “disease diagnosis” schema adapted from an introductory data mining textbook by R. J. Roger and M. W. Geatz (Roger & Geatz, 2003, pp. 16-17):

The students’ task is to determine what sets of symptoms constitute the necessary and sufficient conditions—the standard topic for logic courses—for a particular disease such as Strep Throat (Copi & Cohen, 1998, p. 499). Following the standard method of scientific discovery, an instructor may offer students a hypothesis (derived possibly from past experience):

The symptom of Swollen Glands is a necessary and sufficient condition for the diagnosis of Strep Throat

Then, the students’ task is to formulate a query, showing that aforementioned symptom constitutes a necessary condition for Strep Throat. The requested query could look like:

List all patients with diagnosis Strep Throat and no Swollen Glands

Following the methodology discussed in a context of database management, students should be able to translate this natural language query into the relational calculus query and, consequently, into SQL query such as:

\[
\text{SELECT Patient_ID#} \\
\text{FROM Patients} \\
\text{WHERE Diagnosis=’Strep_Throat’ AND Diagnosis!=’Swollen Glands’}
\]

When run in a commercial database system, the result of the query would be an empty table, allowing us to conclude that Swollen Glands is a necessary condition for the diagnosis in question. The same procedure could be applied to find a sufficient condition; we leave this as an exercise to the reader. The immediate objective of this somewhat simplistic example is to emphasize further the connection between the logical aspects of database management and data mining. Data mining could be also considered, from the more general perspective, as a collection of induction-based machine learning techniques. We discuss some implications of this approach in the next section.

**FUTURE TRENDS: FROM LOGIC TO ARTIFICIAL INTELLIGENCE**

Following the outlined approach, the discussion of data mining could be potentially extended to present database management and data mining as two aspects of a broader process known as knowledge discovery in databases (KDD). Consequently, KDD could be used as an industry-oriented illustration of the general methodology of scientific enquiry, providing an important introduction to philosophy of science as well as more specialized courses. Such a comparison would incorporate a variety of topics such as the necessary and sufficient conditions, different forms of induction, as well as the principles of statistics and probabilistic inference (Copi & Cohen, 1998; Hurley, 2005). In this respect, the use of Turing machines by *Turing World* is still another interesting example of programming technique incorporating both applied and highly abstract logical concepts, thus, potentially benefiting a wide spectrum of college majors.

Moreover, it seems only natural to integrate logic-based programming paradigm with standard logic courses. In particular, the topic of induction, as well as different aspects of data management, could be introduced in the context of logically oriented programming languages such as PROLOG, GODEL, and DATALOG (Bratko, 2001; Hill & Lloyd, 1994; Ullman & Widom, 2002).

PROLOG is by far the most popular implementation of logic-based programming. A basic PROLOG program consists of facts, rules, and questions. For example, the rule established in the previous section—*if one has swollen glands, then one has strep throat*—in PROLOG would look like:

\[
\text{diagnosis (Strep Throat): - symptom (Swollen Glands)}
\]

A more sophisticated rule—*X is grandparent of Z, if Z is child of Y and Y is child of X*—in PROLOG would read (Saint-Dizier, 1989):
grandparent (X, Z) :- child_of (Z, Y), child_of (Y, X)

or as logical implication:

∀ X, Z ∃ Y (child_of (Z, Y) AND child_of (Y, X) => grandparent (X, Z))

In fact, in PROLOG we could rewrite the relational table (like Table 1) as a collection of facts, while the causal connections between the symptoms and the corresponding diagnosis would be expressed by rules. Consequently, PROLOG can be easily used for both the creation of conventional relational databases, and for rule-based knowledge representation in deductive databases and expert systems.

Thus, PROLOG can serve not only as a convenient intuitive tool illustrating the process of logical inference; its ability to represent knowledge underlines its importance in a vast area of artificial intelligence (AI), still another field where logic, philosophy, and industry merge (Luger, 2002). A special focus on AI would allow the instructor to cover advanced topics crucial for both philosophers as well as computer scientists; topics often left outside the scope of introductory and even intermediate logic courses include undecidability, logical inference under uncertainty, and Web ontologies.

Considering that ontologies (including those developed for World Wide Web) encapsulate multiple concepts derived from mathematics, computer science, and philosophy, their educational value seems to be especially high. In general terms, ontology is a conceptualization of a knowledge domain, while somewhat more formally, ontology could be defined as AI-based form of knowledge representation. From the logical point of view, ontologies created in OWL-DL language are computable and decidable (Antoniou & van Harmelen, 2004). The software packages, such as free-source ontology builder Protégé and semantic reasoning tool Racer, are enabled to validate ontologies for logical inconsistencies. Students may be required to develop an ontology relevant to their field of study in a framework of a capstone course, thus integrating their knowledge of logic, databases, and Web programming within one comprehensive project. Such a project could be customized for multiple majors and offered in the interdisciplinary setting of informatics department.

Finally, AI-based decision support tools would allow an instructor to add additional value to the discussion of professional reasoning in almost any area, from medicine to finance. In this context, several interesting software packages are available from Banxia Co., including Decision Explorer, described as “a tool that has been designed to help you to see relationships between different ideas and perspectives which might be expressed about any subject.” (Banxia). Such software would be extremely useful in the context of a broadly conceived course in critical thinking.

**CONCLUSION**

The exact scope, as well as the level of practice-oriented logic and critical thinking courses, should be determined by each educational institution, depending on its orientation as well as faculty and students’ interests. However, the general methodology focused on the proposed integration of modern industrial software into logic curriculum is definitely worth considering. Such integration would involve a wide range of educators, from philosophers to mathematicians and computer scientists. The important learning objective to keep in mind is to ensure that the progress in theoretical study of logic proceeds hand in hand with the progress in learning the practical applications of logic. As it is clear from our exposition, such applications could include database systems, data mining, or a more broadly conceived field of knowledge engineering, thus introducing students to the exciting area of artificial intelligence.

**REFERENCES**


**KEY WORDS**

**Artificial Intelligence:** Collection of methods and techniques focused on modeling different aspects of information processing by humans, such as image recognition, speech processing, and reasoning.

**Critical Thinking:** In the context of college curriculum, refers to the course focused on informal analysis of reasoning in law, ethics, politics, and other areas.

**Data Mining:** Knowledge discovery methodology based on artificial intelligence techniques.

**Predicate Calculus:** Branch of formal logic with ability to represent properties of objects and relations between objects.

**PROLOG:** Logic-based programming language (literally “programming in logic”).

**Relational Databases:** Data management software based on the relational data model proposed by Codd in 1972.

**Symbolic Logic:** Discipline engaged in formal representation and analysis of arguments, their consistency and validity.

**Web Ontology:** In the context of information technology, refers to machine-readable form of knowledge representation for the semantic Web; sufficiently rich and well-structured ontologies satisfy logical criteria of computability and decidability.
Constructivist Learning Framework and Technological Application

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INTRODUCTION

Constructivists believe that knowledge can emerge as learners construct meaning from information they receive and from their participation in the learning activities. As a result, learners gain knowledge from their interaction with the learning environment and from interacting among themselves. Learners construct meaning as they engage in critical reflection and evaluation of learning materials in an effort to discover patterns or new dimensions of the emerging information. This implies that learners have the opportunity to develop the skill to absorb the information before them in a way that connects the previously acquired knowledge and the newly discovered information. Constructivist advocates support learning that focuses on the analysis, synthesis, and evaluation of the learning materials and the related information as a means of constructing new knowledge.

This approach of focusing on higher order knowledge may lead to the discovery of new knowledge while enriching the pre-existing knowledge base. Furthermore, this process allows learners to gain new insight concerning the body of knowledge being studied, and claim ownership of the knowledge gained. Ownership of knowledge implies that learners possess the ability to provide customized application of the newly acquired information. As a result, they may perceive new patterns, shapes, similarities, and abnormalities that equip them to move from the known to the unknown. Matusevich (1995) states that constructivists believe that learning is about constructing knowledge while actively engaging in the learning process rather than passively regurgitating predigested knowledge. Jonassen (1991) asserts that “instruction should be anchored in some meaningful, real-world context” (p. 29). Technology can provide the tools and interactive environment that can engage the mind actively during the learning process.

BACKGROUND

Part of the active engagement in the learning process implies that learners are connected and interact with others such as teachers, peers, family members, or acquaintances to exchange ideas. Dewey (1933) maintains that learning is a social activity and condemns learning initiative that isolates learner from the social fabric and focuses on one-on-one relationship between learners and their learning materials. The essence of education is to prepare individuals for meaningful societal participation including gainful employment. Work by nature is a social activity which involves collaboration and interaction among workers within the work environment in order to move the workflow forward. Unfortunately, instructional planners underscore the importance of collaboration and interaction as necessary conditions for learning. Bruner (1986) rightly points out that learning involves sharing ideas. Cognitive theory which focuses on mental processing of information and behaviorism which primarily uses reinforcement to reward observable behavior as evidence of learning fails to address conditions that could lead to knowledge construction. Constructivist ideology recognizes that learning involves dynamic engagement in a rich learning environment where learners interact among themselves, reflect, and evaluate what they have learned.
Proper use of technology can provide rich environments where learners can explore, partake in problem solving activities, collaborate among themselves, contemplate, and examine the learned materials.

Generally, technology is perceived as a tool and skill to perform a given task. It (technology) has permeated every aspect of our social and economic life as well as our individual consciousness. To make progress is to be technologically savvy. In some cases, technology tends to be used to define our perception of ourselves and others. Ability to use various electronic gadgets is seen as a necessary part of life in this 21st century and being technology illiterate is becoming a disability in a technology-driven world. Businesses and industries are on the threshold of technological explosion. Hospitals advertise their healthcare success by emphasizing the advancement of their various healthcare technologies. American military myth and supremacy are based on technological advancement. Society has moved on with technology but education still lags behind. Technology integration in the field of education is still being implemented in a superficial, peripheral level; in most cases it is used to present instruction, organize instructional activities, or address low level knowledge (ability to recall).

Educators have been criticized for not using technology, specifically computer technology, to address higher cognitive attributes such as synthesis, analysis, and evaluation (Bloom, 1956). Strommen and Lincoln (1992) are critical of the educational system by asserting that “although the schools are embedded in our culture and reflect its values, the technological changes that have swept through society at large have left the educational system largely unchanged” (p. 467). Holm and Horn (2003) stress that it is important that teachers possess the necessary technological skills to be effective instructors and to meet the needs of the learners.

**TECHNOLOGY INTEGRATION**

Communication technologies such as television, radio broadcasting, telephone, fax, and postal services have had impact on the educational system. However, in recent decades, computer technology and other electronic media have broadened the scope of learning. Successful technology integration requires a theoretical framework that will provide foundation knowledge. Constructivist learning principles have emerged as ideal foundation knowledge for implementing technology-based instruction. According to Grant (2002), incorporating technology with constructivist instructional principles will help promote meaningful learning.

Constructivist theory is recognized as important in providing students with the framework to approach learning from inquiry and problem-based approach. According to Nanjappa and Grant (2003), knowledge can be constructed through “reflective thinking that requires careful deliberation” (p. 4). Reflective thinking does not occur in a vacuum; therefore, it presupposes that some kind of knowledge is already acquired. Otherwise, there is nothing to reflect upon. Reflective thinking is higher order thinking and the purpose is to help individuals gain full understanding or clear any misconception that may exist. Dewey (1933) explains that

We reflect in order that we may get hold of all the full and adequate significance of what happens. Nevertheless, something must be already understood, the mind must be in possession of some meaning which it has mastered, or else thinking is impossible. (p. 119)

**Electronic Instructional Plan**

An electronic instructional plan is a text that incorporates sound, video, movie, static images, motion clips, and animation. It also contains hyperlinks that can be used to navigate around documents. The hyperlinks can be used to navigate through various subject disciplines in the Web and through this process virtual learning environment can be created. One of the advantages of using an electronic instructional plan is that students can engage in online research to sharpen their focus on the topic being studied. Students are able to examine, analyze, and evaluate topics of interest from different perspectives as a result of the information acquired from online research.

One method of assisting students in knowledge construction is to enable them to develop analytical skills by completing activities that involve studying patterns and inconsistencies, including searching for assumptions, evidence, or hypotheses that are embedded within various structures of knowledge. This may include requiring students to integrate ideas as new perspectives emerge, and reflect on the new arising viewpoint in an effort to understand its attributes. Teachers may want to pose philosophical questions to students as a way of helping them to engage in cognitive probing. Cognitive probing is a situation where
students engage in a concentrated critical reflection of the learning materials through synthesis, analysis, and evaluation. Gokhale (1995) maintains that through the process of synthesis, analysis, and evaluation, students can classify knowledge to better understand its components and then combine them together as a whole so that it can be assessed for relevance based on predetermined criteria. Teachers can challenge students to critically assess or appraise a piece of knowledge with a view of recognizing the underlying assumption or rationale implicit in such knowledge. Such recognition will enable them to understand that knowledge is socially constructed and that they can play a part in creating knowledge.

An electronic instructional plan provides students with the opportunity to receive instant feedback by reviewing the information retrieved from the Web and by comparing and contrasting such information through the process of analysis and evaluation which are considered higher order cognitive activities. With the use of an electronic instructional plan, instructional materials are limitless. With electronic instructional plan, individuals can learn at their own pace; this makes it possible for teachers to provide individualized instruction. Constructivists believe in approaching teaching and learning process from different perspectives; an electronic instructional plan can be used to accomplish this.

The application of technology in education is more complex because it involves using technology to solve learning problems which in some cases are not well defined. Therefore, to achieve successful technology integration, all educative processes including technology that supports instruction must be considered as part of the instructional process. This implies that in selecting technology for learning, it is important to consider learners’ needs, lesson objectives, methods of presenting instruction, transfer learning, evaluation strategies, and follow-up activities. Purposeful application of technology in education entails connecting all the pedagogical practices together in a harmonious relationship with technology (Okojie, Olinzock, & Okojie-Boulder, 2006). Facilitating instruction using an electronic instructional plan entails breaching the artificial boundary created by subject matter compartmentalization because it uses Web links to explore subject disciplines. A well designed electronic instructional plan provides opportunity for students to assess themselves and it also creates opportunities for follow-up by using Web links to navigate related information. Unfortunately, in some instances the infusion of technology and its related media applications are conducted in a manner that recreates the boredom of the traditional classroom. The present application of multimedia into education encourages “quick fix” and rote memorization of information on the part of the students.

**Rich Learning Environment and Technology**

Constructivists maintain that students do better in a rich learning environment. Technology can be used to create robust teaching and learning environments where students are physically and mentally captivated in the learning process. DVDs, video CDs, flyers, motion pictures, still pictures, movies, animation, and posters can be produced and be used to support and reinforce learning. DVD and video CDs can be used to record off-air radio and television including satellite broadcasting as a means of enriching class materials. Electronic devices such as DVD and video CDs can also be used to produce interactive movies, stories, landscapes, or any event or activity that may be used to explore and illustrate the topic or discipline being discussed. Creating a rich learning environment means that students have materials with which to engage in critical thinking that will challenge them to go beyond the known as they engage in knowledge construction.

Multimedia images such as sound, text, and color can provide interactive and dynamic classroom. Different poster sizes can be created using wide format laser printers. Texts, pictures, and/or graphic representations can be produced and be used as follow-up activities. Young children can work in small groups using posters to learn numbers, colors, letters, words, animals, and so on. Older students can use posters for brainstorming activities by recording all their ideas on the poster while studying in small groups. The teacher can ask students to critique those ideas in terms of their contribution to the topic discussed. This will help students develop analytical and evaluative ability which is described as higher order cognitive skill (Bloom, 1956). Rich learning environments could help learners with diverse learning styles. Sound will provide auditory stimulus to those learners who learn by listening. Movies, animation, and still and motion pictures will be more appropriate for visual learners (learners who
Constructivist Learning Framework and Technological Application

like to learn by seeing). While recording broadcasting, making movies, editing movies, designing posters, and so on will suit kinesthetic learners (learners who prefer to learn by doing something) (Lever-Duffy, McDonald, & Mizell, 2005). This means that learners can approach learning tasks from different perspectives, that is, listening, seeing, and doing, which supports the constructivist doctrine that learning involves cognitive and psychomotor activities.

Heinich, Molenda, Russell, and Smaldino (2002) acknowledge that the purpose of multimedia in education and training “is to immerse the learner in a multi-sensory experience to promote learning. Multimedia makes one’s ‘experience’ as realistic as possible without actually being there” (p. 242). Multimedia technology helps us to create reality in the classroom by using video, digital camera, and Web links to study issues and events far removed from the classroom. Technology can also be used to bring yesterday to life. Multimedia technology increases students’ participation and makes teaching/learning a fun activity. It also provides instant reference through Internet searches.

Knowledge Construction and Technology

Constructivist learning theory can be used to provide opportunity for students to acquire divergent thinking ability by participating in creative learning. This involves the process of scaffolding, a situation where learners are guided to proceed from the known to the unknown parameters (Karagiorgi & Symeou, 2005). By allowing students to explore without communicating knowledge to them—using a constructivist learning ethos of providing insightful learning environment—they will explore learning materials and discover knowledge for themselves. Hendry (1996) argues that knowledge is an adaptive process and through the process of scaffolding, learners will become aware of what fits into their knowledge base and what is needed to expand their repertoire of knowledge accumulation. Adapting knowledge to new situations does not only presuppose that learners have gained information to construct knowledge but also that they have developed systems of knowledge and experience that will enable them to engage in a continuous adaptation of the existing information to new situation.

If we accept that teaching/learning is about gaining knowledge about the real world, interpreting the real world and questioning assumptions made about the real world, then teachers should provide the opportunity for students not only to construct meaning from the real world but to manipulate the real world to their advantage. Manipulation of the real world simply means the ability to subdue the real world by acquiring better understanding in a way that renders the “real world” more explainable in terms of human needs and aspirations. Knowledge is not complete until it fulfills a desire and desires are usually embedded in human needs. By combining constructivist theory of knowledge construction and adaptation with the merits of electronic instructional plan, teachers will be better equipped to teach creatively. By the same token, students will be better prepared to learn creatively by continuous engagement in knowledge construction.

Active Learning Process and Technology

Active learning involves performing an action on the part of the learner. Listening alone is not sufficient for a meaningful learning. Participating in doing something mentally and physically during the course of instruction is considered as a part of the active learning process. Ericksen (1984) has provided a vivid scenario as he describes the importance of active learning. Erickson states:

"Learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers, memorizing pre-packaged assignment and spitting out answers. They must talk about what they are learning, write it, relate it to past experiences, apply it to their daily lives." (p. 51)

Depending on the nature of the instruction, the teacher can reinforce learning by requiring students to practice what they have learned. Harasim (1993) discusses how a global communication network can provide an active learning environment among teachers, students, and researchers all over the world. They can work in groups, share ideas, and discuss teaching and learning tips through e-mail, computer conferencing, or bulletin boards. They can also engage in project activities. A global communication network provides opportunity for teachers, students, and scholars all over the world to be actively involved in making decisions and evaluating information received. Precollege and
Constructivist Learning Framework and Technological Application

college students can be active as they learn using Excel software package to generate data, Access technology to compile databases, or PowerPoint technology to prepare presentations. Word processing technology can also be used to summarize the main topics in a given instruction. Active participation in a learning process eliminates boredom among students and facilitates purposeful learning.

Authentic Learning Environment and Technology

In an authentic learning environment, instructional materials are taken from real life experience; the learning is context-based. The idea is to render students’ learning more meaningful as a way of motivating them to learn. Students are required not only to understand the content of their lessons but also to be able to evaluate the knowledge they have acquired and apply it to a real problem situation. Technology can be used to create a classroom that mirrors an authentic learning environment using video camera, digital camera, interactive video, and the Internet with its hyperlinks. The idea is to create a virtual classroom where students can participate in learning from a distance and yet retain the authenticity of the learning process. Internet technology with its browser can create contextual learning experiences. Learners can visit various Internet Web sites to explore issues and topics of interest as well as to generate ideas. For example, students can learn first hand the nature of volcanic eruption taking place in various locations in the world using the Internet. The constraint posed by time and distance is eliminated through the use of Internet technology.

Critical Thinking and Technology

The ability to demonstrate high order reasoning is a reflection of the presence of critical thinking. Critical thinking is a manifestation of our cognitive ability in dealing with issues that require intense probing, analysis, and evaluation. According to Garrison and Archer (2000), critical thinking finds expression through intuition, problem-solving, and insight. Critical thinking cannot be taught by lecturing. Schafersman (1991) argues that critical thinking is not passive but an active engagement where students analyze and synthesize by reflecting on the various learning activities such as completing assignment, writing examination, or completing homework. Critical thinking is concerned with a higher level of cognitive ability that is necessary in constructing, analyzing, and evaluating meaning. Internet-based learning is known for its rich learning resources. Students can engage in research by exploring issues of interest and by critically evaluating those issues as well as assessing ways to apply them in real life problem situation. Students can engage in a challenging discussion with peers or experts and in doing so gain insight. Walker (2003) believes that active learning which employs instructional methods such as questioning, discussion, and case studies, including completing written exercise and projects, do promote critical thinking.

Collaborative Learning Activity and Technology

From a constructivist standpoint, learning is a social activity. Technology can help students collaborate inside and outside the classroom. Chat room technology can be used to exchange ideas among students, present feedback, and collaborate in group work. Discussion board sessions can be used as a learning forum. Chat room and discussion board sessions can be used to improve student participation and involvement in distance education courses. In a face-to-face instruction, small group discussions can help students collaborate as they learn together. E-mail can be used for feedback and for individual consultation.

Collaborative learning provides the opportunity for students to engage in a healthy competition where students take part in a dialogue of reasoning together, evaluating each others’ work and providing feedback in a nonthreatening manner. Using collaborative learning approach, teachers can create a problem scenario; students may be required to solve the problem by consulting and evaluating each others’ ideas while seeking a solution to the problem. The study of Gokhale (1995) shows that “collaborative learning fosters the development of critical thinking through discussion, clarification of ideas, and evaluation of others’ ideas” (p. 8). Suthers (1998) argues that software technologies can be used as a system for providing learners with activities that can help them to work together collaboratively. Also, Abrami and Bures (1996) indicate that “electronic forms of collaborative learning help reduce the isolation of telecommuting learners and increase the interactivity of the distance experience” (p. 1).
CONCLUSION

The essence of this article is to show how teaching and learning can be improved by using constructivist learning theory as a foundation for integrating technology into teaching and learning. Various constructivists' viewpoints are discussed and these include the following:

- Rich learning environment
- Knowledge construction
- Active learning
- Authentic learning activities
- Collaborative learning
- Critical thinking

Transformation in knowledge and technological advancement are occurring at an alarming rate. Technology infusion needs to be implemented in ways that address higher order cognitive skills. Constructivist framework and technology can be used to promote relationship among theory, practice, and technological skill.

REFERENCES


Constructivist Learning Framework and Technological Application


**KEY TERMS**

**Active Learning Process:** This involves doing something as part of the learning experience. It implies that the learner is not merely listening to the teacher but engages in mental reflection which includes completing test, discussing with others, using computer to complete assignment, or engaging in a worthwhile learning activity either mentally or learning by practice.

**Authentic Learning Activity:** Refers to instructional materials that reflect real-life a learning activity or learning problem that has real life application.

**Collaborative Learning:** This is a method of learning where learners work as a group; in most cases in small groups for the purpose of accomplishing instructional goals. They interact and evaluate each other’s ideas as they work cooperatively on a given project to solve a learning problem.

**Constructivist Learning Framework:** A philosophical viewpoint which stipulates that learning is about constructing meaning rather than passively listening to the teacher. Learning is an active process and should reflect authentic activity that is designed to solve real life problems. Learning is a social activity where learners collaborate and interact with the learning environment as they construct meaning through reflective and critical thinking. The teacher becomes a facilitator of instruction rather than a dispenser of knowledge.

**Critical Thinking:** A situation where students learn by synthesizing, analyzing, and evaluating the learning materials designed to find a solution to a learning problem. It involves mental reflection, turning the topic over and over mentally, or probing the topic being examined as a process of understanding the underlying assumption.

**Electronic Instructional Plan:** A text instructional lesson plan that incorporates sound, video, movie, static images, motion clips, animation, and hyperlinks that can be used to navigate around documents so that teachers can flip forward and backward to reinforce learning both for the quick and slow learners.

**Rich Learning Environment:** A learning environment (setting) that is equipped with various learning resources (equipment and materials including technologies) through which learners can learn by exploring those resources. Constructivists believe that learning does not take place in isolation but through interaction with a rich learning environment.
Critical Literacy and Technology: An Essential Intersection for Our Nation’s Schools

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INTRODUCTION

More than likely, people who are reading this article use, on a daily basis, the abilities to read and write in ways that empower and enrich their lives. We write to legislators, old friends, colleagues, and computer-generated “unsubscribe” lists.

We use stationary, e-mail, yellow-pads, letterhead, Hallmark cards, and even yellow stickies. We write to keep our lives in order. We write because we need to get things done. We write because our world demands it of us.

Our reading habits are just as diverse. We read editorials, old love letters, Oprah’s picks, and the latest best-selling history books by David McCullough and Douglass Brinkley because these men were featured on a recent BookTV broadcast and because they were so eloquent.

We read new textbooks, the New Yorker, various journals, Stephen King novels, and even the odd poem or two by the newest poet laureate. Some of us have even finally begun Bertrand Russell’s The Conquest of Happiness just in case we have accidentally missed something along the way while others of us are trying to move past Page 17 of Ulysses by James Joyce because we heard on NPR that it was the greatest novel of the 20th century.

We Google our own names to see where we pop up. We take a look at each others Web sites to see how we are all doing; and then we decide we need to be doing more.

We produce a digital video of teaching techniques. We create MP3s of our favorite sounds and music. We send jpgs all over the world. We watch United Streaming to supplement our course content. We watch our students text message and instant message each other during our best and most riveting lectures. We Skype our colleagues and friends from all over the world. We create webs of connections, information, knowledge, wisdom, power, and exponentially, more power.

We do all of this and more; and we all use our abilities to read and write and manipulate text, images, language, and power rather unconsciously. We engage in all of these rather unconscious literate behaviors because they are available, because we must, and because we can.

But imagine that you do not have the abilities to read and write text. Imagine that you do not have access to your Blackberry, your cell phone, digital camera, laptop, or the World Wide Web. Imagine that this level of power and this level of language have all been denied to you. Finally, imagine that you are in a situation where information is filtered, withheld, distorted, or narrowed in the name of protecting your safety or even merely to control your thoughts and behaviors. Imagine those things; and you now have the intersection of critical literacy and technology.

BACKGROUND

What is Critical Literacy?

Critical literacy is using text, images, language, and other people to engage in political action and social equity. Freire (1970) is largely credited with this notion of using reading and writing to enable people to improve their lives, balance their individual and collective power, and increase their social and financial capital.
An example of Freire’s pedagogical efforts to teach his fellow, rural Brazilian citizens to read is outlined by Cervetti, Pardales, and Damico (2001). In one example that they provide, Freire chose to teach the farmers the word well in order to begin a dialogue of how the farmers’ water well in their village was being used. Who owned it? Who used it? Who maintained it? Who had power over it? What did this power over the well mean to the farmers?

This practice of thinking and questioning was called critical pedagogy by Freire. Critical literacy is the subset of critical pedagogy in that critical literacy uses text to empower people to improve their lives, take political action, and pursue social equity all on their own terms.

Freire saw that teaching his Brazilian comrades to read and write would allow them to make choices, improve their lives, communicate their needs, and regain some degree of control over their lives.

A logical result of Freire’s conversation with the villagers about their well may have been:

• The villagers needed to learn to read; and their well was an important aspect of life to them making this word, well, an easy starting point for Freire.

• The villagers needed to see that collectively they had power to come together and begin a dialogue about setting new rules and procedures for something that impacted their lives and livelihood every single day; their life-giving well.

• The villagers needed to see that collectively they could learn to read, write, and use their literacy to improve all aspects of life in their village not just the use of their well.

• The villagers could now use reading and writing to promote their causes and needs beyond the borders of their village.

Teaching his Brazilian comrades to read the word and read the world was Freire’s goal (Flores-Dueñas, 2005). Critical literacy then is using ones literacies for political action and social equity.

Critical literacy is assuming control over your life, your livelihood, and your future in ways that you care about. For Brazilian farmers, that started with a well.

For public school teachers and students, this begins with the curriculum.

**Critical Literacy in Today’s Schools**

Clearly, there is a dichotomy between types of reading and writing programs throughout our nation. One side of this dichotomy fosters critical literacy values while the other side promotes back-to-basic reading skills that focus on lock-step phonics lessons, scripted book discussions, and teach-to-the test standards.

The back-to-basics effort is supported by No Child Left Behind legislation founded in part by the U.S. Department of Health and Human Services National Reading Panel (NRP) which promoted “scientifically-based research” perspectives only and yet was, and is, criticized widely for its elimination of all other types of valid and reliable research studies that favor holistic, progressive, and critical literacy types of programs (Flores-Dueñas, 2005, p. 238; Yatvin, 2002).

Teachers who use critical literacy pedagogy will have students engaged in learning that might closely resemble a high-powered United Nations conference where many voices speak passionately from many perspectives. Students in this type of atmosphere will be expected to use their literacy abilities to challenge ideas and confront social realities as they progress throughout their intellectual and academic journeys.

Beck (2005) states that

*Critical literacy has as its goal the development of responsible citizens, able to confront social inequities in their many forms and take action against injustices. Teaching critical literacy requires that the teacher highlight controversial, provocative issues in student-centered discussions that encourage students to reflect on their own experiences and to make changes in themselves and the world around them.* (p. 399)

Teachers who value the critical literacy stance according to Cadiero-Kaplan (2002) will “promote classrooms that value students voices, experiences, and histories as part of the course content” (p. 379). Students will have the “opportunity to explore, create, critique, and transform curriculum within environments that encourage individual voices through dialogue, reflection, and action” (p. 380).

Students who receive the back-to-basics, prescriptive curriculum will be imminently prepared for a
“social structure focused on increasing the labor force with a goal for capital accumulation” (Giroux, 1983, as cited by Cadiero-Kaplan, 2002, p. 374).

COMBINING THE FREEDOM AND RESPONSIBILITIES OF CRITICAL LITERACY WITH TECHNOLOGY

The responsibility of teachers who use critical literacy pedagogy in their classrooms is a tremendous one that perhaps leaves the less-passionate teacher to actually welcome a scripted phonics lesson or controlled book discussion. But for those teachers who choose the road less traveled, combining critical literacy values with technology is a perfect match.

The technology becomes the set of tools required to discover, organize, and disseminate the information needed and found in a critical literacy curriculum. Using the technology in this way means that the technology is simultaneously ubiquitous and invisible. The stars of the event are the information and recommendations for action that have been discovered and organized by the critical literacy learner.

For the technology to meet the goal of ubiquity and invisibility, preplanning must be achieved and the right software must be obtained. The quality of the dissemination can not be diminished because of the level of challenge required in the organizing, displaying, linking, uploading, and modifying of information. The ease of the technology will be an important aspect to a successful combining of critical literacy and technology.

The technology ingredients needed for a critical literacy curriculum in the K-12 arena include music, sound, images, artwork, graphics, video, and text incorporated through hypermedia applications (Myers & Beach, 2001). Using hypermedia (different kinds of multimedia linked together) in connection with critical literacy curriculum requires that students and teachers choose the authoring tools that best meet their equipment needs and levels of expertise.

Myers and Beach (2004) report success with QuickTime videos and Adobe Premiere while also using programs that shipped free with their computers including Avid Cinema, Strata Video Shop, or iMovie (p. 260). Excellent examples of their use of technology are available at http://www.ed.psu.edu/k-12 and also at http://www.inquiry.uiue.edu/.

Another source for selecting the appropriate software is http://www.educational-software-directory.net/multimedia/authoring.html. This site summarizes and links the viewer to 31 sites that offer commercially available authoring software. One of the most promising on the site is http://www.movieworks.com. This software is reasonably priced and supports both Mac and Windows operating systems. The other plus is that this software

Figure 1. Template for a Web site featuring a student’s critical literacy project

<table>
<thead>
<tr>
<th>(click)</th>
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<th>(click)</th>
<th>(click)</th>
</tr>
</thead>
<tbody>
<tr>
<td>photo and bio of a student who is engaging in a critical literacy study project</td>
<td>written and/or audio statements of 1. what student is concerned about and 2. why student is concerned</td>
<td>still images that illuminate the topic in which the student is interested</td>
<td>Quicktime video of student showing the issues involved as the learning process begins</td>
</tr>
<tr>
<td>(click)</td>
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<td>(click)</td>
</tr>
<tr>
<td>written and/or audio interviews with knowledgeable people who have an interest in this critical literacy project</td>
<td>list of resources the student has accessed including books, websites, media, museums, experts, laypeople, peers, and other</td>
<td>key points the student has discovered and how these key points have changed the initial concerns (expressed in any media)</td>
<td>a call to action based on the student’s new information, ideas, or discoveries (expressed in any media and with the degree of action felt by the student)</td>
</tr>
<tr>
<td>(click)</td>
<td>(click)</td>
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<td>(click)</td>
</tr>
<tr>
<td>a place to post ongoing student reflection and written feedback from others who share an interest in this critical literacy learning project</td>
<td>a final summary of this completed project (expressed in any media: text, music, art, poetry, video, song, audio, photographs, graphics, images)</td>
<td>a list of possible areas of concern for future study by this student and a final photo of a job well done</td>
<td>links to previous areas of concern already investigated and completed by this student</td>
</tr>
</tbody>
</table>

Welcome to our Critical Literacy Website
We are students and we are learners.
Share in our website to find out what concerns us.
Take a tour. See what we’ve learned and what we’re recommending.
Thank you for visiting our site.
Critical Literacy and Technology

is supported by Apple and its Podcast technology. An example of a group of elementary students who created a hypermedia site is available at http://www.movieworks.com/movies/gillispiemathpoll.html. Although these students did not take the final step in creating a call for action, they did achieve their goal of investigating something important to them and disseminating the information for wide audience viewing and contemplation.

With this example and these free and commercially available technology applications, it is relatively easy to create a hypermedia Web site for the purpose of disseminating information discovered and created by critical literacy students.

Adapted from Bruce and Bishop (2002), students begin their process of critical literacy. As students 1) identify their concerns, 2) do their research, 3) create their package of knowledge, and 4) organize their package for uploading to the Web, the best of these student sites will be those with an easy-to-use template that will allow the viewer to focus on the site’s information and the call to action rather than the details of how the site was created.

In order to insure that the message and the call to action are the highlights, a preplanned and universal template is recommended as a content base to any critical literacy technology-enhanced project. Based on recent work by a second-grade teacher who uses critical literacy values and a strong technology component (S. Hoffman, personal communication, March 26, 2006), a sample point and click template for an Internet Web site is provided (see Figure 1).

CONCLUSION

Creating an environment for critical literacy and technology to flourish is a natural combination for those whose intellectual pursuits, political beliefs, social values, and energy levels are purposeful and meaningful. Creating this environment for our nation’s K-12 students is for all teachers and students who value independent thought, active participation, and meaningful study.

REFERENCES


KEY TERMS

**Critical Literacy**: The use of reading and writing to achieve political action and social equity.

**Critical Pedagogy**: The observation that teaching strategies are differentiated between income levels of various groups resulting in more powerful learning opportunities residing with upper income levels than lower income levels.

**Hypermedia**: Various kinds of multimedia linked together. A blended word that combines hypertext with multimedia.

**Hypertext**: A collection of media that can be easily viewed and accessed within a Web page and does not need to be viewed sequentially.

**NCLB**: Federal legislation titled No Child Left Behind created in 2001 and which has met with considerable debate about its efficacy and goals.

**Paulo Freire**: A founder of the notion that literacy and education can help those who are oppressed to become more powerful and in control of their lives.

**Ubiquitous Technology**: The use of technology that is seamless, transparent, and fully surrounding the user.
INTRODUCTION

Cyber charter schools often have as their motto a version of the slogan “any pace, any place, any time.” This is because cyber charter schools offer flexibility to the families who enroll in this publicly-funded form of instruction. Students can learn from their homes at a time that meets their needs and choose from a large variety of courses. The classes are delivered via a computer and the Internet, and the students’ work and assessments are guided by a teacher.

BACKGROUND

Charter Schools in General

The cyber charter school movement is an arm of the overarching charter school movement. In fact, virtual schools comprise only 4% of the entire public charter school sector (Rotherham, 2006). All charter schools and cyber charter schools are considered to be public schools that are governed by independent boards of directors. Charter schools have had a great deal of growth; from 1999-2003 they yielded a 40% increase in enrollment. The Center for Education Reform (2004) reported 200 charter schools in 40 states and the District of Columbia that serve over 684,000 students. Charter schools are accountable for student performance and program quality (Bogden, 2003).

Cyber Charter Schools

According to Borja (2005), 22 states have established cyber schools to administer curricula for students who range from kindergarten to 12th grade. “These alternative school models differ from conventional schools by relying on parents and the Internet to deliver much of their curriculum and instruction while minimizing the use of personnel and physical facilities” (Huerta & Gonzalez, 2006, p. 103). Ultimately, cyber charter schools are responsible for demonstrating that the goals

for the school, and therefore the students, are met or the school will “cease to exist” (Center for Charter Reform, 2002; Hipsky & Adams, 2006). The school’s charter will be revoked if it does not perform.

Miron, Nelson, and Risley (2002) explained areas of cyber charter school innovation:

- Providing an innovative way to reach at-risk students who have dropped out of traditional schools.
- Offering a wider range of classes to their students. Students can be offered different (often advanced) instruction compared with courses that may be available in their local district’s schools.
- Providing structure and assistance to parents who were previously home-schooling their children. Enrolling formerly home-schooled students in cyber schools increases the amount of public oversight and guidance.
- Enabling students with health/medical/social problems that preclude attendance at a traditional school to continue their education from home or from a hospital or rehabilitation center (p. 116).

CYBER CHARTER SCHOOLS BENEFITS AND CONTROVERSY

Benefits of Cyber Charter Schools

The Education Commission of the States (2003) explained the draw of cyber charter schools for students and parents:

Typically, cyber charter schools attract students who want an independent, self-directed education. Often, a cyber charter school offers multiple curricula to engage students with different interests, learning styles or needs. Many students attending cyber charter schools were previously home-schooled, live in remote areas or have health problems, which make it difficult to make the trek into a school building for classes each day (p. 1).
Many students who have disabilities find comfort in the anonymity of the cyber charter school environment. It also tends to help some students focus when the social distractions are taken away.

The cyber charter schools provide a variety of technological tools to the homes of their students. The equipment can include a computer, Webcam, printer, headsets, and traditional books at no extra charge to the families (Cook, 2002; Huerta & Gonzalez, 2004; Rapp, Eckes, & Plucker, 2006). This can be a huge service to students who otherwise would not be able to afford technology in the home, and it could potentially begin to fill in the “digital divide” for some students who have fewer financial resources.

There is a great deal of flexibility and choice for the student at a cyber charter school. For instance, students can choose from a multitude of courses based on their own interests, talents, and ability levels because the course catalogs are not limited by the constraints of a brick and mortar school. With the asynchronous method, students can participate at their own pace and at a time that best suits their learning needs and schedule regardless if it is day or night. Because most schools provide the ability to choose a combination of virtual classes and self-paced classes, they are able to receive more support in areas of need and move ahead in their own strengths.

Societal Controversy Regarding Cyber Charter Schools

Because costs range from $5,000 to $7,000 per student to attend a cyber charter school (KPMG Consulting, 2001), there is controversy regarding funding. The cyber schools bill the public school districts per student enrolled in their classrooms. Although many of the charter schools deliver comparable instruction if not a higher quality, some public school advocates believe that if the school is not a traditional “brick and mortar” school it should not be funded by the charter school laws. Some states are beginning to move in this direction. California created a law in 2001 to curb funding for “nonclassroom-based charters”. Pennsylvania lawmakers enacted new rules that focused on bringing more scrutiny to both the financial and curricular details of online charter schools. The governor of Ohio signed a bill in 2003 that initiated a year-long study on how to finance these schools and imposed new funding restrictions on cyber charters (Hendrie, 2003).

INSTRUCTION, ASSESSMENT AND BEYOND

Instruction

Cyber charter schools utilize packages such as ClassServer (Bilyk, 2003) and Blackboard in order to have a common password protected place on which to log into the school. Once there, the students can go to their classes; they can find and submit their assignments and assessments. The students can engage in games, timelines, WebQuests, flash cards, slide shows, presentations, and quizzes.

Classes can be participated in through asynchronous and synchronous platforms. Asynchronous classes are conducted through two-way communication that occurs with a time delay (i.e., a classroom discussion board) that allows the participants to respond at their own convenience. The word “asynchronous” literally means not synchronous, in other words, not at the same time. For synchronous classes, all students meet in the online class at the same time and participate through chat types of discussions that are guided by the course instructor. During these lessons, the teachers can use online chalkboards to demonstrate concepts, students can break into small groups, and emoticons at the bottom of the screen demonstrate understanding. The emoticons (icons that represent various emotions in the students) can show a variety of scenarios including clapping if the student understands the concept or frowning if the student needs to have something re-taught. Figure 1 demonstrates a small group discussion that utilizes emoticons to represent the students.

Parents often play a large role in the instruction of the students, particularly in the younger years. Many families are required to communicate via phone, e-mail, or in-person with the school. Prior to beginning the process, most schools require that the parents attend an orientation and train alongside the student on the basics of technology. Often they are asked to sign a contract regarding their own responsibilities since the classroom is in their home.

Some cyber charter schools are beginning to include simulation games to teach important concepts through virtual science labs that allow students to explore volcanoes, rain forests, and other environments that were not previously available to online learners. This can be particularly helpful to the physically disabled student.
who may not otherwise be able to easily maneuver around that particular setting in real life.

**Assessment**

Students participate in both off-line and online assessments depending on the curriculum provider and the specific course. Answers to online assessments are keyed into the computer based on textbook quizzes and activities that were participated in during the instruction, such as a PowerPoint or video presentation that was viewed. Assessments that are conducted off line typically consist of writing samples and project assignments (for example, a product from an online art course) (KPMG Consulting, 2001). Assessments can be delivered through word jumbles, online games, and an assortment of other techniques so that they are not simply multiple-choice every time. One of the positive aspects for students is that right after they complete an assessment their grade is automatically viewed and entered into the grade book. The grades are calculated by the computer, which provides less room for error and no wait time. After providing immediate feedback on their work, students can be automatically directed either to engage in remedial activities or move on ahead to new challenges.

**Beyond the Virtual Classroom**

Many cyber charter schools strive to meet social goals as well academic goals since the students don’t see each other in classrooms as they would in traditional schools.
Cyber Charter Schools

To provide social interaction for their students many cyber charter schools arrange for PSSA and SAT test preparation, guest speakers, career days, clubs, science fairs, parent nights, and field trips.

Brick and Cyber

Some schools are moving from strictly cyber charter schools to “brick and cyber” models. These schools have a physical building that the students can go to take some or all of their courses that have an online component. These buildings often resemble office space with multiple cubicles for independent learning. The benefit of this form of instruction is that trained teachers are available in the building to guide the students through work that they are struggling with. Younger students can participate in reinforcing, hands-on, active learning activities and utilize manipulatives with a teacher present.

Eric Woelfel, principal of PA Cyber ++ , a brick and cyber school, explained a typical day. “I’m hoping to see students take advantage of this building and what’s being offered. I can see students sitting in on a virtual class, attending a group tutorial session for English, taking a creative writing class through the Henry Mancini Arts Academy, then walking down the hall to take a college course. There is so much to offer; a student’s day depends on how they wish to participate.”

Also, some traditional brick and mortar schools have invited cyber school curricula to be placed on computers in the regular public schools so that public school students can share the wide variety of courses that cyber schools can provide.

CONCLUSIONS

While this new mode of instruction and curricula may provide many positive benefits for the students, it is involved in funding controversy. Cyber charter schools are still looked at as a new frontier in learning and a fertile source for research. As the charter schools have expanded, charter advocacy centers, education associations, and research clearinghouses write policy reports and articles that outline salient issues (see Education Commission of the States, 2003), yet more empirical research must be conducted in the future.

REFERENCES


Cyber Charter Schools


KEY TERMS

Asynchronous Classes: These online courses are at the student’s pace and can be accessed at anytime because the students do not meet all at the same time. One tool for this type of learning model would be a discussion board on which the students post responses to a question.

Brick and Cyber Schools: This is a newer model of learning that fuses the curricular choices of the cyber school presented through a computer with the benefits of face-to-face teaching in a building if the student desires this for all or particular subjects.

Brick and Mortar Schools: This is the traditional public school model of curriculum and instruction. In this setting, students typically spend a set amount of time during the day being educated face-to-face by their teachers in a school building.

Charter Schools: Charter schools are considered to be independent nonprofit public schools that are established and operated under a charter. They operate under the constraints of a board of directors, must follow the law regarding accountability, and are publicly funded.

Cyber Charter Schools: These schools follow the same restrictions of charter schools. The curricula and instruction are delivered via computers and the Internet. Students can learn at their own pace, in a variety of sites (typically the home environment), and can engage in many classes at any time of day.

Synchronous Classes: These online classes meet at a previously selected time, and the students are guided through the instruction by a teacher often heard on headphones as well as communicating by typing online. A tool for this type of learning model could be a virtual blackboard where the teacher could explain in writing and then circle important parts or create symbols to guide the student through the lesson.
**INTRODUCTION**

Data mining is the process of extracting previously unknown information from large databases or data warehouses and using it to make crucial business decisions. Data mining tools find patterns in the data and infer rules from them. The extracted information can be used to form a prediction or classification model, identify relations between database records, or provide a summary of the databases being mined. Those patterns and rules can be used to guide decision making and forecast the effect of those decisions, and data mining can speed analysis by focusing attention on the most important variables.

**BACKGROUND**

We are drowning in data but starving for knowledge. In recent years the amount or the volume of information has increased significantly. Some researchers suggest that the volume of information stored doubles every year. Disk storage per person (DSP) is a way to measure the growth in personal data. Edelstein (2003) estimated that the number has dramatically grown from 28MB in 1996 to 472MB in 2000.

Data mining seems to be the most promising solution for the dilemma of dealing with too much data having very little knowledge. By using pattern recognition technologies and statistical and mathematical techniques to sift through warehoused information, data mining helps analysts recognize significant facts, relationships, trend, patterns, exceptions, and anomalies. The use of data mining can advance a company’s position by creating a sustainable competitive advantage. Data warehousing and mining is the science of managing and analyzing large datasets and discovering novel patterns (Olafsson, 2006; Wang, 2005).

Data mining is taking off for several reasons: organizations are gathering more data about their businesses, the enormous drop in storage costs, competitive business pressures, a desire to leverage existing information technology investments, and the dramatic drop in the cost/performance ratio of computer systems. Another reason is the rise of data warehousing. In the past, it was often necessary to gather the data, cleanse it, and merge it. Now, in many cases, the data are already sitting in a data warehouse ready to be used.

Over the last 40 years, the tools and techniques to process data and information have continued to evolve from data bases to data warehousing and further to data mining. Data warehousing applications have become business-critical. Data mining can compress even more value out of these huge repositories of information. Data mining is a multidisciplinary field covering a lot of disciplines such as databases, statistics, artificial intelligence, pattern recognition, machine learning, information theory, control theory, operations research, information retrieval, data visualization, high-performance computing or parallel and distributed computing, and so forth (Hand, Mannila, & Smyth, 2001; Zhou, 2003).

Certainly, many statistical models emerged a long time ago. Machine learning has marked a milestone in the evolution of computer science. Although data mining is still in its infancy, it is now being used in a wide range of industries and for a range of tasks in a variety of contexts (Lavoie, Dempsey, & Connaway, 2006; Wang, 2003). Data mining is synonymous with knowledge discovery in databases, knowledge extraction, data/pattern analysis, data archeology, data dredging, data snooping, data fishing, information harvesting, and business intelligence (Han & Kamber, 2001).

**MAIN FOCUS**

**Functionalities and Tasks**

The common types of information that can be derived from data mining operations are associations, sequences, classifications, clusters, and forecasting. Associations happen when occurrences are linked in a single event. One of the most popular association
applications deals with market basket analysis. This technique incorporates the use of frequency and probability functions to estimate the percentage chance of occurrences. Business strategists can leverage off of market basket analysis by applying such techniques as cross-selling and up-selling. In sequences, events are linked over time. This is particularly applicable in e-business for Web site analysis.

Classification is probably the most common data mining activity today. It recognizes patterns that describe the group to which an item belongs. It does this by examining existing items that already have been classified and inferring a set of rules from them. Clustering is related to classification, but differs in that no groups have yet been defined. Using clustering, the data-mining tool discovers different groupings within the data. The resulting groups or clusters help the end user make some sense out of vast amounts of data (Kudyba & Hoptroff, 2001). All of these applications may involve predictions. The fifth application type, forecasting, is a different form of prediction. It estimates the future value of continuous variables based on patterns within the data.

**Algorithms and Methodologies**

**Neural networks.** Also referred to as artificial intelligence (AI), neural networks utilize predictive algorithms. This technology has many similar characteristics to that of regression because the application generally examines historical data and utilizes a functional form that best equates explanatory variables and the target variable in a manner that minimizes the error between what the model had produced and what actually occurred in the past, and then applies this function to future data. Neural networks are a bit more complex as they incorporate intensive program architectures in attempting to identify linear, nonlinear and patterned relationships in historical data.

**Decision trees.** Megaputer (2006) mentioned that this method can be applied for solution of classification tasks only. As a result of applying this method to a training set, a hierarchical structure of classifying rules of the type “if…then…” is created. This structure has the form of a tree. In order to decide to which class an object or a situation should be assigned, one has to answer questions located at the tree nodes, starting from the root. Following this procedure, one eventually comes to one of the final nodes (called leaves), where the analyst finds a conclusion to which class the considered object should be assigned.

**Genetic algorithms (or Evolutionary Programming).** Biologically inspired search method borrows mechanisms of inheritance to find solutions. Biological systems demonstrated flexibility, robustness, and efficiency. Many biological systems are good at adapting to their environments. Some biological methods (such as reproduction, crossover, and mutation) can be used as an approach to computer-based problem solving. An initial population of solutions is created randomly. Only a fixed number of candidate solutions are kept from one generation to the next. Those solutions that are less fit tend to die off, similar to the biological notion of “survival of the fittest.”

**Regression analysis.** This technique involves specifying a functional form that best describes the relationship between explanatory, driving, or independent variables and the target or dependent variable the decision maker is looking to explain. Business analysts typically utilize regression to identify the quantitative relationships that exist between variables and enable them to forecast into the future. Regression models also enable analysts to perform “what if” or sensitivity analysis. Some examples include how response rates change if a particular marketing or promotional campaign is launched, or how certain compensation policies affect employee performance and many more.

**Logistics regression.** Logistic regression should be used when you want to predict the outcome of a dichotomous (e.g., yes/no) variable. This method is used for data that is not normally distributed (bell-shaped curve), that is, categorical (coded) data. When a dependent variable can only have one of two answers, such as “will graduate” or “will not graduate,” you cannot get a normal distribution as previously discussed.

**Memory based reasoning (MBR) or the nearest neighbor method.** To forecast a future situation or to make a correct decision, such systems find the closest past analogs of the present situation and choose the same solution which was the right one in those past situations. The drawback of this application is that there is no guarantee that resulting clusters provide any value to the end user. Resulting clusters may just not make any sense with regards to the overall business environment. Because of limitations of this technique, no predictive, “what if” or variable/target connection can be implemented.
The key differentiator between classification and segmentation with that of regression and neural network technology mentioned above is the inability of the former to perform sensitivity analysis or forecasting.

Applications and Benefits

Data mining can be used widely in science and business areas for analyzing databases, gathering data, and solving problems. In line with Berry and Linoff (2004), the benefits data mining can provide for businesses are limitless. Here are just a few examples:

- **Identify best prospects and then retain them as customers.** By concentrating marketing efforts only on the best prospects, companies will save time and money, thus increasing effectiveness of their marketing operation.
- **Predict cross-sell opportunities and make recommendations.** Both traditional and Web-based operations can help customers quickly locate products of interest to them and simultaneously increase the value of each communication with the customers.
- **Learn parameters influencing trends in sales and margins.** In the majority of cases we have no clue on what combination of parameters influences operation (black box). In these situations data mining is the only real option.
- **Segment markets and personalize communications.** There might be distinct groups of customers, patients, or natural phenomena that require different approaches in their handling.

The importance of collecting data that reflect specific business or scientific activities to achieve competitive advantage is widely recognized. Powerful systems for collecting data and managing it in large databases are in place in all large and mid-range companies. However, the bottleneck of turning this data into information is the difficulty of extracting knowledge about the system being studied from the collected data. Human analysts without special tools can no longer make sense of enormous volumes of data that require processing in order to make informed business decisions (Kudyba & Hoptroff, 2001).

The applications of data mining are everywhere: from biomedical data (Hu & Xu, 2005) to mobile user data (Goh & Taniar, 2005); from data warehousing (Tjoe & Taniar, 2005) to intelligent Web personalization (Zhou, Cheung, & Fong, 2005); from analyzing clinical outcome (Hu et al., 2005) to mining crime patterns (Bagui, 2006).

POTENTIAL PITFALLS

Data Quality

Data quality means the accuracy and completeness of the data. Data quality is a versatile issue that represents one of the biggest challenges for data mining. Data quality problem is of great importance due to the emergence of large volumes of data. Many business and industrial applications critically rely on the quality of information stored in diverse databases and data warehouses. As Seifert (2004) emphasized, data quality can be affected by the structure and consistency of the data being analyzed. Other factors like the presence of duplicate records, the lack of data standards, the timeliness of updates, and human errors can significantly impact the effectiveness of complex data mining techniques, which are sensitive to subtle differences in data. To improve the quality of data it is sometimes necessary to clean data by removing the duplicate records, standardizing the values or symbols used in the database to represent certain information, accounting for missing data points, removing unneeded data fields, and identifying abnormal data points.

Interoperability

Interoperability refers to the ability of a computer system and/or data to work with other systems or data using common standards or process. Until recently, some government agencies elected not to gamble with any level of open access and operated isolated information systems. But isolated data is in many ways useless data: bits of valuable information on the September 11, 2001, hijackers’ activities may have been stored in a variety of databases at the federal, state, and local government levels, but that information was not collected and available to those who needed to see it to glimpse a complete picture of the growing threat. So Seifert (2004) suggested that it is a critical part of the larger efforts to improve interagency collaboration and information sharing. For public data mining, interoperability of databases and software is important.
to enable the search and analysis of multiple databases simultaneously. This also ensures the compatibility of data mining activities of different agencies.

**Standardization**

This allows you to arrange customer information in a consistent format. Among the biggest challenges are inconsistent abbreviations, misspellings, and variant spellings. Among the types of data that can be appended are demographic, geographic, psychographic, behavioristic, event-driven, and computed. Matching allows you to identify similar data within and across your data sources. One of the greatest challenges of matching is creating a system that incorporates your “business rules,” or criteria for determining what constitutes a match.

**Preventing Decay**

The worst enemy of information is time. And information decays at different rates (Berry & Linoff, 2004). Cleaning your database is a large accomplishment, but it will be short-lived if you fail to implement procedures for keeping it clean at the source. According to the second law of thermodynamics, ordered systems tend to disorder, and a database is a very ordered system. Contacts move. Companies grow. Knowledge workers enter new customer information incorrectly. Some information simply starts out wrong, the result of data input errors such as typos, transpositions, omissions, and other mistakes. These are often easy to avoid. Finding ways to successfully implement these new technologies into a comprehensive data quality program not only increases the quality of your customer information but also saves time, reduces frustration, improves customer relations, and ultimately increases revenue. Without constant attention to quality, your information quality will disintegrate.

**No Generalizations to a Population**

In statistics, a population is defined and then a sample is collected to make inferences about the population. This means that data cannot be re-used. They define a model before looking at the data. Data mining does not attempt generalizations to a population. The database is considered as the population. With the computing power of modern computers, data miners can use the whole database, making sampling redundant. Data can be re-used. In data mining, it is a common practice to try hundreds of models and find the one that fits best. This makes the interpretation of the significance difficult. Machine learning is the data mining equivalent to regression. In machine learning, we use a training set to train the system to find the dependent variable.

**FUTURE TRENDS**

**Predictive Analysis**

Augusta (2004) suggested that predictive analysis is one of the major future trends for data mining. Rather than being just about mining large amounts of data, predictive analytics looks to actually understand the data content. They hope to forecast based on the contents of the data. However this requires complex programming and a great amount of business acumen. They are looking to do more than simply archive data, which is what data mining is currently known for. They want to not just process it, but understand it more clearly, which will in turn allow them to make better predictions about future behavior. With predictive analytics, you have the program scour the data and try to form, or help form, new hypotheses itself. This shows great promise and would be a boon for industries everywhere.

**Diversity of Application Domains**

Data mining and “X” phenomenon (Tuzhilin, 2005) where X constitutes a broad range of fields in which data mining is used for analyzing the data are everywhere. This has resulted in a process of cross-fertilization of ideas generated within this diverse population of researchers interacting across the traditional boundaries of their disciplines. The next generation of data mining applications covers a large number of different fields from traditional businesses to advance scientific research. Kantardzic and Zurada (2005) observed that with new tools, methodologies, and infrastructure, this trend of diversification will continue each year.

**CONCLUSION**

The emergence of new information technologies has given us much more data and many more options regard-
Data Mining

ing how to use it. Yet managing that flood of data and making it useful and available to decision makers has been a major organizational challenge. Data mining allows the extraction of diamonds of knowledge from huge historical mines of data. It helps to predict outcomes of future situations, to optimize business decisions, to increase the value of each customer and communication, and to improve customer satisfaction.

The management of data requires understanding and a skill set far beyond mere programming. Managing data mining is a new revelation as analysts will have to sift through more and more information daily due to the ever increasing size of the Web and consumer purchases. Data mining can have enormous rewards if properly used. We have an unprecedented opportunity for the future if we could avoid data mining’s pitfalls.

REFERENCES


Data Mining: Also known as knowledge discovery in databases (KDD), data mining is the process of automatically searching large volumes of data for patterns. Data mining is a fairly recent and contemporary topic in computing.

Data Visualization: A technology for helping users see patterns and relationships in large amounts of data by presenting the data in graphical form.

Explanatory Variables: Used interchangeably and refers to those variables that explain the variation of a particular target variable; also called driving, or descriptive, or independent variables.

Information Quality Decay: The quality of some data goes down when facts about real world objects change over time, but those facts are not updated in the database.

Information Retrieval: The art and science of searching for information in documents, searching for documents themselves, searching for metadata which describe documents, or searching within databases, whether relational stand-alone databases or hypertext networked databases such as the Internet or intranets, for text, sound, images, or data.

Machine Learning: Concerned with the development of algorithms and techniques which allow computers to “learn.”

Neural Networks: Also referred to as artificial intelligence (AI), which utilizes predictive algorithms.

Pattern Recognition: The act of taking in raw data and taking an action based on the category of the data. It is a field within the area of machine learning.

Predictive Analysis: The use of data mining techniques, historical data, and assumptions about future conditions to predict outcomes of events.

Segmentation: Another major group that comprises the world of data mining involving technology that identifies not only statistically significant relationships between explanatory and target variables, but determines noteworthy segments within variable categories that illustrate prevalent impacts on the target variable.
Data Mining Software

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INTRODUCTION

With increasing amounts of data being generated by businesses and researchers, there is a need for fast, accurate, and robust algorithms for data analysis. Improvements in databases technology, computing performance, and artificial intelligence have contributed to the development of intelligent data analysis. The primary aim of data mining is to discover patterns in the data that lead to better understanding of the data generating process and to make useful predictions (Hand, Mannila, & Smyth, 2001). Most companies now collect and refine massive quantities of data in data warehouses. These companies realize that to succeed in a fast paced world, business users need to be able to get information on demand.

Many organizations now view information as one of their most valuable assets, and data mining software allows a company to make full use of these information assets. Data mining software analyzes relationships and patterns in stored transaction data based on open-ended user queries. Several types of analytical software are available: statistical, machine learning and neural networks, decision trees, naive-Bayes, K-nearest neighbor, rule induction, clustering, rules based, linear and logistical regression time sequence, and so forth (Wang, 2005). There is never enough time to think of all the important questions; that is why the computer should do this itself. It can provide the winning edge in business by exploring the database and it brings back invaluable information.

BACKGROUND

The concept of data mining is relatively new; however, the technology has been around for decades. Companies have been using computers to sort through data and analyze reports for years. Nevertheless, continuous advancement in technology like improved computer processing power and state of the art statistical software are dramatically increasing the accuracy of analysis, while at the same time lowering overall operating costs. As Zhou (2003, p. 139) observed,

The rapid progress in the digital data acquisition and storage technology has led to the fast growing and tremendous amount of data stored in databases, data warehouses, or other kinds of data repositories such as the World Wide Web. Although valuable information may be hiding behind the data, the overwhelming data volume makes it difficult if not impossible, for human beings to extract them without powerful tools.

Data mining uses advance pattern recognition and mathematical and statistical techniques to find hidden patterns, trends, and correlations within the data sets. Data mining software is the prime result of this ever-improving technological age. It has become one of the most popular diagnostic tools for analyzing data. It gives organizations the ability to examine data from different dimensions, helps them categorize it, and then summarizes the relationships identified in order to provide useful information. Most forms of data mining software typically group data into four types of relationships. They are class, cluster, association, and sequential pattern. A class relationship is formed when stored data are used to locate data in predetermined groups. A cluster is developed when data items are grouped according to logical relationships or consumer preferences. Associations simply links between the items consumers choose and when they chose them. And lastly, sequential pattern is when data are mined to anticipate behavioral patterns and trends.
Data mining technology and software can be used with just about any type of data. It can combine information from many diverse sources to create a detailed data image about each of us—our income, our driving habits, our hobbies, our families, and our political interests (Laudons, 2005). Due to its ability to gather and analyze such diverse data about the preferences of large groups of people, it is the perfect tool for companies, especially retailing and marketing organizations, who have a strong customer focus. It enables these organizations to establish relationships among factors like price, product placement, and competition. They then can use these relationships to determine the impact on sales, customer satisfaction, and profits.

Today, data mining has become an essential part of doing business, and almost all major businesses use some sort of data mining software. Some of the more prevalent software suites are CART by Salford Systems, Clementine by SPSS Inc., and Enterprise Miner by SAS. These programs are the premier in analytical software because they help to make data more predictive, and provide useful insight for decision makers. For instance, Wal-Mart has realized that all their customer data has a great value. They have approximately one hundred million customers entering their stores every week and they are able to collect all the data at the checkout and then map and update it by store, state, and region. Wal-Mart looks at this data to constantly make their operation more efficient; they even use this data when they negotiate with their suppliers. They like to find out what products sell together and then often use one item to attract the customer into the store at a rock bottom price and then have the other items that usually sell with that item at a moderate price that may not be the lowest price in the area. This approach in data mining has worked very well for Wal-Mart stores (Hays, 2004).

**MAIN FOCUS**

Data mining software is used across many industries. Data mining tools can answer business questions that traditionally were too time-consuming to resolve. Data mining is, in some ways, an extension of statistics, with a few artificial intelligence and machine learning twists thrown in. Like statistics, data mining is not a business solution; it is just a technology. It is designed to help to simplify data mining and eliminate some of the errors other systems cannot. It also makes it easier to gather information and use it effectively within the company. By combining this with a skilled management team, this program can save money and increase profits in a shorter period of time rather than other database systems.

Executives need to make a sound decision on what type of application fits into the corporate environment and meet project needs. The choice of data mining software is not an easy task. Contrary to common opinion, the best tool suite for one company may not be the most advanced tool; it may not be the one with the most data mining algorithms or the one that gives the greatest accuracy in prediction.

**TECHNICAL PERSPECTIVE TO CHOOSE DATA MINING SOFTWARE**

The characteristics of the cutting edge data mining software applications can be classified into the following rubric (Giraud-Carrier & Povel, 2003).

**Portability**

A wide variety of standalone data mining tools are available on the commercial market. Some are general-purpose tools and others are tailored to use in specific industries such as finance or retail. To be truly effective as a tool to improve yield and reliability, data mining software technology needs to be available as part of an integrated yield management software environment. Otherwise, the user will be faced with importing and exporting data from one tool to another depending on where they are in the analysis cycle. To achieve this ease of use, data mining needs to be available as part of a commercially acquired yield management system, or it needs to be integrated in a seamless fashion with an in-house system. The latter case requires both a fully functional programmatic interface as well as an adequate internal staff to set-up and maintain the integration.

**Reliability**

Investments in high availability technologies, additional backup and restore capabilities, and replication enhancements will enable enterprises to build and deploy highly reliable applications. Moreover, improved
enterprise-wide analytical capabilities tool will enable organizations to more easily integrate and analyze data from multiple heterogeneous information sources. By analyzing data across a wide array of operational systems, organizations may gain a competitive edge through a holistic understanding of their business.

Efficiency

It is important that processes of installation and administration are simplified. For example, the extenders for DB2 Intelligent Miner are part of DB2 once they are installed. There is no need to set up additional tools or client/server interfaces. A database administrator can manage the configuration by using standard database tools.

Moreover, the maintenance of mining metadata and results need to be simplified as well. Every piece of information is an object in a database table. Updating a scoring model is a database update. While using data mining software, access control and backup of the data-mining environment is automatic because these tasks are part of the overall database maintenance activity. Users can easily combine application-specific metadata with the mining objects making ongoing updates of the mining models simple, efficient, and automatic.

Human Engineering

Because intelligent systems complement human abilities rather than replace them, human engineering and the human-machine interface is an integral component of data mining applications. The interface, which is built around knowledge representation and interactive visualization software, allows operators to interact with intelligent machines by presenting vast quantities of data in formats that make sense to humans.

Understandability

Many companies like Microsoft that produce data mining software are making their software more user-friendly. These databases have tables that have columns and rows which hold the data. They are making these databases easier to create, manage, and analyze. Many programs have debugging applications which can help companies self-fix their problems and report generators to make the data more usable.

Modifiability

Most data mining software products are interchangeable, which allows users at many different locations able to access the data and synchronize with the database on the server. It is very important for data mining software to be modifiable because business conditions are always changing and it is important to be able to change with the times. Data mining is supposed to support and drive organizations. Countless programs operate on different devices, integrated tools, and platforms with different applications.

Training and Support

Every company has different terms for their training and support. They all have help and support Web sites which often have a frequently asked questions area, online tutorials, message boards, and technical articles written and used by professionals. Companies can also send employees for training programs where they can get certifications. Companies and individuals can also purchase support packages for 24 hour, 7 day a week support or join user groups.

MANAGERIAL PERSPECTIVE TO CHOOSE DATA MINING SOFTWARE

Executives need to make a sound decision on what type of application fits into the corporate environment and meet project needs. The choice of data mining software is not an easy task. Contrary to common opinion, the best tool suite for one company may not be the most advanced tool; it may not be the one with the most data mining algorithms or the one that gives the greatest accuracy in prediction. Managers should pay attention to the following items in order to identify the most appropriate data mining software tool.

Ease of Use

Some traditional data mining tools may provide a rich variety of data processing and modeling capabilities, but require a legion of experts to use them. Often, these “experts” of data mining are developed only after many years of practice and travel up the learning curve of the tool’s capabilities. Rather than be very procedural (programmed with a scripting language),
the user interface to data mining technology should be easily acquired.

**Provides Acceptable Accuracy/Cost Tradeoff**

Several data mining tool suites available today can provide high functionality but they come with a high price tag. Managers must carefully evaluate cost-benefit scenarios to meet budget needs as well as project/client needs. For most purposes, the best tool might be the most accurate tool that could be obtained at a reasonable price. Holland and Jones (2005) introduced feature-based cost analytics (FBCA). The software combines data and data-mining algorithms to generate cost models. Users can learn accurate cost implications of various scenarios and make better decisions. FBCA software gives users a kind of cost-analysis X-ray vision.

**Versatility**

Data mining tool suites software should be able to perform all the common tasks in a regular project. For instance, IBM DB2 Intelligent Miner software can be used for purposes such as detecting fraud, segmentation of customer bases, and breaking down market basket analysis so the data is easily usable. One great thing about this software is that it allows users to use existing systems without having to move to a proprietary data-mining platform (IBM, 2006). Oracle, which took over Siebel Systems and Peoplesoft, is a database designed for Grid Computing without changing code, which makes it easy to adopt without much of an investment or disruption to your organization. The software uses Real Application Clusters which provide nonstop availability, scalability, and low cost clustering. Also Oracle is a self-managing database because it automates administrative tasks (Oracle, 2006).

Data mining is the one sure way to progress regardless of the economy’s direction, but which vendor’s solution works best remains an open-ended question. SPSS Inc. just introduced the current version of the software which is entitled Clementine 10. With each release or update the software seems to get better and better. Robert Lerner, a senior software analyst, says “SPSS continues to enhance Clementine. With Clementine 10, the company is helping users to boost productivity” and is also helping to deliver a 360-degree view of their customers (Brailov, 2006). SAS Institute Inc. has announced plans to enhance its data- and text-mining software. Enterprise Miner 5.2 includes new visualization and enhanced Web-mining features (SAS Institute Inc., 2005). One thing is for sure: data mining software will continue to evolve and help companies make quicker and better decisions.

It is important to know that there is no best tool overall. If a particular tool is successful enough to make it into the mainstream of data mining use, it must serve as at least a moderate segment of business needs well. Each tool suite has its strengths and weaknesses; each tool suite may be the best for particular needs in particular companies. Managers must make an effort to review and evaluate information about data mining applications to gain enough insight to take the first step in the choice of the data mining tool suite that is right for the organization. Burns (2005) found that although data mining offers great business opportunities but most enterprises still do not use it strategically.

The future of data mining software and application lies in predictive analytics. The technology innovations in data mining since its first introduction have been truly Darwinian and show promise of consolidating and stabilizing around predictive analytics. More than ever, the emerging market for predictive analytics has been sustained by professional services, service business, and profitable applications in industries such as retail, consumer finance, telecommunications, travel and leisure, and related analytic applications. Predictive analytics have successfully proliferated into applications to support customer recommendations, customer value and churn management, campaign optimization, and fraud detection.

On the product side, success stories in demand planning, just in time inventory (JIT) and market basket optimization is a staple of predictive analytics. Predictive analytics should be used to get to know the customer, segment and predict customer behavior, and forecast product demand and related market dynamics. However, one must be realistic about the required complex mixture of business acumen, statistical processing, and information technology support as well as the fragility of the resulting predictive model; but one should not make any assumptions about the limits of predictive analytics. Breakthroughs often occur in the application of the tools and methods to new commercial opportunities.
FUTURE TRENDS

In line with Bloor Research (2006), let’s look at possible scenario for the future of data mining market.

Fewer Companies to Offer a Broader Perspective

As vendors come up with good ideas, both in terms of deployment and in improved algorithms, these will be copied by other supplier. More particularly, we will see the major suppliers incorporate multiple algorithms into their products, with integration between them where this is feasible. As a result of these trends, smaller vendors will disappear from the general purpose market and specialize in niche sectors.

Improved End-User Ease of Use, Particularly Improved Use of Graphics and Visualization Techniques

As Haughton, Deichmann, Eshghi, Sayek, Teebagy, and Topi (2003) observed, the data visualization capabilities of current software are impressive but there are relatively few opportunities for direct manipulation of the graphical elements and those that exist are awkward.

The Functionality of Data Mining Tools Will Stress the Business Problem Rather than the Technology (Thearling, Becker, DeCoste, Mawby, Pilote, & Sommerfield, 2001)

The functionality of database marketing products will increase to integrate with relational database products and with key decision support systems application environments, it will stress the business problem rather than the technology and present the process to the user in a friendly manner. Database marketing will start losing some of the hipe and begin to provide real value to users. This will make database marketing an important business in and of itself. The larger data warehouse companies have already expressed an interest in integrating data mining into their database products. In the end, this new market and its business opportunities will drive mainstream database companies to database marketing. Ten years from now there may be only a few independent data mining companies left in existence. The real survivors will likely be the ones with the foresight to develop a strong relationship with the mainstream database industry.

Growth in Nonrelational Data Mining, Both in Term of Unstructured Data and Objects-Oriented Data

For example, growth in text mining and Web mining.

CONCLUSION

Data mining software allows users to analyze large databases to solve business decision-making problems. Data mining tools predict future trends and behaviors, allowing businesses to make proactive, knowledge-driven decisions. Data Mining is here and it is here to stay. With countless companies taking advantage of the user-friendly, reliable, and accurate data mining software that are available in the market, it is just a matter of time when other companies follow suit.

New technological innovations and revolutions will also pave the way for more powerful data mining software in the future. With more emphasis on the user-friendly interfaces and easy to use applications, the new data mining software are what every company needs to succeed in this technology-savvy society. Furthermore, the new data mining software also improves the basic features and advantages of their predecessors making for a better and more helpful tool for business to analyze, examine, predict, and summarize its information, and, ultimately, serve us, their customers, even better.

REFERENCES


**KEY TERMS**

**Efficiency**: Measure of actual output over effective capacity or the ratio of output to input.

**GUI (Graphical User Interface)**: The screen interface with a computer’s operating software where graphical components such as icons are used to represent computer files and programs. The usual range of graphical components in such an interface normally includes windows, icons, menus, and pointers, and as a result is sometimes referred to as WIMP interfaces.

**Human Engineering**: The extent to which a software product fulfills its purpose without wasting users’ time and energy or degrading their morale.

**Modifiability**: The degree of augment ability and the ability to change and expand over time.

**Portability**: The ability of a program to be run in various environments, operating systems, and so forth.

**Reliability**: The probability of performing a specified function without failure under given conditions for a specified period of time.

**Testability**: The degree to which a system or component facilitates the establishment of test criteria and the performance of tests to determine whether those criteria have been met.

**Understandability**: The degree to which the purpose of the system or component is clear to the evaluator.
Data Warehouse Software

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INTRODUCTION

A data warehouse (DW) is a complete intelligent data storage and information delivery or distribution solution enabling users to customize the flow of information through their organization (Inmon & Hackathorn, 2002). It provides all authorized members of users’ organization with flexible, secure, and rapid access to critical information and intelligent reporting. DW can extract information from sources anywhere in the world and then delivers intelligence anywhere in the world. It connects to any platform, database, data source, and it will also scale to businesses and applications of any size. As early as the 1970’s, data warehousing software (DWS) was recognized when the earliest systems were first developed. The database designs of operational systems were not effective enough for the information analysis and reporting (The Data Warehousing Information Center, 2006).

Today, many corporations are experiencing significant business benefits by using DWS technology. DWS is a separate architecture used to maintain critical historical data that has been extracted from operation data storage and transformed into formats understandable to the organization’s analytical community. DWS is a system for storing, retrieving, and managing large amounts of any type of data, and it is a copy of transaction data specifically structured for query and analysis. It is also a complete, powerful, scalable, and customizable intelligent DW solution, which also optionally offers the most complete analytic functionality available on the market, fully-integrated into the system.

BACKGROUND

DW is a field that has grown out of the integration of a number of different technologies and experiences over the last two decades. These experiences have allowed the IT industry to identify the key problems that have to be solved (Fayyad, Piatetsky-Shapiro, Smyth, & Utthurusamy, 2000). According to Bill Inmon (2001), known as the father of DW, a DW is a subject-oriented, integrated, time-variant, non-volatile collection of data in support of management decisions. Subject-oriented means that all relevant data about a subject is gathered and stored as a single set in a useful format. Integrated refers to data being stored in a globally-accepted fashion with consistent naming conventions, measurements, encoding structures, and physical attributes, even when the underlying operational systems store the data differently. Non-volatile means the DW is read-only: data are loaded into the DW and accessed there. Time-variant data represent long-term data, from 5 to 10 years as opposed to the 30- to 60-day time periods of operational data.

DWs build on a database and database schema customized for user’s particular business. The solution can be installed either inclusive of a high performance database engine or as a database schema compatible with most industry standard databases. So, it will seamlessly integrate into existing database systems. DW does not depend on one particular database vendor or hardware platform, it is itself entirely platform-independent, and the main DW will connect to any database format, and hence can efficiently combine and pool information from multiple sources. The software will run on servers with multiple processors, or banks of multiple-processor servers for super-computer like performance. The system will scale effortlessly and economically to even huge data sizes and analysis problems. Most of DWs are used for post-decision monitoring of the effects of decisions or for operational issues (Inmon, Welch, & Glassey, 2000).
MAIN FOCUS

Data management needs for large companies evolve at alarming rates. On average, businesses double their volume of data annually. As a result, it is expected that DW will actually be measuring in petabytes instead of terabytes in the next several years. As transaction processing time and synchronization of business functions become ever more essential steps to serving the customer, businesses look for more efficient business intelligence solutions. DWS can often provide such solutions, and its general popularity in major industries has transformed data management. Not only has it fueled competition in business by providing a means to do things faster, better, and for less than the competitors, but DWS in itself has become a competitive industry. Creating the most compatible, user-friendly solutions in a software package is an unending battle among DWS producers.

Benefits and Drawbacks of Data Warehousing

The many advantages to using a DW are helping end-user access to a wide variety of data, increase data consistency, and productivity while decreasing computing costs. It is also able to bring together data from many different sources in one place and provides an infrastructure that could support changes to data and replication of the changed data back into the operational systems. Another very important advantage that the DW has over the general operational systems is its accessibility through a variety of modern software tools. A lot of software can be distinguished on the basis of how suitable it is for the task at hand or how recognizable it is to the customer.

Before the arrival of DWS, problems such as heterogeneous data, legacy data, data unsaved in online transaction processing (OLTP) databases, and files made primarily for small, conventional transactions, often signified unbearable delays in the production of reports usually needed for appropriate decision making.

It is a departure from the existing model for operational systems where the primary availability is through custom applications programs written to succeed in specific tasks. For some companies, they view DWS as complex, costly, and almost certain to fail. But more companies are successfully building and operating DWs that boost operational efficiency, lower operating costs, and get them closer to their customers. Information Week (2006) listed the following benefits: (1) merging subject specific data together to create information; (2) standardizing data across the organization; (3) improving turnaround time for reporting; (4) lowering costs to print and distribute reports; and (5) sharing data or allowing others to easily access your data.

Some of the disadvantages are extracting, cleaning, and loading data could be time consuming. A DW project scope might increase, and there may be problems with compatibility with systems already in place. Security could develop into a serious issue; especially if the DW is web accessible (DMReview (B), 2006).

Let’s look at why a company would want to build a DW in the first place. Seemingly, many companies have information needs that are currently not being satisfied by their operational and decision support systems. In all possibility, the company is suffering from considerable losses due to the non-availability of this important information. These losses can range from anything such as losing a business to the competition or losing customers to cost overruns. Most likely, the reason for not being able to help satisfy their information needs is due to dirty data, redundant data, inaccessible data, untimely data, and so forth. In other words, companies can suffer real business pain, which they cannot solve with their current systems. This pain usually translates into high losses. When companies go over the cost of a DW solution (which addresses all the data issues when finished accurately), the company has to decide if the benefits (profits to be gained or losses to be eliminated by having their information needs satisfied) overrides the costs of building a DW. If it doesn’t, a DW solution is not suitable and maybe it should not be built.

Another disadvantage of DWS is when it is poorly designed. Indeed, a DW will certainly introduce data quality issues as well as many other processes, data, and resource changes—however, all for the better. It is important to understand that the maintenance of a DW can be a time-consuming and difficult task. A company must make the commitment to supply a dedicated support team, appropriate hardware and software, and business sponsorship to make it effective.
Representatives of DWS

SAS

SAS Data Integration is a type of DWS that is very understandable and provides organizations the ability to respond quickly to new data integration requirements, consolidate vendors, standardize one-on-one integration solutions, and reduce the overall cost of data integration. This type of software also can give a business the contingency to reach and manage accordant and important data that is a part of their company. There are many benefits to using this software, such as eliminating delivery delays and high costs associated with having IT building custom codes for each integration project or having to piece together a myriad of non-integrated technologies by providing single, integrated, and easy-to-use solutions (SAS Data Integration, 2006). Another benefit is that it limits the dependency to obtain new tools to match the changing needs of each new data integration project a business must finish and can bring a business the solutions that will deal with all of their data integration activities.

Microsoft

SQL Server has a wide variety of applications; data warehousing is one of its most prominent. Since SQL Server comes with many tools and modules, it allows the user to perform a broad range of functions, such as data extraction, transformation, and loading. It has a reputation for providing superior data analysis capabilities to users.

Hilton Hotels is one of many corporations utilizing this software for DW management. The company’s catering division sought out SQL Server 2005 to aid them in analyzing and forecasting customer trends. In addition, they needed a faster way to process catering requests, and had been finding it difficult to organize data regarding customer history, preferences, and pricing details. Since implementing the software, catering revenue has increased significantly (Microsoft, 2006).

Oracle

The Oracle Corporation is a Fortune 500 company specializing in the software and related services for the information-driven enterprise. This application software giant is the proud parent of the Oracle Warehouse Builder 10g. This data management software is widely known for being extremely successful across different operating platforms such as Windows, Linux, and UNIX. It has also successfully met the challenge of managing continually larger volumes of data (WinterCorp., 2005). Improvements made to 10g that are evident in Oracle Warehouse Builder 10g Release 2 are faster processing of reports for analysis, and the ability to preserve, monitor, and even enhance the quality of data being stored. This helps users save time for themselves and their customers (Oracle, 2006).

IBM

IBM has long been known for producing PCs and laptop computers. However, they are also in the business of developing information management software. Specifically, IBM’s DB2 Data Warehouse Edition and its Tivoli Enterprise Data Warehouse are popular choices for companies managing a large, complicated mess of data. While IBM has created an entire DB2 product line to serve databases of all shapes and sizes, the Warehouse Edition is specially designed for the mid- to large-size business, and utilizes Web-based applications for data mining and analysis.

One company in particular that has benefited greatly from the use of this software is the United Parcel Service, commonly known as UPS. UPS uses one of the world’s largest DB2 databases to catalogue every single transaction and delivery they handle. With the Warehouse Edition software, UPS headquarters up and down the east coast have the ability to access customer and tracking information at any given time (UPS, 2006).

NCR

In hopes of improving customer satisfaction, NCR released Teradata Warehouse 6.0. Their advantages include quick answer time, active data warehousing, and event-based processing which allows the delivery of product services and special offers on those products to the front end of the store. Teradata’s patented parallel architecture supplies the fundamentals for the one of a kind capacity to provide a vast array of data
Data Warehouse Software

warehousing functions, ranging from reports to ad-hoc queries to data mining, all from a single DW that combines data from across the enterprise (Teradata Corporation, 2006).

Hyperion

Another great type of DWS is Hyperion System 9 Master Data Management or also called Hyperion MDM. It is known for being able to synchronize business performance management (BPM) master data such as business dimensions, reporting structures, hierarchies, attributes, and business rules across distributed DWs, data marts, analytic applications, and transaction systems. There are many times when data are not consistent from one system to another and dealing with this is typically done by hand and is very time consuming for businesses. Instead, Hyperion eliminates this problem by letting a business create and tailor master data views and configure security in a fashion that enables individual users to work freely within their area of responsibility and reconcile any differences quickly and easily when they arise (Hyperion System, 2006).

WinPure

This company actually makes the software that cleans businesses DWS, especially when it comes to dirty data. It cleans mailing lists, marketing databases, spreadsheets, and e-mails with its five different cleaning modules, and then performs a powerful data duplication to ensure lists do not contain any duplicates. For example, it uses a special step-by-step problem solving procedure for wrongly spelt addresses, recognize nicknames and company names, while also featuring their powerful and advanced delete options. WinPure is also helpful in that it can import two different data’s while cleaning and matching on both lists all at the same time (WinPure, 2006). This type of list cleaning, data cleansing, and data duplication software is a great choice for small business owners to use since it will not cost them a lot of money in the end.

Hummingbird

Hummingbird Enterprise 2005 gives businesses a real framework to succeed in the content-driven industry and help process certain type of solutions that eliminate risk, reduce costs, and generate business advantages. It considers itself to be the basis for streamlining and automating very important tasks, such as regulatory compliance, contract management, practice support for law firms, correspondence management, dealing with room management, and even e-mail management. Enterprise Content Management Platform has moved from a tactical technology solution for managing increasing volumes and centralizing access to business information into the realm of strategic imperative for delivering cost savings and generating business advantage (Hummingbird, 2005).

Cognos

Most businesses today want DWS that have the ability to get quick answers to questions with minimal impact on infrastructure which is very beneficial in a business’ overall decision-making process. Cognos is software that extracts and disseminates businesses’ information in a timely yet cost-effective manner. For example, plans, reports, and metrics all come with a module and are all interconnected so that a company can easily investigate a sales issue and then link it back to their financials as necessary. It also has the ability to work thorough project-pricing analysis and the right techniques to evaluate target market strategy and success. Another strength is the ability to draw on proven industry best practices, reports, and analysis in core functional areas of the business to gain greater visibility into company data without building everything from scratch (Lack, 2006).

Netezza

As an enterprise-class data appliance, the NPS system delivers 10 to 100 times the performance for large, complex, and constantly evolving business intelligence (BI) efforts at half the cost of existing systems (Netezza, 2006). Netezza has placed processing power next to the data, so data analysis occurs at the source at streaming speeds, delivering an unprecedented boost in performance. It is also able to process many repetitions, it allows a user to quickly distinguish and address problems, change promotions, and fine-tune datasets. With the Netezza Performance Server (NPS), a user can optimize the BI analytic and reporting tools the user already rely on to realize real-time results for
comprehensive analysis of a customer’s datasets. Since Netezza is equipped for quick use, simple administration and even infinite scaling, the NPS system is completely well-matched with companies’ existing BI infrastructures, applications, legacy systems, and data.

FUTURE TRENDS

According to Hamm (2006), DWS will be so advanced that it will understand when different people use different words to describe similar ideas. It will soon be able to generate an index of linked information and produce outcomes in response to queries. This capability will be known as non-obvious relationship awareness. We should also be on the lookout for the buzzword “biggle”, a combination of BI, and Google, a concept named by Gartner, a tech-market researcher.

In line with the DMReview (A) (2006), a few more trends are to be observed in the entire BI field which includes DWS. A few of these trends include: a move from BI tools to integration platforms, vendor consolidation, increase of data volumes, and BI and analytics embedded within process automation and composite applications. These future trends will not only open up new opportunities in the job market, but encourage innovative DWS.

CONCLUSION

DWs aim to supply the right data at the right time to the right set of business users, providing them with the analytical capability to make better strategic decisions. A large company has thousands if not millions of pieces of data to analyze. An accurate DW backed with a strong analytical software program can empower company decision makers to make the right choices. According to Gardener (1998), although the infrastructure pertaining to DW is costly and involves a lot of work to put into place, it is definitely worth the hassle as overall more effective operations will save the company money and resources in the long run.

Even though building and maintaining a successful DW is a difficult job, the benefits far outweigh the expense. Hopefully in the future most companies will see and reap the benefits of using DWS and prove that DWs, when designed, built, and operated the right way, can deliver a comparative advantage. We believe that DWS will increase overall efficiency and help today’s modern cutting-edge corporations meet all of their goals. It will rise above its challenges and prove to be beneficial in every possible way.

REFERENCES


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**KEY TERMS**

**Business Intelligence (BI):** A broad category of application programs and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI applications include the activities of decision support, query and reporting, OLAP, statistical analysis, forecasting, and data mining.

**Extraction, Transformation, and Loading (ETL):** Extract, transform, and load data from across the enterprise to create consistent, accurate information.

**Integrated Data Warehouse:** Data warehouses at this stage are used to generate activity or transactions that are passed back into the operational systems for use in the daily activity of the organization.

**Online Analytical Processing (OLAP):** A broad term to describe a type of processing that allows for unlimited views of multiple relationships within summarized data. It is typically, although not necessarily, associated with multi-dimensional databases where this pre-summarized data can be efficiently stored.

**Online Transaction Processing (OLTP):** Handles real-time transactions which inherently have some special requirements.

**Petabyte:** Equal to approximately 1,000 terabytes.

**Real-Time Data Warehouse:** Data warehouses at this stage are updated on a transaction or event basis, every time an operational system performs a transaction.

**SQL Server:** SQL Server is a relational database management system (RDBMS) produced by Microsoft.

**Terabyte:** Equal to approximately 1,000 gigabytes.
INTRODUCTION

“Big ideas” drive the disciplines. In biology, the insights of Darwin generated evolutionary theory. In chemistry, Mendeleev’s vision of the organization of elements predicted subsequent discoveries. In computing, the database and associated database management systems (DBMS) are one of the “big ideas”. The database was conceptually possible prior to the development of the computer, but it was the digital computer that made the database the common tool it is today. The core idea of the database is distinguishing between the data description and the data itself. Among other things, this idea makes the Web possible and has made manageable new fields for discovery, such as modeling the human genome.

BACKGROUND

The modern database is an invention of the 1960’s that took the computer hardware developments of the 1970’s and the infrastructure of technology companies in the 1980s to become the multi-billion dollar industry of the 21st century. The foundations for the database, however, reach back to the 1890s.

The Article 1, Section 2 of the U.S. Constitution requires a population “Enumeration…” which has become the decennial census. Approaching the census of 1890, when the U.S. population had risen to more than 65 million, presented a problem because the prior census, when the population was almost half as much, had taken seven years to tabulate. The government addressed the concern by contracting with Herman Hollerith to mechanically tabulate the results using punch card machines he had designed. Hollerith successfully completed tabulating the census in less than three years, some even say in three months (Austrian, 1982). He subsequently formed the Hollerith Tabulation company to promote his invention and method of managing data. Through mergers and growth, the company, renamed Computing Tabulating Recording (CTR) Company became International Business Machines (IBM) in 1924.

Two core concepts stemmed from Hollerith’s mechanical tabulators. First, data could be represented numerically by location on a punch card. Second, a machine with a wiring panel could be used to tabulate different data. The first concept allows for more than mechanical computation and permits representation of personal data, such as a name, numerically. The second introduces the notion of a general purpose machine that may be programmed—in the mechanical case, by switching the wiring pattern, in later digital computers, through a programming language.

Until the development of digital computers, database-like technologies remained in the punch card arena. Developments in national governments, such as the requirements of tracking wages for a Social Security system, required more sophisticated, specialized machines to record and tabulate information. It was the military, however, in its early Cold War defense projects such as SAGE that provided impetus to the issues of data management.

Database applications become the focus of interest in the computing industry in the late 1950s with the formation of the Conference on Data Systems Languages (CODASYL). While the first achievement of this group was the COBOL programming language for business, the group reformed in the mid-sixties to create extensions to COBOL to assist with processing records (Olle, 1978). At about the same time, data storage evolved from magnetic tape, which required serial access, to magnetic disks (forerunner of the computer hard drive) which permitted random access. The results of the conference were CODASYL compliant databases using a network data structure. Its network data structure allowed the representation of one-to-many relationships. The dominant database in this area was the integrated data store (IDS) based on ideas of Bachman (1982) and developed at General Electric. Almost simultaneous to these developments, IBM developed the information management system (IMS)—a hierarchical database independent of the CODASYL group (Blackman, 1998).
This database was also able to represent one-to-many relationships and was largely a result of support for the Apollo project at the National Aeronautics and Space Administration (NASA).

As the network and hierarchical database models became commercial products and consolidated their positions in government and business, E. F. Codd, a mathematician and IBM researcher, discovered and promoted the relational model for databases. He was forced to defend his seminal paper, *A relational model of data for large shared data banks* (Codd, 1970), within IBM because the company had developed IMS as its primary database product.

The relational model challenged both the hierarchical and network models as both data models depend upon navigating paths to the data. Codd instead argued for a high-level, non-procedural language to access data, which itself was represented free from any machine constraints. The flexibility of the model resulted from its theoretical foundations in relational algebra, a mathematical sub-field of predicate calculus. In response to external interest in Codd’s model, IBM developed System R in the mid-seventies as a demonstration project. The project created SEQUEL, an acronym for “structured English query language” to access the data. Later shortened to SQL (structured query language), it became an ANSI standard in 1986.

The relational database management system (RDBMS) using SQL has become the standard for databases in government and industry. The leading vendors include: Oracle, with its namesake products, first released in 1979; IBM with DB2, released in 1983, and includes NCR’s Teradata for very large data stores; and the Microsoft SQL line of products and Access, desktop database for the Microsoft Office Suite. More recently, with the rise of Linux, open source databases, such as Postgres (build on Ingres, initially a government sponsored SQL project in the mid-seventies) or MySQL, have gained greater followings.

**Database Definition**

While the ability to store material is relatively trivial, witness the offices of some co-workers with their piles of papers, books, and magazines, to store data meaningfully is a challenge for two reasons. First, meaning derives from context; therefore the data must map to the real world. Second, raw data has little value. As a response to a question, however, its value increases because result has become information.

The value of this information increases with the complexity of the question. For example, one can store the following data—country, gross domestic product, and the population. The country, GDP value, and population are all pieces of data. The answer to the question, “Who has the highest GDP?” gives me some information. The answer to the question, “What is the GDP per person?” gives me information evaluated on two parameters: size and relative size per person. Furthermore, the second question responds with derived data, achieved by dividing the GDP by the population.

An entry in a database is known as a record. A record is made up of fields. A field is a characteristic of the item being specified by a record. For example, a person may be described by a first and last name, a height, weight, gender, and age. Each descriptor is a field. A record would describe a specific person, for example “Jane Doe, 150 cm, 50 kg, female, 27 years old.” Records are collected in tables.

Depending upon the database model and the theoretical level of interest, the terms “table”, “record”, or “field” may be referred to as “entities” or “attributes”. For the purposes of this article, tables will contain records, and records will contain fields. In the table, records will be the row entry while fields will be the column entry. The data is the value at the intersection of a specific row and column.

Inherent in modern databases is the notion of relationships. Often these relationships are referred to as parent-to-child relationships to indicate dependencies of data. In the first example, specific GDP and populations are “children” of the country or “parent” because they are dependent upon them. Additionally, a person could have a home address and a work address. The person’s identity can be considered the “parent” and the address the “child”. In this example, one parent record has two child records.

**Database Models**

**Flat File**

The most common data model is the flat file. For example, a phone book that orders entries alphabetically with a corresponding phone number is a flat file database. An Excel spreadsheet, which is an ordered array of
rows and columns, has become the most common flat file. Simple operations, such as sorting (or ordering) and counting may be done. More complex operations, such as showing only those records meeting more than one specific criterion, are more difficult. For example, the Yellow Pages listings for restaurants frequently lists them alphabetically, and then in a sub-section, alphabetically by cuisine.

Hierarchical Model

This model is based upon a tree structure where a parent may have a number of child nodes. The weakness of this structure is that a child cannot have multiple parents. The most common current instance of this database model is the desktop file system. A drive can contain many folders, and each folder can contain many documents. The hierarchy follows from the drive, or root, to the folder, or branch, to the documents, or leaves.

Network Model

The network model is the theoretical underpinning of the CODASYL specification and was closely allied with the COBOL programming language. This model allows for multiple parent relations, where each record is a member of a set, where the set contains the owner, the set name, and the member. A member may belong to more than one set, allowing for one-to-many relations. This model is being reconsidered with the rise of more free-form data collection as a result of the popularity of the World Wide Web.

Relational Databases

The relational model has become the most popular data model (Date, 1982). It allows one-to-many relationships and accommodates many-to-many relationship. The latter, however, are decomposed into two one-to-many relationships.

The relational model organizes data into a table defined by rows and columns. Each column contains data of the same type, such as textual, numeric, or specialized forms such as a date. Each table is assigned a key to uniquely identify each row in the table. Relationships between tables and retrieval of data from multiple tables are made through the keys. Furthermore, the key fields are frequently indexed, allowing for faster data access and query response.

Relational databases use a dialect of SQL to create, query, and maintain the database. The following code, for example, creates a table.

```sql
CREATE TABLE tblExample (  
  fld_Ex1 INT,  
  fld_Ex2 VARCHAR (50),  
  fld_Ex3 DATE NOT NULL,  
  PRIMARY KEY (fld_Ex1) )
```

This code, on the other hand, selects the customer’s last name, and the purchase price of transactions, related to the specific customer using a join to create the relationship based upon the customer’s identification (CustID).

```sql
SELECT tblCustomer.Clname, tblTrans.PurPrice  
FROM tblCustomer  
INNER JOIN tblTrans ON tblCustomer.CustID = tblTrans.CustID;
```

DATABASE SKILLS

The skills associated with a database fall into two areas: administration and user. The administration of databases is formalized in larger corporate settings as a database administrator (DBA), who is the person responsible for the design, maintenance, and implementation of a database. Database users will frequently only use those aspects of the database permitted by the database administrator.

Entity Relation Diagrams

The primary database skill for an administrator is being able to translate the organizational needs into a database; this requires a deep understanding of the data collected, the queries that may be proposed, and the business rules governing the data. A number of model tools have been developed to assist the DBA, with the entity relation diagram (ERD) being the primary one.

The Chen (1976) formulation is the most common ER diagram (Figure 1). This model uses boxes to identify entities, ovals to identify attributes, and diamonds to identify relationships.

In the example, Doctors and Patients are the entities for this database and will be represented by tables. The fields are the name, specialty (for the doctor) and phone
(for the patient). As is common, the nouns are represented as entities and the verbs as relationships—“A doctor examines patients”. In practice, these diagrams are developed to fully specify the database, indicating the type of relationships, or cardinality, and the requirements of the relationship, ordinality.

Restrictions on the database are used to enact the business rules. As at the simplest level, a patient may require a doctor whereas a doctor may be entered without patients. This would model the situation where a patient requires a referral to a specialist and a new specialist can join the practice before having patients assigned. More sophisticated business rules may be programmed in the database design. For example, in a stockbroker database, a cash transaction of greater than $10,000 may require a notice to banking regulators and the SEC as an implementation of the federal statutes.

Data Integrity and Normalization

In addition to the ease of querying an electronic database, an additional reason for the rapid adoption is the ability to make the data more accurate and maintain data accuracy. In part, business rules serve this role. However, the design of the database plays a significant role.

Normalization is a formal process to eliminate redundant data, or the same data occurring in more than one table or record in a database, thereby ensuring the one data entry is valid. Generally, databases are normalized to the 3rd Normal Form. The 1st Normal Form ensures that field can have only one element of data stored therein. The 2nd Normal Form requires that each field be dependent upon the primary key. The 3rd Normal Form reinforced the field’s dependency on the key and only the key. While additional normal forms exist, the discussion moves into more advanced database design issues.

When considering data integrity, not only are the design issues important, but the capabilities of the database itself are critical, especially for databases that record transactions, such as a bank. The evaluation criteria for databases go by the acronym ACID, which stands for:

- **Atomicity**: All tasks must be completed or no task completed.
- **Consistency**: The transaction cannot violate an integrity rule of the database.
- **Isolation**: Other operations cannot view a transaction until it is complete.
- **Durability**: A completed transaction cannot be erased.

The easiest example for an ACID compliant transaction is a banking transfer. If the transfer cannot be completed, an account will not be debited (atomicity). If the transfer will create a negative account balance, in violation of banking rules, the transfer fails (consistency). During the process of the transfer, the transfer itself cannot be viewed, only the results, either a credit or debit at the close of the transaction (isolation). The transfer will be recorded when completed and cannot be erased. If the transfer was in error, it must be reposted to correct the error (durability).

User Skills

The database administrator usually permits a user to run only pre-written queries. For example, using an online travel booking service creates an SQL query...
that includes departure date and time, departure city, destination city, and airline. However, a well-designed relational database has a flexibility to respond to unanticipated queries. In this case, a user may need to become familiar with SQL or, at a minimum, relational operators such as AND, OR, and NOT. These operators allow for more complex queries, such as “All the flights from Dulles OR BWI airports, AND via Southwest Airlines, NOT before noon.” The user, however, must understand that a logical OR allows for selection from both item and expands the selection, while the AND allows for selections that meet all criteria and is restricts the selection, and NOT negates the element of selection. The challenge is that these functions seem to contradict common usage.

FUTURE DEVELOPMENTS

While the relational database has become the most widespread, developments are uncovering limitations. Some developments include object-oriented and object-relational databases which treat all components as objects, following an object-oriented programming paradigm. The development of very large databases has led to specific data warehousing products (Chaudhuri & Umeshware, 1997). To extract meaningful data, commonly known as data mining, they use online analytic processing (OLAP). This form of query requires modifying a relational structure; however, Codd (1993) again was one of the instrumental thinkers behind this data model.

With the increasing graphical capability of computers, spatial databases combine data with underlying positional information. Originally the province of graphical information systems (GIS), they have been popularized by better access to positional information via geographic positioning systems (GPS).

Given the prevalence of the Internet and its developments, it is not surprising that databases are being influenced. There has been considerable interest in XML, the enhancement to HTML, the original language of the Web. The W3C (2006) is developing XQuery as a formal means to query XML documents located on the Web.

CONCLUSION

Databases are a core development in computing and information systems. They have changed business by making storage, retrieval, and accuracy of stored data more efficient, effective, and reliable. The concept of describing and storing data in a structured manner that is independent of the actual data, coupled with a simple language to extract only desired data from storage, has created powerful systems to represent business practices evolved. This concept has allowed for descriptions of more complex documents, such as the description of a Web page, to be independent of the content of a specific page.

REFERENCES


**KEY TERMS**

**Database**: A structured collection of data.

**Flat File**: A single table containing all data in a database.

**Hierarchical Data Model**: A data model that employs a tree structure to represent one-to-many relationships.

**Network Data Model**: A data model based upon members of sets where a member may belong to multiple sets.

**Normalization**: Process of ensuring data integrity in a relational database design.

**Relational Data Model**: A data model based upon keys to uniquely identify and relate records in different tables.

**SQL (Structured Query Language)**: A higher-ordered programming language for querying a relational database.
INTRODUCTION

Throughout the years many have argued about different definitions for DSS; however they have all agreed that in order to succeed in the decision-making process, companies or individuals need to choose the right software that best fits their requirements and demands. The beginning of business software extends back to the early 1950s. Since the early 1970s, the decision support technologies became the most popular and they evolved most rapidly (Shim, Warkentin, Courtney, Power, Sharda, & Carlsson, 2002). With the existence of decision support systems came the creation of decision support software (DSS). Scientists and computer programmers applied analytical and scientific methods for the development of more sophisticated DSS. They used mathematical models and algorithms from such fields of study as artificial intelligence, mathematical simulation and optimization, and concepts of mathematical logic, and so forth.

A DSS is an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions (Druzdzel & Flynn, 1999). The concept of decision support has evolved from two main areas of research: the theoretical studies of organizational decision making done at the Carnegie Institute of Technology during the late 1950s and early 1960s, and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s (Finlay, 1994). In the middle and late 1980s, executive information systems (EIS), group decision support software (GDSS), and organizational decision support software (ODSS) evolved from the single user and model-oriented DSS (Huber, 2006).

BACKGROUND

DSS plays a different role in many fields of business today. It helps companies ranging from automobile to healthcare to telecommunications make and implement strategies best suited to service their consumers. Some of the solutions that DSS provides are activity-based management, compliance, financial intelligence, cost benefit analysis, forecasting, simulation, risk management, and Web analytics to name a few. DSS also helps with data integration; it assists with the migration and synchronization of data used to assist companies in the decision-making process.

For the reason of the lack of one generic model of decision making, the concept of DSS is extremely broad and its definitions vary depending upon the author’s point of view and are strongly dependent on the DSS application context. A DSS can take many different forms, and the term can be used in many different ways. Despite DSS being such a helpful tool in organizations not all organizations benefit from owning this type of software. Many of the company’s purchasing software do not meet the organizations goals or address core decision-making situations. This is why researching the proper DSS is a key element in the success of the software in the company. This however is not the only element required for DSS to effectively work in an organization. There must be proper knowledge and use of the software on the part of the users. If the user mishandles the software, it will provide the user with an inaccurate decision which will only cause more problems.

DSS has been present in articles and work environments for years, more recently new software has been added on a constant basis. The software was ultimately designed to help employees in all fields gain confidence about their decisions while using the software as a guide.
The software programs can perform tasks that vary from advice to developing diagnosis for illnesses to calculating costs for a project. These software packages can be classified according to the function or activity they engage into. The following is a brief description of each classification, which will be discussed in detail providing all advantages such software offers and how and why it is beneficial to all who use it.

MAIN FOCUS

Holsapple and Whinston (1996) suggested that a DSS can be classified as text-oriented, database-oriented, spreadsheet-oriented, solver-oriented, rule-oriented, and/or compound (or hybrid). Power (2003) classified five categories—model-driven, communication-driven, data-driven, document-driven, and knowledge-driven—and identified three different user levels as passive, active, and cooperative. In terms of support scope, we can see personal, group, and organizational support. Also, it may be either custom-made or ready-made systems. While DSS technology has been growing and has aided many, there are still some shortcomings of the software.

Model-Driven Software

A variety of model-driven software can be found in the market used by private and public sectors in different departments and areas. This kind of software, once called computationally-oriented software, can be adopted by any company that wishes to manipulate statistical, financial, optimization, and/or simulation models in order to combine information from different sources and make effective decisions that will generate higher production and/or profits.

Along the lines of Twery and Hornbeck (2001), NED (NorthEast Decision model) is a group of software products that supports managers develop goals, assess current and future conditions, and produce management plans for forest properties. NED was developed by USDA Forest Service, and its design includes landscape-level view which is difficult to understand in most cases. This software requires the selection of goals in five different categories, each one having a set of variables that allow comparison with each other.

In the private sector, model-driven DSS can be applied in different fields such as: construction, human resources, R&D, accounting and investment, transportation, and so forth. For example, DSS can evaluate and analyze pay increases, hiring, training, and other activities that can cost a lot of money to a company.

CargoProf is a customized package from Manugistics Inc. and considered to be a revenue optimizer. The way CargoProf works is simple and easy to use. Once the cargo booking agent enters all information in Continental’s reservation system, it is forwarded to the CargoProf system which calculates the most efficient and less costly way to transport the merchandise. It will require certain information such as weight, size, and maximum price the customer is willing to pay. Once it has all information available it will check availability in different flights and will accept or reject according to the price provided. Also, this system will consider some other factors such as extra fuel, passenger baggage, seasonal requirements, and so forth. CargoProf has demonstrated to save Continental $9 million over a period of two years (Laudon & Laudon, 2005).

Communications-Driven Software

It allows users to communicate between groups facilitating the sharing of information, supporting collaboration and coordination between them. The simplest types of communications software are boards, bulletins, e-mail, interactive videos, meeting rooms, and so forth. Also, groupware and Web-based tools are part of this type of software and allow groups to discuss and decide the best and most efficient solutions for specific problems.

Communications-driven software can be classified according to time and location; when the software is used at same time or different times (synchronous, asynchronous respectively) and same place or different places (face-to-face, distributed respectively) (Power, 2001).

One of the most popular tools of communications-driven software is electronic meeting systems (EMS). This type of software is popular among executives who spend from 35% to 70% of their time in meetings. Having software that provides deliberation, negotiation, consensus building, decision making, generation of alternatives, problem solving, and planning is undoubtedly one of the most important intangible resources of any company. Two examples of EMS software packages are: The Meeting Room (TMR) and Team Talk (TT) (Grohowski, McGoff, Vogel, Martz, & Nunamaker, 1990).
**Data-Driven Software**

It allows the user to manage the data currently in place without giving up manageability or operational integrity. With the business market changing on a constant and rapid basis, companies need to make sure they are on top of the competition and understand as well as provide the services that the public demands. SAS in particular has been meeting the needs of companies and providing them with top software for the past 30 years. Some of the services that the SAS software provides are: financial intelligence, human capital, and risk management (SAS Institute Inc., 2006).

*Microsoft SQL* focuses on the ability to provide their customers with insight into their business’s main function and to provide them with the ability to make better, more-informed decisions for their company while providing fast and accurate service. *Microsoft SQL* uses extensive reporting that provides real-time information data that assists managers or business leaders to make informed and quick decisions that ultimately enhance their business decisions. These results are obtained in the form of analysis reports and measurements provided by using existing information or data. Report builder was described as the most significant addition to this software previously in place. Some of the services that *Microsoft SQL* 2005 software provides are: data management and analysis solution (Microsoft Corporation, 2006).

**Document-Driven Software**

*ZyIMAGE* is a document-driven software that provides solutions to archive, find, share, and organize documents with ease. Document-driven software allows customers to access huge amounts of documents in more than 300 electronic file formats (ZyLAB, 2004). *ZyIMAGE* is a revolutionary type of software that benefits companies/businesses like hospital, medical, and legal offices which require storage of large amount of documents. *Document management system* as it has been commonly phrased is the solutions to capture and store electronic data. Using this software allows companies to automatically store information without having to scan, fax, or copy (Healthcare Management Association, 2004).

*XpresReview* allows customers to create solutions that permit sharing of documents in a business environment. It allows participants of the same company to review and process information they need in order to communicate effectively commonly referred to as package collaboration file (Gould, 2005). This software allows group work efficiently and effectively, and it avoids delays in the presentation process.

**Knowledge-Driven Software**

It is also called an intelligent DSS, active DSS, and/or an expert-support system. Expertise and skills are clearly valuable when using knowledge-driven software to understand a particular domain and solve a problem. Examples of this software include data mining and intelligence support software (Power, 2003).

Knowledge-driven DSS deals with one’s own general knowledge to aid in the decision-making process. This software is present in many different kinds of medical cases. O’Cathain, Sampson, Munro, Thomas, and Nicholl (2004) mentioned that *NHS Direct* is a 24-hour telephone advice line based in England. This software takes the anonymous callers’ problems, which are entered-in by the nurse on duty, to help determine the appropriate advice for the nurse to give. It uses three kinds of computerized DSS in its work. One includes the use of predetermined questions, another uses guidelines based on a decision tree principle, and a third that prompted questions for the nurse to ask and drew attention to the critical symptoms the patients is describing.

*ISABEL*, developed particularly for general practitioners, is used to help reduce medical errors and misdiagnoses. It was put into effect in 2002, through a charity called “Isabel”, which a man named Jason Maude and his family help set up. Jason Maude’s daughter, Isabel, had contracted a rare bacterial infection when she was suffering from the chicken pox in 1999. The infection had gone undiagnosed, and Isabel suffered disfiguring scarring. The software, *ISABEL*, was a result of Maude’s work, since Jason Maude believes that diagnostic DSS, which aims to reduce misdiagnoses by presenting physicians with a full array of possible conditions, might have all the difference to his daughter (Burton, 2005).

There has been other *clinical decision support software* (CDSS) that has been created for the management of chronic heart failure. It is thought that software such as this can provide the guidelines needed along with advice from experts to aid in solving such a problem. Some features of the CDSS include meeting the needs...
of the user, leading users to their own management decisions, and possessing both qualitative and quantitative methods (Leslie et al., 2006).

*Expert choice* is a multi-criteria DSS tool based on analytical hierarchy process (AHP). After the model is constructed comprising of a goal, the criteria, the sub-criteria, and the alternatives, the evaluation and choice module within *expert choice* assists in the assignment of judgments and preferences through pair-wise comparisons. Also, the theory of the analytic network process (ANP) can handle negative priorities (Saaty & Vargas, 2006).

**Challenges of DSS**

DSS can be a powerful tool to assist any decision-making process, but DSS alone is typically not the answer. The fundamental challenge is to understand the decision context, structuring the decision, eliciting criteria, developing workable performance measures, constructing weights, and to understand uncertainty and incorporate risk (Turban, Aronson, & Liang, 2005). For these reasons, operations research and management science experts recommend that an analyst work with the decision maker or group; and that the client considers developing simple yet rigorous software which is often developed for the specific challenge at hand. This approach is often less expensive as well.

According to Kimball and Streinlo (1995), while decision software programs can help an individual or a group think through a problem, there are many challenges such as:

- Danger of the software driving the process and the decision. All software programs should be considered tools that support to the decision and planning processes and not tools that lead the process.
- Overconfidence in the software and thus losing the focus on the problem structure and key issues.
- Most software does a poor job with multiple decision maker (multi-stakeholder) contexts. Often they overcome this challenge by simply averaging scores.
- Because developing value weights for criteria or objectives is an exercise in “constructing” values rather than “revealing” values, multiple weighting methods should be utilized.
- Committing to one particular software program may cause the focus of the decision and planning process to shift to the particular software technology (understanding it and fitting the process to the software) rather than on the public planning process.
- A commitment to one software package over another may commit the decision process to a particular theoretical approach and method when decisions are not always suitable or clear-cut.
- Different software packages may be more or less appropriate, depending on how the public planning table develops and the critical issues/areas of controversy that arise.
- Any software should be considered as one of many support tools available to the analyst/facilitators of a decision and planning process.

And many other issues remain: manager has insufficient computer training; manager fears reduced status; mismatch with problem-solving style; manager prefers face-to-face; fear of high cost; bad DSS design; information overload, and so forth.

**FUTURE TRENDS**

Continued growth is expected for DSS because the demands of organizations are growing, and many of them are realizing that the need to make decisions based on facts that specifically affect their company’s profit to stay both in compliance and competitive (Stodder, 2006). Not only are software programs very important in the growth of DSS but also the ability of the software makers to meet the needs and demands of their respective consumers.

Undoubtedly there will be an increase in DSS in all industries all around the globe. With emerging technology, software that is present now can be refined to incorporate the changing technology and to add the new and improved ideas of professionals and experts that can make the software even more helpful. Competition will rise between companies, which can result in a plethora of opportunities in all areas already adorned with software for decision making. Training will increase and could possibly become a requirement for certain jobs if DSS continues to grow. Certain software could fail while others thrive, but either way, DSS will show no sign of slowing down anytime in the future.
CONCLUSION

DSS has begun to capture markets, and in the last couple of years, it has taken a front seat for many businesses from small owner-operated to large corporations. Certainly, DSS is one of those innovations that are helping managers to succeed in their daily activities. Since its appearance in the 1960s, DSS has evolved and improved helping decision makers to access different kinds of information, analyze it, and decide which solution is the most efficient and valuable for the company. DSS has been defined as interactive tools that can collect large amounts of data and incorporate them into models for appraisal. Although DSS provides positive outcomes whenever applied, there are some other factors that should be considered before incorporating this type of software into a business; these are price, complexity level, and availability. Decision makers need to assess how this type of software can support the company’s goals and objectives and how it will affect its daily activities. In the future, it is expected that more companies will incorporate DSS because it will become a vital tool required for a company’s growth and success.

REFERENCES


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**KEY TERMS**

**Analytical Hierarchy Process (AHP):** An approach to decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion, and determining an overall ranking of the alternatives.

**Decision Support Software:** An interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions.

**Executive Information Systems (EIS):** Systems that can extract data from an enterprise system to provide managers a view of quantitative performance measures online.

**Group Decision Support Systems (GDSS):** Grouping management together to come up with a decision using a room full of micro-computers and having the group say what they believe is the best way to solve a situation.

**Model:** It’s a conceptual representation of reality that helps creating forecast and simulations. It allows decision makers to convert data into useful information that can be used in specific plans for decision making.

**Model Integration:** Many models are looked over when making decisions, and model integrations help look for a common point between these scenarios.

**Risk Management:** Decisions to accept exposure or to reduce vulnerabilities by either mitigating the risks or applying cost effective controls.

**Sensitivity Analysis:** Models that can be changed easily and provide answers to “what if” questions.

**Solver:** It serves as a connection between the model and the solution or answer by using specific mechanisms that allow reaching a goal.
INTRODUCTION

Over the four decades of its history, decision support systems (DSSs) have moved from a radical movement that changed the way information systems were perceived in business, to a mainstream commercial information technology movement that all organizations engage. This interactive, flexible, and adaptable computer-based information system derives from two main areas of research: the theoretical studies of organizational decision making done at the Carnegie Institute in the 1950’s and early 1960’s as well as the technical work on interactive computer systems which was mainly performed by the Massachusetts Institute of Technology (Keen & Morton, 1978).

DSSs began due to the importance of formalizing a record of ideas, people, systems, and technologies implicated in this sector of applied information technology. But the history of this system is not precise due to the many individuals involved in different stages of DSSs and various industries while claiming to be pioneers of the system (Arnott & Pervan, 2005; Power, 2003). DSSs have become very sophisticated and stylish since these pioneers began their research. Many new systems have expanded the frontiers established by these pioneers yet the core and basis of the system remains the same. Today, DSSs are used in the finance, accounting, marketing, medical, as well as several other fields.

BACKGROUND

The basic ingredients of a DSS can be stated as follows: the data management system, the model management system, the knowledge engine, the user interface, and the users (Donciulescu, Filip, & Filip, 2002). The database is a collection of current or historical data from a number of application groups. Databases can range in size from storing it in a PC that contains corporate data that has been downloaded, to a massive data warehouse that is continuously updated by major organizational transaction processing systems (TPSs). When referring to the model management system, it’s primarily a stand-alone system that uses some type of model to perform “what if” and other kinds of analysis. This model must be easy to use, and therefore the design of such model is based on a strong theory or model combined with a good user interface.

A major component of a DSS is the knowledge engine. To develop an expert system requires input from one or more experts, this is where the knowledge engineers go to work, who can translate the knowledge as described by the expert into a set of rules. A knowledge engineer acts like a system analyst but has special expertise in eliciting information and expertise from other professionals (Lauden & Lauden, 2005).

The user interface is the part of the information system through which the end user interacts with the system—type of hardware and the series of on-screen commands and responses required for a user to work with the system. An information system will be considered a failure if its design is not compatible with the structure, culture, and goals of the organization. Research must be conducted to design a close organizational fit, to create comfort and reliability between the system and user. In a DSS, the user is as much a part of the system as the hardware and software. The user can also take many roles such as decision maker, intermediary, maintainer, operator, and feeder. A DSS may be the best one in its industry but it still requires a user to make the final decision.

Power (2003) introduced a conceptual level of DSSs, which contains five different categories. These categories include model-driven DSS, communication-driven DSS, data-driven DSS, document-driven DSS, and knowledge-driven DSS. Defining DSS is not always an easy task due to the many definitions avail-
able. Much of this problem is attributed to the different ways a DSS can be classified. At the user level, a DSS can be classified as passive, active, or cooperative.

Essentially, DSS is a computer-based system that provides help in the decision-making process. However, this is a broad way of defining the subject. A better way of describing DSS is to say it is a flexible and interactive computer-based system that is developed for solving non-structured management problems. Basically, the system uses information inputted from the decision maker (data and parameters) to produce an output from the model that ultimately assists the decision maker in analyzing a situation. In the following sections, we first discuss design and analysis methods/techniques/issues related to DSSs. Then, the three possible ways to enhance DSSs will be explored.

**DESIGN AND ANALYSIS METHODS/TECHNIQUES/ISSUES RELATED TO DSSS**

**Design Methods**

Today, DSSs hold a primary position in an organization’s decision making by providing timely and relevant information to decision makers. It has become a key to the success or survival of many organizations. However, there is a high tally of failure in information systems development projects, even though they are a focal point of industrial concern (Goepp, Kiefer, & Geiskopf, 2006). Designing methods have become an important component that assures a successful information system design. This issue is in relevance to the design of a DSS.

There have been many different strategies employed for the design of a DSS. Current research on DSS design has witnessed the rapid expanding of object-oriented (OO), knowledge management (KM), structured modeling (SM), and design science (DS) approaches.

**Object-Oriented Approach**

The characteristic of OO approach is to use object-oriented software engineering with unified modeling language (UML) in the design and implementation of a DSS. OO approach involves basically three major steps (Tian, Ma, Liang, Kwok, & Liu, 2005). The user’s requirements are first captured by using a set of use case diagrams. These diagrams indicate all the functionalities of the system from the user’s point of view. Then classes and their relationships are identified and described in class diagrams. Finally, sequence diagrams or collaboration diagrams are developed, which describe the interaction between objects (instances of classes). Tian et al. (2005) designed a DSS with the OO approach for an organization, which was implemented successfully.

**Knowledge Management Approach**

In some environment (non-preprogrammed applications), end users, especially the less experienced end users, need to have certain knowledge guiding them how to use the system. The KM design approach supports end users by embedding declarative and/or procedural knowledge in software agents. This approach provides better assistance to inexperienced users of spatial DSS, which requires a design approach that will prioritize knowledge support of the end users’ decision-making activities (West & Hess, 2002).

**Structured Modeling Approach**

SM approach “uses a hierarchically organized, partitioned, and attributed acyclic graph to represent models” (Srinivasan & Sundaram, 2000, p. 598). It consists of three levels: elemental structure, generic structure, and modular structure. The elemental structure intends to capture the details of a specific model instance. The generic structure targets at capturing the natural familial groupings of elements. The modular structure seeks to organize generic structure hierarchically according to commonality or semantic relatedness. The leveled structures allow the complexity of a model to be managed and ranked according to its hierarchies. The graph feature allows modelers and decision makers to understand the model better. A key advantage of SM is the ease with which structured models can be visualized (Srinivasan & Sundaram, 2000).

**Design Science Approach**

The functionality of a DSS evolves over a series of development cycles where both the end users and the systems analyst are active contributors to the shape, nature, and logic of the system (Arnott, 2004). Yet system developers have little guidance about how
to proceed with evolutionary DSS development. DSS developers are facing the fact that insufficient knowledge exists for design purpose, and designers must rely on intuition, experience, and trial-and-error methods. Design science approach, on the other hand, can facilitate developers to create and evaluate information technology artifacts that are intended to solve identified organizational problems (Hevner, March, Park, & Ram, 2004). Vaishnavi and Kuechler (as in Arnott, 2006) proposed a design science methodology with the major process steps of awareness of problem, suggestion, development, evaluation, and conclusion. Arnott (2006) proposed a five steps approach, which was adapted from Vaishnavi and Kuechler, for designing evolutionary DSS: problem recognition, suggestion, artifact development, evaluation, and reflection. A research project by Arnott indicates that design science approach can tackle problems of both theoretical and practical importance.

**Design Techniques**

As we are advancing in information technologies, business decision makers can now have access to a vast amount of information. On one hand, they may gain necessary and important information for making informed decisions, but, on the other hand, they may also become overloaded by the information irrelevant to what they need. Thus, there is a pressing need for decision-aiding tools that would effectively process, filter, and deliver the right information to the decision makers. Proper combination of DSSs and agent technologies could prove to be a very powerful tool for rendering decision support (Vahidov & Fazlollahi, 2003/2004).

A software agent performs interactive tasks between the user and the system. The user instructs the system what he/she intends to accomplish. The software agent carries out the task. By analogy, a software agent mimics the role of an intelligent, dedicated, and competent personal assistant in completing the user’s tasks (Bui & Lee, 1999). In the DSS environment, software agents have been more formally described as autonomous software implementations of a task or goal that work independently, on behalf of the user or another agent (Hess, Rees, & Rakes, 2000). As the traditional, direct manipulation interface of our computing environment is much limited (Maes, 1994), software agents would seem to be a suitable and most needed solution for providing procedural assistance to end users (West & Hess, 2002). “These ‘robots of cyberspace’ can be effectively utilized in automating many information processing tasks” (Vahidov & Fazlollahi, 2003/2004).

In some DSS environment, such as spatial DSS (Sikder & Gangopadhyay, 2002; West & Hess, 2002), Internet-based DSS (Bui & Lee, 1999), and Web DSS (Vahidov & Fazlollahi, 2003/2004), a multi-agent system should be designed and implemented in the DSS to facilitate the decision makers since decision making involves a complex set of tasks that requires integration of supporting agents (Bui & Lee, 1999), and these agents should have behaviors to work in teams (Norman & Long, 1994). Vahidov and Fazlollahi (2003/2004) developed architecture of multi-agent DSS for e-commerce (MADEC), in which the intelligence team (agents), design team (agents), and choice team (agents) were composed. The multi-agent system was implemented in a prototype of MADEC, which received higher user satisfaction.

**THREE POSSIBLE WAYS TO ENHANCE DSSS**

**Creating Knowledge Warehouses (KW)**

Nemati, Steiger, Iyer, and Herschel (2002) proposed that a new generation of knowledge-enabled systems provides the infrastructure required to capture, enhance, store, organize, leverage, analyze, and disseminate not only data and information but also knowledge. Expanding data warehouses to encompass the knowledge needed in the decision-making process is the creation of knowledge warehouses (KW). An important component of KW is a very complex process known as knowledge management. Knowledge management allows for knowledge to be converted from tacit to explicit through such processes as filtering, storing, retrieving, and so forth, thus allowing it to be utilized by decision makers.

The goal of KW is to give the decision maker an intelligent analysis standpoint that enhances all aspects of the knowledge management process. The main drawbacks of KW are the amount of time and money that need to be invested as well as some of the same problems that are found in successfully implementing DSSs. Among these factors are the users’ involvement and participation, values and ethics, organization and...
political issues within the company, and other external issues. The development and implementation of KW still has much work to be done, however, DSSs seem to be headed toward knowledge enhancement in the future, and KW looks to have a promising outlook in the upcoming years as a result.

**Focusing on Decision Support**

While knowledge management systems seem like a logical way to advance the shortcomings of DSSs, another view also exists. By removing the word “system” from DSSs and focusing on decision support, decision making might cause some interesting, new directions for research and practice. Decision support (DS) is the use of any plausible computerized or non-computerized means for improving sense making and/or decision making in a particular repetitive or non-repetitive business situation in a particular organization (Alter, 2004).

DS embodies a broader perspective that seems logical in environments where the user does not necessarily need the technical aspects of DSSs. This is based on the belief that most work systems of any significance include some form of computerized support for sense making and decision making (Alter, 2004). The difference between DSSs and DS is not too drastic but DS is a sensible option for many companies due to the increase in technology since the creation of DSSs; DSSs may not fit the needs of a business as it had in the past.

**Integrating DSSs and KMSs**

In line with Bolloju, Khalifa, and Turban (2002), integrating decision support and knowledge management may correct some of the deficiencies of DSSs. The decision-making process itself results in improved understanding of the problem and the process, and generates new knowledge. In other words, the decision-making and knowledge creation processes are interdependent. By integrating the two processes, the potential benefits that can be reaped make the concept seem more worthwhile.

Integrating DSSs and KMSs seems to be the best choice out of the three possible ways to enhance DSS. The reasoning behind this selection is that integrating the two seems to provide a way for including both options without sacrificing one for the other. More importantly, while KW appears to have a very bright future, KW currently requires a great amount of time and money. The combination of both areas allows for a better overall utilization in the present. In time, KW may not be as time consuming and costly as it is now. However, to achieve a better balance of usefulness and efficiency, the integration of DSSs and KMSs appears to be the smartest choice.

**FUTURE TRENDS**

The future of DSSs, Angus (2003) argued and supported by SAS, Inc. (2004), is in the field of business analytics (BAs). BAs differ from that of the recently and previously more common business intelligence (BI). With the fast pace of business and life today it would only make sense for a shift to BA because it does focus on the many possibilities and the future outcomes for production and service.

BAs focus on the future of operations. Opposed to that of BI where it focuses on the past and what can be done to change the past if things were done wrong or repeat if things were done right. However, BAs let managers center on what future trends are developing, which allows them not to accumulate a surplus of inventory of outdated products. It also enables managers to change their prices before the market does, or introduce their new product before anyone else gets the chance to. This is known as first-to-market (Gnatovich, 2006). BAs give the companies that use it a tremendous advantage over their competitors in the marketplace.

**CONCLUSION**

Since their creation in the early 1960’s, DSSs have evolved over the past four decades and continues to do so today. Although DSSs have grown substantially since its inception, improvements still need to be made. New technology has emerged and will continue to do so and, consequently, DSSs need to keep pace with it. Also, knowledge needs to play a bigger role in the form of decision making.

Shim, Warkentin, Courtney, Power, Sharda, & Carlson (2002) emphasized that DSSs researchers and developers should: (1) identify areas where tools are needed to transform uncertain and incomplete data, along with qualitative insights, into useful knowledge;
(2) be more prescriptive about effective decision making by using intelligent systems and methods; (3) exploit advancing software tools to improve the productivity of working and decision-making time; and (4) assist and guide DSS practitioners in improving their core knowledge of effective decision support.

The prior statement sums up the courses of action that need to be taken. The successful integration of DSSs and KMSs could revolutionize DSSs and propel it to even greater heights in the future. In closing, DSSs have a storied history which spans the course of four decades; however, the greatest mark may be made in the not so distant future as DSSs continue to evolve.

REFERENCES


**KEY TERMS**

**Business Analytics (BA):** A technological system that collects and evaluates all relevant data then scrutinizes it and puts it into different simulations to find out which one is the most appropriate.

**Business Intelligence (BI):** A system of technologies for collecting, reviewing, and hoarding data to assist in the decision-making process.

**Decision Support Systems (DSSs):** An interactive, flexible, and adaptable computer-based information system, especially developed for supporting the solution of a non-structured management problem for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision maker’s own insights.

**Interface (or User Interface):** A component designed to allow the user to access internal component of a system, also known as the dialogue component of a DSS.

**Knowledge Management:** The distribution, access, and retrieval of unstructured information about human experiences between interdependent individuals or among members of a workgroup.

**Sensitivity Analysis:** Running a decision model several times with different inputs so a modeler can analyze the alternative results.

**Software Agent:** A program that performs a specific task on behalf of a user, independently or with little guidance (Bui & Lee, 1999).

**Structured Modeling:** A generic design strategy for representing complex objects that are encountered in modeling applications (Srinivasan & Sundaram, 2000).

**Transaction Processing System (TPS):** Computerized systems that perform and record the daily routine transactions necessary to conduct the business; they serve the organization’s operational level.

**Use Case:** A collection of possible sequences of interactions between the system under discussion and its users relating to a particular goal (Tian et al., 2005).
Decision Trees

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INTRODUCTION

Decision trees are part of the decision theory and are excellent tools in the decision-making process. Majority of decision tree learning methods were developed within the last 30 years by scholars like Quinlan, Mitchell, and Breiman, just to name a few (Ozgulbas & Koyuncugil, 2006). There are a number of methods and sophisticated software used to graphically present decision trees. Decision trees have a great number of benefits and are widely used in many business functions as well as different industries. However there are also disagreements and various concerns as to how useful decision trees really are. As technology evolves so do decision trees. Therefore not only do many controversies arise but also solutions and new proposals to these arguments.

BACKGROUND

Decision trees date back to the early 1960’s, and were originated by C. I. Hovland and E. B. Hunt (Fu, 2000). Their book which was published in 1961 entitled, Programming a Model of Human Concept Formation, was the earliest published discussion of a concept learning program (CLP). The topic of CLP was further expanded in the book titled, Experiment in Induction, of 1966 which was written by E. B. Hunt, J. Marin, and P. J. Stone. This publication is considered a starting point to Ross Quinlan’s work, whose contribution to the decision tree theory is mainly credited to his ID3 and C4.5/5.0 algorithms in the tree-based methods (Fu, 2000).

Decision trees are a useful technique for classification. Its core concept is based on the graph of decisions that presents possible consequences, with corresponding resource costs and risks, leading to the final conclusions. The main purpose of the decision tree is to make the decision-making process clearer and more understandable. They are also constructed to ease prediction about possible outcomes and alternatives of a specific situation. A set of “if-then” conditions allows the establishing of a final outcome.

Decision trees deal only with predictive values and consist of “square decision nodes, circle probability nodes, and branches representing decision alternatives” (Taylor, 2004, p. 490). The process of constructing a tree involves computation of an expected value of each outcome and makes a decision based on these expected values. Such decision trees can be drawn simply on a piece of paper or go as far as to use sophisticated software in order to present more complex trees.

MAIN FOCUS

Advantages, Problems with DTs, and Proposed Solutions

No matter which method is used, decision trees share many advantages. They provide an illustration of the decision-making process, and therefore are simple to understand and interpret. They require little data preparation and apply to both nominal and categorical values. Thanks to statistical test and formulas, decision trees are reliable. They also perform well with large data in a short time. Decision tree learning can be applied in many different business functions like finance, marketing, or management and many others. It is also very useful across various industries. It has ascribed a particular importance in data mining. Algorithms like Chi-Square Automatic Interaction Detector, CHAID Decision Tree Algorithms, or CART are considered a specifically useful tool in data mining. Cambridge Business Review states that “from a business perspective decision trees can be viewed as creating a segmenta-
tion of the original dataset: each segment would be one of the leaves of the tree (Ozgulbas & Koyuncugil, 2006, p. 316).

While all of the advantages may make decision trees seem perfect, they are not. Currently, a few problems exist with the decision trees modern formation. One current problem exists in some large decisions that require many calculations which lead to inefficiencies. The calculation problem can easily be shown by a simple example. Zebda (2006) observed that a problem with two decisions, ten states of nature, and one-level signal would require 699 operations using the traditional decision trees approach. The same problem with two-level signal would require 7,399 operations to solve the problem using the traditional decision tree approach. This problem has led to researchers suggesting alternatives instead of decision trees to solve problems. Some researchers do not feel that the alternatives would work better than decision trees. These researchers feel that decision trees perform better in decision making and suggest a new modified decision tree method.

The newly modified decision tree will alleviate the current calculation problem. The modified decision trees can decrease calculations needed by the traditional decision tree method by more than 75% in some examples. The modified decision trees can be used in the same situations as traditional decision trees. It can be used for single level and multi-level trees and symmetrical and non-symmetrical decision-making problems. Even with fewer calculations, the modified decision tree will still maintain the advantages of the traditional trees and make them more efficient than the current state of traditional decision trees. The modified decision tree helps fix the problem with excessive calculations and keeps the advantages of the traditional decision tree. It becomes more efficient, requires less work, and counters the claim of some researchers’ problems with traditional decision trees (Zebda, 2006).

Also, there is the issue of “overfitting” rules with few data, limiting the predictive power of decision trees for previously unseen data (Quinlan, 1993). Another problem encountered in most trees is that they are axis-parallel, making them convenient to analyze but they may result in intricate and inaccurate trees if the “data can be partitioned by hyper-planes that are not axis-parallel” (Cantu-Paz & Kamath, 2003, p. 56). Cantu-Paz and Kamath (2003) evoked a revolutionary concept of oblique trees designed to reduce the flaws of the ordinary trees. Then, again, the data became more complex to analyze, requiring a pundit in the field for interpretation.

**RECENT DEVELOPMENT IN DECISION TREE THEORY**

**Genetic Algorithm Trees (GA Trees)**

The originality of a genetic algorithm, compared to other algorithms used in decision-tree building, is its reliance in addition to the variance of the tree’s accuracy, on the expected value of the classification, and a probabilistic method of measuring the performance of the tree (Fu, Golden, Lele, Raghavan, & Wasil, 2003). Also, genetic algorithms fundamentally emulate the natural Darwinian theory of “survival of the fittest”, based on a roulette wheel selection, involving a series of mutations and crossovers with the goal to yield the best trees (Michalewicz, 1996). An experiment conducted on 40 test subsets, repeated 10 times, by Fu (2006) and his colleagues revealed an average accuracy of 78.71% for a GA tree. The main advantage of using GA trees is that large, complex analytical problems can be reformulated in a manner that is computationally more efficient than the original problem. Further, their coding aspect inherently takes care of most of the constraints associated with the scheduling problem. Results from a number of test problems demonstrate that genetic algorithms are able to find optimal schedules with a reasonable computational resource (Fu, Golden, Lele, Raghavan, & Wasil, 2003).

**Orthogonal Decision Trees (ODTs)**

Orthogonal decision trees, as the name implies, are a set of functionally orthogonal decision trees corresponding to the principal components of the underlying function space (Kargupta & Dutta, 2004). Their major advantage is that they offer an effective way to construct redundancy-free ensembles that are easier to understand and apply. Also, they allow the monitoring of data streams from resource-constrained platforms such as PDAs, pocket PCs, and cell-phones where CPU computing power is limited. A special method called “Fourier Spectra” is used to remove redundancies, yielding an
efficient representation of an ensemble, often needed for fast feedback in complex environments such as a battlefield or emergency-response personnel (Kargupta & Dutta, 2004, p. 428) calls. In other words, ODTs represent an effort to miniaturize decision trees without reducing their accuracy. As a metaphor, they could be compared to today’s higher-computing-power laptops as opposed to super computers of the sixties. However, their efficiency is still limited and much work still needs to be done, given that they under perform when the range of data is unreasonably humongous.

Hybrid Decision Trees

Decision trees and neural networks are two powerful tools used in the decision-making process. There has been some research that tries to combine the power of both tools. Some research was done because of a lack of reliable methods to determine the size of feed-forward neural networks. The methods derived from this research use decision trees to assist with the neural networks. Some other research was done because of the lack of a method to determine the splits or tests of decision trees. This method used neural networks to help with decision trees. A new method called hybrid decision tree (HDT) virtually embeds feed-forward neural networks into binary decision tree leaves. The HDT has unique ways of tree growing, neural processing, incremental learning, and constructive induction. This helps it generate accurate and compact decision trees that can handle new data input (Zhou & Chen, 2002).

The HDT also possesses the ability of incremental learning. It is important for two reasons. It is very difficult to collect all the training examples for the system before the system will be used. Also, it is usually cheaper to modify a system than to create a brand new one. These reasons are why it is important to have incremental learning in the HDT method. To test the new HDT method, the researchers compared it to C4.5, BP, and FANNC. HDT ranked first 11 times and last zero. The other three methods did not match HDT 11 times. HDT was also the only method never to rank last in the test. The only problem is with training time cost and that is because the HDT has not been optimized yet. The HDT method is a new way to help with decision tree creation and combines the power of both decision trees and neural networks (Zhou & Chen, 2002).

DECISION TREES IN DATA MINING

Recent publications discussing decision trees devote much attention to the usefulness of decision trees in data mining. Among the most popular ones are applications of Classification and Regression Trees (CART) and Chi-squared Automatic Interaction Detection (CHAID) algorithms. The first one is used to construct binary decision trees in order to solve classification and regression problems. CART has been introduced by Breiman, who discussed this topic in his book co-written with J. Friedman, R. A. Olshen, and C. J. Stone, Classification and Regression Trees, which was published in 1984 (Fu, Golden, Lele, Raghavan, & Wasil, 2003). CART has a number of advantages over the alternative techniques of decision trees. One of them is simplicity of results, which allows for rapid classifications of new observations. It permits the evaluation of only a few logical conditions rather than running calculations and equations on all possible alternatives.

Despite the benefits, CART also has its downsides. A major issue is complexity of general theory and specific computational solutions which determines the best split to construct simple and useful trees. Concern when to stop splitting while applying classification and regression trees is discussed under the topic of over-learning or over-fitting. In order to avoid unnecessary splits, a few techniques are being used. One solution is to stop generating new split nodes, when following splits do not have an improving impact on the prediction. To avoid over-fitting, other methods like pruning, cross-validation, and v-fold cross-validation are also used.

The second most popular tree-building algorithm known under the acronym CHAID was introduced by Vera Kaas (1980), a famous German physician. The “Chi-squared” part of the name arises because the technique essentially involves automatically constructing many cross-tabs, and working out statistical significance of the proportions (Hoare, 2004). The Business Review considers this method as one of the “most efficient and up-to-date data mining methods” (Ozgulbas & Koyuncugil, 2006, p. 314). Theoretically, CHAID is composed of three essential steps. First, statistically similar values to the variable studied are put together, and heterogeneous values are kept aside. Then, the best predictor variable is chosen to constitute the branch of the tree, each node being formed by homogeneous values of the
variable. Finally the process is iterated until a complete tree is edified. Categorical variables are studied using a series of Chi-square tests, while continuous ones are dissected through an F test, to optimize accuracy. An obvious advantage is the fact that both the predictor and dependent variable can either be categorical or continuous. Categorical variables can be nominal or ordinal, allowing ranking of the values.

APPLICATIONS

Decision trees are used in many different business functions and various industries. They can be used for different reasons such as data description, to classify objects and in regression cases. They are used in business functions like finance, management, and marketing, and industries like travel, healthcare, and psychiatry. According to BaseGroup Labs (2006), a consultant firm that offers distribution of decision tree software, banking and molecular biology are among many that use decision trees in the decision-making process. Decision trees algorithms have also been applied in chemical detection and finding genes and DNA (Fu, Golden, Lele, Raghavan, & Wasil, 2003).

Use of Decision Trees in Risk Management

Let’s consider a company faced with the problem of replacing its obsolete technology. Hullet and Hillson (2006) recommended specific steps to build an optimal decision tree. First, the manager should choose which technological choice to adopt among available ones. Should the company develop its own system or should it buy existing ones? If the manager chooses to buy, then considering all the major and minor problems inherent to its use, he should devise alternative solutions to fix them. Then, considering the likelihood and cost of each possibility at each node, final path values are computed with their probabilities at the end of the tree. Only after this process can the manager make an optimal decision. Other factors not included in the tree, such as the decision to develop its own system through research and development, which might lead to revenue-generating licenses, must also be evaluated in the decision making. In the contacting industry, Hullet and Hillson identified an issue of lateness causing penalties fees to many contracting firms. Using the same steps as previously mentioned, it would be recommended to first identify the contractor as well as their level of risks of being late, before making a decision.

Use of Decision Trees in Supply Risk Management

Decision trees are a useful method to answer a crucial question for manufacturers and material/purchase managers of determining an optimal number of suppliers considering risks. Berger, Gerstenfeld, and Zeng (2004) try to answer this question using a decision tree approach. They analyze certain events and its probabilities that may affect single and/or multiple suppliers to arrive to the conclusion. As the article points out, decision tree approach is especially important in supply risk management because despite extensive literature in this topic only “few quantitative models have been proposed that can be used to aid decision making” (p. 10). Decision trees therefore play a crucial role because through usage of various criteria, they determine the optimum number of suppliers in the presence of uncertainty.

FUTURE TRENDS

Thanks to the developments of new software which is especially helpful in complex cases, decision tree usage will greatly increase in many different industries. Benefits like clarity and ease of interpretation will have a positive influence on the increase of decision tree applications. We forecast that improved decision tree algorithms or emergence of new ones will allow using decision trees in areas that are not explored at this time. Many trees have evolved to compensate for some shortcomings of their predecessors, but in turn, have developed internal failures for diverse reasons. Ultimately, in the future, the ideal tree will be one that can handle tons of data without losing its accuracy. At the same time, it should be able to summarize vast amounts of information in user-friendly fashion to facilitate decision makers’ interpretations.

CONCLUSION

Decision tree theory originated in 1960’s, and as our discussion shows, its future seems promising. The range
Decision Trees

of application of decision trees to real-life situations is tremendous. It has many advantages like clarity and simplicity. Major issues that decision trees are known for comes down to determining when to stop splitting. But problems like these and others in our view will only trigger future research toward improvement. With new technology and knowledge of scholars like Ross Quinlan who devoted over 20 years to decision tree algorithms, the future of decision trees and its potential set the stage for further exploration.

REFERENCES


KEY TERMS

Algorithm: A step-by-step problem-solving procedure, especially an established, recursive computational
procedure for solving a problem in a finite number of steps.

**Classification:** Synonymous with what is commonly known in machine learning as clustering.

**Data Mining:** Process of automatically searching large volumes of data for patterns.

**Decision Tree:** A diagram consisting of square decision nodes, circle probability nodes, and branches representing decision alternatives.

**Deductive Reasoning:** Reasoning in which the conclusion is necessitated by previously known facts—the premises: if the premises are true, the conclusion must be true.

**Inductive Logic:** Process of reasoning in which the premises of an argument support the conclusion but do not ensure it.

**Machine Learning:** Development of algorithms and techniques that allow computers to “learn”.

**Overfitting:** Fitting a statistical model that has too many parameters.

**Pruning:** Term in mathematics and informatics which describes a method of simplification of a decision tree.
INTRODUCTION

As an effective visual communication tool, desktop publishing is used in every area such as general publications and graphics, multichapter documents, and publications with tabular materials such as technical and statistical publications (Chagnan, n.d.). General publications and advertising graphics like newsletters, magazines, brochures, small booklets, posters, and flyers are created and distributed every day. Classroom teachers in K-12 usually send flyers, newsletters, and/or posters to students and parents to announce classroom news, activities, field trip instructions, and the like. College and universities use brochures and flyers to recruit students and to advertise new courses. Additionally, more and more instructional materials are created with desktop publishing programs in classrooms.

Skill level for desktop publishing can range from what could be learned in a few hours to what requires a college education and years of experience. Therefore, creating a desktop publishing product varies a great deal from taking a couple hours to several days to complete. People who are familiar with Microsoft Word can easily create a fancy project by integrating clipart or graphics with the text-based materials. Professional designers or people with design backgrounds can create a professional looking project with more complicated and sophisticated software. This article will briefly review the background of desktop publishing, the software that can be used, and appropriate design principles that should be adhered to when developing publications. The author will also discuss teaching strategies used in a desktop publishing class that involved students creating and designing desktop publication materials using Adobe InDesign.

BACKGROUND

Desktop publishing began in 1985 when the first page-layout software, Page Maker, was released. The ability to create “what you see is what you get” (WYSIWYG) page layout on the screen along with the print capability of 300 dpi (dots per inch) resolution was revolutionary for both the typesetting industry as well as personal computer industry. However, PageMaker had many limitations and its interface was not user friendly. With the introduction of QuarkXpress, a more powerful page-layout software in 1987, and an increasing number of digital typefaces, desktop publishing became mature in the publication realm. QuarkXPress held its dominancy in the publishing world from 1990s to early 2000s because of its various functions that professional designers needed. QuarkXPress added new features each time a new version was released. However, QuarkXPress is not for inexperienced users due to its complicated interface and the steep learning curve. In addition, the software is very expensive. Therefore, people regard QuarkXPress as a desktop publication tool only for the “talented” professional designers.

The first version of Adobe InDesign was released in 1999 and immediately attracted many users because it provided almost every feature appeared in QuarkXPress but much easier to use and a couple hundred dollars cheaper than QuarkXPress. More and more inexperienced users can create professional design in InDesign with little training. InDesign began gaining popularity in desktop publishing since then and overtook the dominant position from QuarkXPress in recent years because of its powerful typographic controls and integration with other Adobe publishing products such as Photoshop, Illustrator, and Acrobat in the Creative Suite. In addition, InDesign has other unique features such as Story Editor to make editing text easier; a Separation Preview palette which lets designer actually see color separations on screen before printing; nested styles for automatically applying character styles to a drop cap; headings automatically appear at the top of each column; the ability to export PDF format or save a page as a JPEG image without buying third-party tools (Blatner, 2003). With InDesign CS3 (version 5.0), announced in March 2007, InDesign becomes more powerful and user friendly.
Desktop Publishing in Education

Desktop publishing refers to the creation of digital files for desktop or commercial printing such as newsletters, brochures, posters, flyers, name cards, and other projects that use page layout software. Graphic designers and nondesigners use desktop publishing software such as QuarkXPress, Adobe InDesign, Microsoft Publisher, or Apple Pages to create print projects for business and for pleasure and to create visual communications for professional or desktop printing. Desktop publishing software helps designers to set up the document page layout, place text and graphics accordingly, choose fonts and colors, and prepare digital files that will print properly by using desktop or commercial printing processes. Most desktop publishing software has drawing tools so that users can draw simple graphics in the document. However, complicated and fancy graphic design should be done in a specific graphic design application. Therefore, desktop publishing software is also called a page layout program.

According to Bear (n.d.), desktop publishing is often used interchangeably with graphic design. However, desktop publishing is often considered an easier activity than graphic design because graphics used in publication documents are often created in other applications so the designer does not have to spend a lot of time in designing them in desktop publishing applications. According to Bear (n.d.), not everyone who creates desktop publishing does graphic design. In contrast, most graphic designers are involved in desktop publishing. Desktop publishing is the production side of design. One has to be trained to be a designer, but can create a desktop publishing project with little training.

Best Desktop Publishing Software

Two page layout applications are dominant the professional desktop publishing market: QuarkXPress and Adobe InDesign. Both are powerful desktop publishing tools and each has its own advantages and disadvantages as described above.

Having taught Desktop Publishing for four years, the author prefers Adobe InDesign to QuarkXPress and other similar software because InDesign is relatively easy to learn and less expensive to own. Although Blatner (2003) had been using QuarkXPress over 10 years, he immediately switched to InDesign CS after comparing QuarkXPress 6 and InDesign CS because he found that InDesign was the real page-layout program he needed. Chagnon (n.d.) also mentioned that InDesign is not as difficult to learn as QuarkXPress because the interface of InDesign is clear and logical. Users who have experience with other layout programs can make the transition to InDesign easily.

InDesign has movable dockable tabbed palettes giving users quick access to most formatting commands that helps minimize visual clutter on smaller computer monitors. The program has the ability to quickly and easily manipulate text and graphics on the screen to try out new ideas. InDesign has the function of transparency and inserting drop shadows on photos, graphics, and texts. The ability of conduct clip paths, techniques used to mask the background of a graphic, clearly places InDesign ahead of QuarkXPress, which does not have this feature (Chagnon, n.d.).

Design Principles

The way that items are placed on the page determines the structure of the design and may affect the overall readability. Placement also determines how well the design communicates the desired message. Therefore, learning and implementing some rules or principles of design that govern the placement and structure of layout is important. Robin Williams (2004), in her book: The Non-Designer’s Design Book, provided four basic design principles for those who have no experience or formal training in design to adopt. The principles include: contrast, repetition, alignment, and proximity.

**Contrast** means to make different items on the page very different. For instance, altering the type, color, size, shape, line thickness, and space on the page can give the layout different contrasts. According to Williams, contrast is what makes a reader look at the page in the first place. Therefore, contrast is the most important visual attraction on a page.

**Repetition** helps keep the design consistent and strengthens the unity by reusing elements or using similar elements. Designers usually repeat colors, shapes, textures, fonts, size, graphic concepts, and so on, to maintain consistency of the page layout.

**Alignment** refers to the visual relationships between items on a page. Alignment is achieved by lining elements up along an edge or imaginary path (Lohr, 2003). Components cannot be arbitrarily placed on the page. Instead, every element should have some visual connec-
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Alignment with another element on the same page. Alignment creates a clean, sophisticated, and fresh look.

**Proximity**, in contrast with alignment, refers to the physical relationship between elements on a page, that is, moving related items close together or unrelated items far apart. Proximity helps to organize information, reduce clutter, and give the page a clear structure.

In addition to these four design principles, Williams also provided three relationships between different typefaces. They are concord, conflict, and contrast. According to Williams (2004), type or typography is the basic building block of any printed page and most designers tend to use more than one typeface on a page to make the design visually appealing and attractive. Concord is a solid and useful concept and easy to create. A concordant relationship occurs when one type family without much variety in style, size, and weight is used. Designers use concordant relationships in a wedding invitation or other pages that need to be calm and formal. Conflict is what designers should avoid. Conflicting relationship occurs when typefaces that are similar in style, size, and weight are combined. Contrast is one of the most effective, simplest, and satisfying ways to design with type. A contrasting relationship occurs when the designer combines separate typefaces and elements that are clearly distinct from each other. Contrast increases visually appealing and exciting elements on a page to stand out. Williams’ (2004) book is a very practical and valuable book for nondesigners because it is easy to read and understand with many examples and tips.

**Strategies in Teaching Desktop Publishing**

In the fall of 2004, the author began teaching graduate and undergraduate students a desktop publishing course. This course was designed to prepare the student to utilize skill development opportunities in desktop publishing while learning proper techniques in concept, layout, and composition as well as final printing techniques in the production of quality publications using desktop publishing software InDesign CS. Students experimented with many practical projects to illustrate their understanding and mastery of design principles and visual literacy theory. They learned to critique their peers’ work and other instructional media by using the design principles, the visual literacy theory, and aesthetic judgments.

Upon completion of this course, students would be able to:

- Describe the components of desktop publishing and the types of publications that can be created with desktop publishing.
- Understand the principles, equipment, and skills used in the publishing process.
- Use basic design principles in the desktop published documents.
- Learn to choose the tools of desktop publishing wisely and to utilize the tools effectively.
- Take a publication from initial concept through composition, layout, and final printing.
- Design and create a variety of publication such as direct mail letters, catalogs, booklets, brochures, print ads, business forms, reports, and newsletters.
- Demonstrate knowledge, skills, and understanding of concepts related to technology.
- Demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies.
- Identify and apply instructional design principles associated with the development of technology resources.

In order for students to achieve the above objectives, the author used the following strategies to ensure that students mastered the technology skill in using the software and applying the design principles:

1. **In-class practice exercises**: Students learned technology skills through completing the in-class exercises by following teacher’s instruction that involved half-done designs such as newsletter/poster/flyer/book cover. Upon finishing these exercises, students not only learned the skills, but also applied the design principles to authentic projects.

2. **Creative projects**: Students were asked to design five creative projects: resume, flyer, CD-ROM case cover, brochure, and newsletter by applying the principles such as contrast, repetition, alignment, and proximity. They could: (a) organize the page using grids, columns, gutters, and margins, (b) choose appropriate typefaces, (c) apply appropriate type styles, type sizes, alignment, kerning, tracking, leading paragraph spacing, tabs,
and indents, and (d) use appropriate graphics. If graphics were used for any of the projects, they needed to provide information concerning the sources of the graphics (e.g., URLs). Students also needed to state if the graphic materials were copyrighted and why they had the right to use them. All creative projects had to be submitted both in print and in electronic format.

3. **Peer critique:** Each time the students submitted their projects, they had to view each others’ products which were posted on the classroom wall and had to critique them according to the design principles they learned. They had to provide comments for each project they viewed so that their peers would be able to revise their project accordingly. Students benefited a lot from this activity. As one student stated in her reflection, “The peer critiques on all the projects were very helpful. I feel that critiques helped me to understand another’s opinions and see the project from their perspective. On-the-other-hand, the projects that I critiqued helped me learn from studying a peer’s work. I benefited from the exercises and the peer critiques.”

5. **Project revision:** After peer critique, the projects would be returned to students with peers’ and instructor’s comments on the project. Students had to review the comments and decide whether they agreed with the comments or not. If they agreed with the comments, they would revise their projects accordingly. If not, they had to explain why in writing. Students had to submit their projects after revision along with their written reflections, in which they had to indicate what comments they received, what they did accordingly, and why. In most cases, students revised their projects more than twice. All students admitted that this process helped them really learn the concepts taught.

6. **Reflection:** The final project was to create an electronic portfolio using InDesign and to export the portfolio to Adobe PDF format. Students had to document their achievements by collecting different versions of their creative projects, providing reflections on the revisions, and giving a reflection on their entire learning process. They were asked to demonstrate what they had learned in this class, illustrate their strong and weak points in knowledge and skills, and state their future learning goals.

After four years of classroom teaching, the author realized that viewing examples of professional products help students learn and master design principles. Williams (2004) is right in saying that professional designers are always “stealing” others’ ideas because nobody can create a perfect product without a search of predesigned products. Designers constantly look around for inspiration and use others’ good ideas for theirs. If one is creating a flyer, the first step is to find a flyer that can be easily adapted in terms of layout. After changing the text and graphics, the flyer becomes a personal, unique flyer. If a perfect example cannot be located, one can combine ideas from different flyers. For instance, one can adapt the layout of the design from one flyer, the color theme from the second flyer, and font style from the third flyer. Students in the author’s class reported that they learned a lot from viewing peers’ work and other professional designs.

To be effective as well as competitive in this information-oriented world requires skills in presenting and communicating, verbally and visually, because visuals can condense vast amounts of information into formats that are easy to understand (Lohr, 2003). According to Lohr (2003), the effective use of visuals can help people to perform procedures with or without words, learn vocabulary, organize data to solve problems, and communicate across cultures. For instance, most people recognize the symbols of a bus, library, lady’s room, and no enter no matter what language they speak. Therefore, it is important to understand and use images in educational settings.

**FUTURE CONSIDERATIONS**

As the lower cost desktop publishing software and inexpensive laser and color inkjet printers can be easily used to create and print brochures, flyers, and business cards at a fraction of the cost of traditional printing, the desktop publishing (DTP) business exploded into many different directions. Desktop publishing classes are offered at many universities to nondesigners or professional designers. Bear (n.d.) indicated that even classrooms and schools with limited technology resources could integrate desktop publishing into the classroom. According to Bear, a teacher can use the desktop publishing lesson plans for three common desktop published documents—business cards, brochures, and resumes to teach visual communication and
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design as well as almost any subject normally taught in the K-12 classroom.

It is true with the desktop publishing course the author taught. Students in this course not only learned technology skills in using desktop publishing software but also learned design principles in creating professional designs. The most important is that they learned visual communications skills and were able to apply what they learned in desktop publishing class to their own interest of fields. However, research on how desktop publishing affects teaching and learning is rare. Knowing how to use a tool technically is not the same thing as knowing how to use the tool for instructional purpose. They are two completely different things. Most people can easily master the technology skills, but few people know how to use the tools effectively. Teachers should help their students not only master skills but also apply what they learned to practice effectively. As noted, not much research has been performed in this particular area. Research in this field needs to be conducted to fully understand DTP’s potential in assisting students and educators to address topics as well as convey and express ideas and thoughts.

CONCLUSION

As the advent of more easier-to-use and consumer-oriented desktop publishing software has become more available, almost everybody can do desktop publishing with the right software. In the educational setting, teachers, students, and office secretaries have an urgent need to create desktop publishing for the purposes of teaching and learning. The ability to change fonts, add graphics, and print pretty colors does not exclude the need for mastering the basic design principles and guidelines. Therefore, if one wants to create professional looking desktop publishing documents, he/she has to learn the basics of design and explore the full capabilities of the software and hardware.

Integrating desktop publishing into teaching is important because students will learn not only technology skills but also learn design principles. In addition, they could use what they create in class in their own areas. Viewing examples from peers, especially from professional designers, helps students get design ideas and apply the design principles into practice. Peer critiques and electronic portfolio creation were proven to be an effective way to motivate student critical thinking and reflective learning. In addition, the projects that they created in this class would be valuable and beneficial for their student, personal, and professional career, as one student described in her reflection.

REFERENCES


KEY TERMS

Desktop Publishing: Uses the computer and specific types of software to combine text and graphics for books, brochures, newsletters, and so forth. Desktop publishing is the production side of design used by nondesigners. Therefore, consumers use the computer and desktop publishing software to create and print the same type of projects as professional graphic designers.

Graphic Design: The art of combining text and graphics to communicate an effective visual message in the form of a logo, newsletter, poster, and brochure. Graphic designers need to be professionally trained and experiences in design.

Page Layout: The way to format texts and graphics on a page, for example, how many regions will appear on the page, how they are organized, and what content will be there.

Type Family: Refers to all the varieties of a particular typeface, for example: Arial, Arial Bold, Arial Italic, and other Arial styles.

Typography: The art of selecting and editing letter forms for the content of the material to be printed or displayed electronically.

User Friendly: A description of design that focuses on making tools effective, efficient, and easy to use.

Visual Communication: The communication of ideas by presenting information in a visual form. Desktop publishing documents are one form of visual communications.
Differentiated Instruction and Technology

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INTRODUCTION

Differentiated Instruction

The variety of students’ needs and backgrounds in classrooms include students with special needs, gifted, and typical students who have grown up in differing socio-economic levels and diverse cultures. Differentiated instruction is based on the premise that instructional approaches should vary and should be adapted in relation to individual and diverse students in classrooms (Tomlinson, 2001). When teachers engage in differentiated instruction, they address every student’s interests, ability levels, and learning profiles. The instructor plans both curriculum and instruction that honor the individual student’s strengths and needs in order to benefit the learning of all the students (Tomlinson, 1999; Tomlinson & Eidson, 2003). Teachers adapt their content (what will be taught), process (how it will be taught), and product (the assessment of the content through culminating projects) in order to differentiate instruction (Hipsky, 2006a). The reality of why instructors should be differentiating instruction goes beyond theory into the reality of today’s classrooms. Teacher Patricia Holliday expressed,

“Even though it takes a lot of time upfront to plan for a differentiated classroom, the benefits have been proven. Each year that I get better at planning for differentiation, I can see an improvement in the outcomes of my students” (Lewis & Batts, 2005, p. 32).

Ability Levels

Many of the concepts that are utilized in differentiated instruction are used in special education to meet the needs of those students that are on the ends of the ability spectrum. Differentiated instruction extends the concept of individualizing to meet the needs of all students in the class whether they are below average, average, or above average ability.

Curriculum Compacting

“Curriculum compacting” is a technique that has been used for gifted students that focuses on the most important learning skills and utilizes the child’s talents and strengths to delve deeper into knowledge. The instructor identifies the goals and standards for each student who will engage in the compacting. A discussion takes place regarding what needs to be learned, what the potential enrichment activities are, and how the student will be assessed. Collaboratively, the student and teacher determine enrichment materials and guidelines for projects. Seminars conducted over the Web or in person, apprenticeships, and virtual mentoring can add to the compacting experience for the student.

Tiered Instruction

When planning tiered instruction, the teacher gears the lesson and activities toward the average student. Then that lesson is either leveled up or down to meet the ability level of each student. Often the students find activities that have been tiered to their needs in folders, at stations, or on computers.

Learning Profiles

A student’s learning profile is determined predominantly by learning style. The teacher and student need to decide how the student learns best. Some look to the theorists in intelligence, Gardner and Sternberg, to support their decisions about students’ learning styles. By establishing a student’s learning profile, the teachers can garner insight into how to prepare instruction that will enhance the student’s strengths and work on individual needs.

According to Gardner, students can have one or many ways of learning that dictate their strongest mode of learning. Gardner’s Theory of Multiple Intelligences includes: verbal/linguistic, spatial, bodily/kinesthetic, logical/mathematical, musical, interpersonal, intra-
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personal, naturalist, and existential (Gardner, 1983, 1999).

Sternberg’s Triarchic Theory of Successful Intelligence includes creative intelligence (ability to go beyond what is given to generate unique and interesting ideas), analytical intelligence (ability to analyze and evaluate ideas), and practical intelligence (the ability that individuals use to find the best fit between themselves and the demands of the environment). According to Sternberg, students need to make the finest use of these strengths. Not everyone is naturally disposed to excel in all three. Therefore, the students need to utilize coping skills to compensate for weaknesses in any of these areas. This balance of intelligences can lead to student success (Sternberg, 1985, 1996). There are some teaching techniques that specifically tap into the student’s learning profiles including using software such as Kid Pix®, Kidspiration®, and Inspiration® for students who need to learn visually, hear, or interact with information.

Learning Contracts

Learning contracts are a way to guide the students toward meeting the needs of learning profiles. Often the students recognize their own learning style. A contract allows the student to take responsibility for determining not only the way the information will be garnered, but also how the findings will be presented. Gregory and Kuzmich (2005) created a list of questions for the planning of a learning contract for differentiated instruction:

• How will the student demonstrate what was learned (i.e., record work, use a computer, or work with a partner)?
• What type of time and work would help the student to finish the assignment (i.e., extra time, fewer items, and/or new work)?
• What type of resources and materials does the student need (i.e., extra help from my teacher, use the Internet, and/or use different materials)?
• What else does the student need to be successful? In response to that last question, the student would write or draw what is needed.

After an agreement has been reached, the teacher and student would sign the learning contract. The student would be held accountable for the knowledge gained and for demonstrating growth in the way that they mutually decided is best.

Interests

A variety of interests—from sports to the arts—can be taken into consideration in a classroom, and weaving these interests into instruction can lead to “flow” for the students. “The concept of flow, according to Csikszentmihalyi (1990), involves a state of consciousness in which a person becomes so totally immersed in an activity that time flies by unnoticed” (Hipsky, 2006b, p. 188). Through active differentiated learning in combination with the students’ interests, the state of flow can be reached in the classroom.

Technology: Software for Differentiating Instruction

Kent State University professor, Leskovec (2005), studied the effect of CC Lab software on differentiating instruction in math and reading on first grade students. The results of the study were determined by surveys, observations, interviews, and pre- and post-tests. It established that all of the students who participated made gains in the standards that were to be met. The students can access the software and work at their own appropriate level. The CC Lab Software generates reports for a communication and assessment tool.

In 1979, Bernice McCarthy created the 4MAT Method (http://www. aboutlearning.com/) which is a cycle for delivering instruction of any kind in a way that: (1) connects to learners, (2) offers an opportunity for practice, (3) provides relevant information, and (4) allows for creative adaptation of material learned. The process of the 4MAT Method can now be found in a software package developed for instructors to engage learners and go beyond the “drill and kill” redundancy of traditional instruction.

Scholastic’s Read 180 (http://teacher.scholastic.com/products/read180/overview/) is adaptive and instructional software that utilizes high-interest literature, and direct instruction in reading and writing to differentiate instruction for English/Language Arts classes. The Enterprise version of the Read 180 software is available to meet the needs of students who speak Spanish, Cantonese, Hmong, Vietnamese, and Haitian Creole. The management system utilizes an achievement manager that captures data on student performance.
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and provides the instructor with the tools to run reports, manage student data, and locate resources.

**Technology: Web Quests**

For a less package-driven approach than simply choosing a software package that will differentiate according to the student’s interests and needs, Web quests can guide a student’s individualized learning. A Web quest begins with a question or a topic and produces a research project using information that is found on the Internet in a scavenger hunt type format.

**Flexible Grouping**

In the past, small groups were created in classrooms strictly based on the students’ abilities. In the differentiated class, students can be grouped by ability, learning profiles, or interests. These groups can interact together by meeting in person in a physical classroom or they can be established online. For example, students may meet on a Blackboard online course management site to meet synchronously in a chat room or asynchronously on a discussion board to discuss their favorite literature genre (e.g., science fiction).

**BACKGROUND**

**Technology to Support Differentiated Instruction**

Benjamin (2005) highlighted six features of technology that help to support differentiated instruction:

- **Privacy:** An issue with differentiating instruction has always been that the self-esteem of the student who needs a least sophisticated task needs to be protected, and technology allows for confidentiality.
- **Collaboration and Communication Skills:** Although some people are concerned that computers can be isolating, others see the instructional possibilities of e-conferencing, e-mail, discussion boards, and chat to enhance the learning community.
- **Organization:** By utilizing software such as Inspiration or Kidspiration, students can create outlines and graphic organizers to help guide their own learning based upon their interests and abilities.
- **Learning Styles and Sensory Learning:** Students can utilize visual, auditory, and social learning through engagement with words, images, and sounds.
- **Choices:** From the Internet to software packages, the choices for students based on their needs and interests are extensive.
- **Authentic Learning:** Differentiated instruction tends to be project-based, favoring constructivist learning (where the student builds on prior knowledge) rather than constantly focusing on testing. Technology can offer this type of learning experience (p. 5-6).

**Remediation through Technology**

The National Network of Digital Schools (NNDS) in collaboration with Provost Systems is creating efficient ways to determine when a child needs intervention for a specific standard. Figure 1 provides an example of the instructor’s view of the progress and intervention needs for each student in a specific course. If the student is performing at a proficient level based on a variety of formal and informal assessments, they will have a green light icon under the standard that they have mastered. By clicking on the not-proficient icon (a red stop sign) for each student, the instructor can execute a workflow for learning intervention. Each stop sign icon shows a number that represents the step in the intervention process. Once the instructor has moved to the standard that the student needs help in, they will see the Figure 2 Intervention Workflow screen that shows the intervention (which will state the type of remediation needed). It then documents the other steps in the process including: contacting the student, assigning tasks, receiving tasks, and the completion. At this time, the student would be reassessed to determine if the standard has been met. If it has been mastered, the student will see a green light, and if not, the process can begin again with a different intervention to meet the needs of the student.

**CONCLUSION**

The type of approach taken by the National Network of Digital Schools towards assessing and differentiat-
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Figure 1. Instructor view of student performance in a cyber course

<table>
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<th>Name</th>
<th>9.2.1: Estimation</th>
<th>9.2.3: Factoring</th>
<th>9.2.6: Remainders</th>
<th>Test 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Peters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jane Rogers</td>
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<tr>
<td>Peter Smith</td>
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<tr>
<td>Sam Davis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Differentiated instruction provides information and data driven by individualized learning for the students. With performance-based standards becoming increasingly important to teachers and administrators, it is likely that there will be continued growth in the area of utilizing technology in order to differentiate instruction.

Technology resources can help to meet the students’ needs in the areas of interests, ability, and learning profiles. Differentiating instruction can provide students with an opportunity to find success in the classroom.

REFERENCES


Differentiated Instruction and Technology

Figure 2. Intervention workflow per student in a cyber course

http://www.etech.ohio.gov/jcore/doclib/DocView.jsp?step=view&file=B68FA2AF-C8A5-4DB2-8CA8-E97A64A5EC9E


**KEY TERMS**

**Constructivism:** This is the concept that students actively construct their learning based on prior knowledge.

**Differentiated Instruction:** Differentiated instruction individualizes the content, product, and process for each student based on three main factors: learning profiles (how the student learns best), abilities (exceptionalities, gifted, English as Second Language students, and the typical student), and interests (what the student finds intriguing).

**Flexible Grouping:** When creating groups, it is not necessary to pair homogeneously based strictly on the ability level. Instead, vary the groupings according to similar and dissimilar interests, learning profile, and ability.

**Learning Contracts:** Learning contracts guide the student through the independent study of a specific topic. The foundation of the learning contract is the student’s strengths, needs, and interests. It clarifies the student’s responsibilities to learn the standards, the process, the timeframe, and how learning will be demonstrated (Hipky, 2006b).

**Learning Style:** Learning styles are the way that a student best processes and uses information. A variety of theories exist on types of learning styles, including multiple intelligences, emotional intelligences, brain-based learning, and VARK.

**Tiered Tasks:** Groups that work toward learning of the same content, yet they utilize different processes, varying in depth and complexity to develop different products to demonstrate understanding. Groups are chosen by student choice or a pre-assessment.

**WebQuests:** The student begins with a question or a topic and produces a research project using information that is found on the Internet. The final product can be a written report, PowerPoint presentation, three-dimensional project, dramatic interpretation, or any other technique that can demonstrate understanding.
INTRODUCTION

Many people are oblivious of the structured paths that lead them from one level of knowledge or one career path to another. Unless they are unusually reflective and deliberately trace their intellectual growth, most people move along and go with the flow of daily living and daily work needs. Whereas professionals keep pace with new requirements placed upon them, students move ahead according to the required collegiate curriculums, taking the prescribed courses as directed. Both groups, however, accumulate valuable experiences along either path.

Students find that as graduation approaches, preparing comprehensive resumes requires them to sum up their achievements and experiences. This is usually an onerous task. Rather than waiting until the end of the program, it may increase the students’ ability to comprehend the path of learning if they had to collect and preserve their work in a creative accumulative project, reflecting and assessing during the process.

Business people are certainly aware of keeping their resumes up to date, although they may not do this until some employment crisis forces them to reflect and report on their accomplishments. Annual job assessment reviews often prompt scrambling through the papers or memories of the prior year to compile a report for the desired salary raise or promotion.

Developing a creative portfolio can also help to guide writing a creative resume. Overall declarations in resumes are strengthened by providing concrete examples of competencies and skills attained. Statements on the resume can be linked to the portfolio artifacts to show specific examples of projects or supporting documents for claims made by the interviewee. This is “show and tell” brought to life by the creator of a digital portfolio who not only proclaims that to know about technological advances but can put them into practice, using them for creative enhancement of the traditionally static resume.

PORTFOLIO OVERVIEW

Although comparatively innovative in business settings, structured portfolios are not new to many other disciplines. Their uses range, depending on their purpose and their intended audiences. Whereas self-reflective portfolios serve as journals or organizers of activities and experiences, academic portfolios show student learning and progress or the development of skills. Professional portfolios are used in career determination or assessment of accomplishments as well as serving as demonstrations to validate claims of professional development.

Some portfolios consist of one’s own work while others, such as teachers’ portfolios, incorporate the tasks they developed for their students along with evaluations, exemplary projects, or external and internal assessments.

Another definition of portfolios is common in the financial world. There a portfolio is a collection of monetary assets reflected in stocks, bonds, real estate, and personal possessions. Reallocating and shifting these assets for optimal return is the task of financial analysis. Borrowing from this description of an asset portfolio, another way of summing up one’s assets is by evaluating a collection of one’s personal achievements. These assets are perhaps more precious than mere monetary accumulations. It takes a lifetime of work to acquire educational, professional, and personal assets. Enhancing this theme of portfolios as a collection of assets, Poore (2001) considers a person’s business career as a portfolio of well-chosen investments.

DIGITAL PORTFOLIOS

Digital business portfolios are basically collections of artifacts used to validate claims made by the creator. These artifacts are in a creative variety of formats: text documents, Web pages, presentations, research papers,
assessment instruments, original projects, academic or external teamwork, internships, performance videos, certificates of achievement, spreadsheets, databases, digital images, and multimedia demonstrations. These digital portfolios serve the business student population as well as business professionals encouraging them to look critically at their work and analyze it objectively. Using the concrete examples of their achievements and growth, portfolio developers create technologically creative resumes with the portfolio artifacts to support statements of proficiency in their chosen fields.

In short, a portfolio is a demonstration of skills and abilities, containing evidence of growth and competence. Portfolios can be learning tools, job search tools, and career growth tools. The purpose of the portfolio to some degree dictates the artifacts collected as well as the format of the design.

**TYPES OF DIGITAL PORTFOLIOS FOR ASSESSMENT, JOB SEARCHES, AND INTERVIEWS**

**Learning and Assessment Portfolio**

Students create portfolios as part of classwork for assessment or for tracking their growth during their academic careers. While collecting the artifacts of learning, students realize that they have concrete evidence to support their perceptions of their own development. Their belief in their own growth is given support by looking objectively at the increasing complexity of their projects. Their self-assessment is substantiated by recognizing how their knowledge base changed comparing the artifacts from the beginning of their studies with the more sophisticated projects done toward the end of their academic years.

This reflection on one's work prompts another important area: that of developing the ability to be objective when assessing both the quality and/or quantity of materials used in the portfolio. Nicholson (2004) considers self-reflection as “the first step in knowledge construction” (p. 322). With encouragement from a teacher/mentor, the students have a chance to reflect upon their progress, do remedial work, and plan their paths for continued growth.

Students also find portfolios invaluable when pursuing internships or employment at the conclusion of their program. Learning portfolios preserve artifacts that later can become part of career portfolios. Thus the initial portfolio done as a student provides a base or example for any future portfolio development. At many points in a work career, the employee frequently pursues further skills or education in a full degree program, a certification, or even a workshop. It is important that these achievements be documented to demonstrate growth or achievement to the employer, so the portfolio is the constant base ready to receive and preserve new artifacts.

**Initial Job Inquiry Portfolio**

In advertisements for employment, the candidate is often directed to send documents such as resumes or supporting material electronically. If the initial inquiry is made online, a small portfolio of work examples could be submitted along with an electronic resume as an e-mail attachment. The content of the portfolio would consist primarily of text documents including a resume and several work examples or a few highly compressed images. The portfolio creator must be aware that sending this type of portfolio has restrictions in that there are a variety of e-mail systems on the receiving end. Any portfolio sent electronically should be in the neighborhood of one megabyte of memory.

An alternative to actually sending the resume, text documents, or supporting images would be to compose a resume and cover letter with internal hyperlinks directing the reader to a Web-based portfolio. This type of portfolio can also take the form of an expanded Web resume or be an extensive multimedia Web-based presentation. This different strategy means that the original portfolio need not be restricted in size. In these cases, the portfolio is Web-based and simply linked from the job application materials.

The introductory portfolio differs in structure from a comprehensive portfolio in the amount of material available. The introductory portfolio might also be an electronic document tailored for each job application or initial inquiry, showing just the type of experience, skill, or education that best pertains to each company or position being sought. Thus the creator would pick and choose among the various artifacts in order to focus on the needs expressed by the employer or interviewer. This more personal, focused approach would show depth of preparation as well as forcing the prospective employee to focus on addressing the specific requirements of the job proposed.
Interview Presentation Portfolio

This portfolio should also be tailored to the particular needs of the company or the position sought, perhaps using the mission statement of the specific company as the base for comparison with the job-seeker’s competencies. Since the purpose of this portfolio is to add to the smaller introductory portfolio, it should include more materials since size is not as great a limitation. Graphically, this portfolio should follow the rules of good visual communication for presentations, being aware of appropriate colors or formatting. This type of portfolio lends itself to including slide presentations or multimedia projects.

This portfolio should fit on a CD, with several copies available. When taken to a job interview, the applicant can present the portfolio during the interview session. A copy can then be left with the interviewer to accompany their application materials following the interview.

Career Growth Portfolio

Once hired, the employee should continue to collect artifacts and include them into portfolios to demonstrate the work performed and growth achieved in skills and responsibilities. This type of portfolio is very helpful in yearly performance reviews and for applications for promotion. As Williams and Hall (2004) state, “the portfolio should be designed to transition” (p. 2) with the employee. Quality artifacts should increase as the years on the job increase.

As an example of this concept of transition during one’s career, the field of teacher education has been in the forefront for the past decade encouraging portfolio development. Wilcox and Tomei (1999) address developing portfolios to fit three growth phases of a professional career in education: teacher as learner, teacher as expert, and finally, teacher as scholar. These phases are direct reflections of the portfolios of many professional educators.

This type of portfolio could fit on a CD; or if it includes video or other multimedia, can be distributed on DVD. If there is a yearly review, the parameters of the review should dictate the main content of this type of portfolio. The employee would choose artifacts focusing on more recent achievements and would not include irrelevant material.

PORTFOLIO ARTIFACTS

A simple rule of thumb is to save everything that relates to work, professional growth, and achievement. It is vital to organize storage methods and to digitize artifacts as soon as possible. Artifacts may be digitized by scanning or photographing them with a digital camera. Once the materials are digitized, it becomes less important to store artifacts in paper form. It is important to create at least one backup of the original digital materials.

Table 1. Career portfolio artifacts

<table>
<thead>
<tr>
<th>Personal Information</th>
<th>Evidence of personal interests, mentors, role models, personality inventory or assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Credentials</td>
<td>Evidence of education history, thesis or other major papers or research, examples of coursework products</td>
</tr>
<tr>
<td>Career Achievements</td>
<td>Evidence of work history, career plan, references, inventory of career accomplishments</td>
</tr>
<tr>
<td>Communication Competencies</td>
<td>Evidence of communication skills, technical skills, certifications, speaking, diversity skills, teamwork</td>
</tr>
<tr>
<td>Professional Activities</td>
<td>Examples of publication, presentations</td>
</tr>
<tr>
<td>Recognition</td>
<td>Evidence of academic honors, workplace achievement or recognition, promotions</td>
</tr>
</tbody>
</table>

Table 2. Interview presentation portfolio artifacts

<table>
<thead>
<tr>
<th>Statement of Career Goals</th>
<th>Statement of how skills and competencies will enhance the mission of the company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievements</td>
<td>Transcripts, relevant courses taken, honors, awards, internships</td>
</tr>
<tr>
<td>Evidence of Competencies</td>
<td>Skill-based projects, reports, papers, relevant team activities, original computer-based cases</td>
</tr>
<tr>
<td>Exterior Assessment</td>
<td>References, academic commendations, club or group affiliations, leadership roles, community service, volunteer work</td>
</tr>
</tbody>
</table>
The purpose of the portfolio will determine which of the artifacts is placed into the digital document when it is time to create the digital portfolio. For example, a career portfolio would contain the documentation evidenced in Table 1.

Students may find the documentation outlined in Table 2 helpful in preparing their portfolios for the interview presentation portfolio.

The sample of careers found in Table 3 may find the suggested portfolio content topics helpful when preparing for new job interviews, for annual reviews, or for promotion requests.

**PORTFOLIO PRODUCTION TIPS**

Digitizing documents and objects for archiving is different than scanning or photographing for presentation. For archiving, the largest file possible should be created. It should be the highest resolution in RGB color mode at the largest scale the hard drive, digital camera, or scanner can handle.

If the original document becomes lost or disintegrates through aging, this technique of using the maximum settings creates the best possible digital representation of the document. Using the highest settings allows for creating additional smaller files, optimized for portfolio presentation.

**Creative Digitizing**

Digital documents that are originals should be copied and stored at least twice. Full-size original digital files should be kept on CDs or DVDs. When it is time to prepare them for a portfolio, the original files should be copied from the discs. The archivist should be alert to several situations relating to present and future technologies. Digital files should be in standard formats. Proprietary or native application formats may not stand the test of time. These should also be saved in a standard format such as TIFF for images or RTF for text documents with formatting. This does not mean resizing or compressing the files. The original files are best saved uncompressed. Once the files are sized and prepared for a portfolio, then they can be compressed.

Dimensional objects should also be saved. Good, high-resolution digital pictures of the objects should be taken and at least two copies of these images on CD or DVD should be stored. It is worth the time and cost to get a professional to create quality images as artifacts. If a nonprofessional chooses to take digital pictures, the photos should be shot in a large format with the highest resolution the camera allows. Natural or bright artificial lighting is necessary to illuminate the object in order to separate it from the background. Tools such as tripods help to steady the camera for crisp, sharply focused images.

Tape or digital audio and video media may be used in portfolios. Since analog tape media degrades in the duplication process, the tape that is closest to the original edit should be kept and backed up digitally to CD or DVD discs. When preparing files for a portfolio, the file size may be reduced or compressed, but the best quality digital copy of the original serves as backup to return to.

**Digital Portfolio Formats**

Portfolios can be constructed using a variety of media, including popular office applications programs as well as portfolio software and Web-based platforms.

**Text-Based Portfolio Formats**

Microsoft Word, PowerPoint, and Adobe Acrobat provide a ready source for text-based digital portfolios.
These popular software programs are very efficient, especially for the novice to use when creating a portfolio. Adobe Acrobat, for example, requires a free plug-in, but is rarely a limitation since the Acrobat Reader is a business standard and can be installed on virtually all computers. This program particularly makes the collection of creative artifacts possible as it allows for a combination of text, graphics, video, Web projects, and interactive displays to be integrated into an easily accessible electronic format. Since portable document files (PDF) are transportable across all platforms, they are readable by both sender and receiver.

Another key criterion for software selection, according to Barrett (2004), should be its capability to allow hypertext links between stated goals and outcomes as related to the artifacts. Each of these programs has sophisticated hypertext features which provide flexibility in portfolio design while still maintaining coherence when relating one section to another.

Portfolio Software

There are several software programs which specialize in areas crucial to portfolio creation. Among these are Extensis Portfolio, Cumulus Canto, and Epsilen Portfolios. The underlying goal of each of these programs is digital asset management (DAM), which is the underpinning of portfolios. DAM is an enabling technology and solution to creating, archiving, managing, and finally using the collected artifacts or assets.

There are several benefits to using professionally created programs. They provide the structure needed to create portfolios efficiently. They catalog the digitized assets or artifacts using metadata, which is data about the data describing the artifact. This description standardizes the naming and filing of each artifact, thus enabling the portfolio creator to find appropriate material when creating different portfolios needed during various levels of a professional career.

Web-Based Portfolio Formats

The three software programs mentioned: Extensis Portfolio, Cumulus Canto, and Epsilen Portfolios, are also Web-based. Their features vary, but secure server storage is common to all three. Along with storage, the most desirable features in Web-based software should include the structure needed to create and archive artifacts, create personal Web pages, provide suggestions for Web design, and offer well-designed templates. Helpful features should also guide the user through the steps needed for distribution of the portfolio, burning to CDs or DVDs, creating QuickTime movies, developing slide shows, and e-mailing.

Another Web-based portfolio collection and storage area is available through a feature in Blackboard, a widely used educational course management system. The Blackboard Content System includes the ability not only to store artifacts but also to manage the portfolio by allowing the creator to control its availability to external users and to check that the links to items within the portfolio maintain their validity.

Constructing and implementing Web-based portfolios successfully involves more than just collecting artifacts and distributing an attractive and useful portfolio for career purposes. Academic use during a student’s development may aid in greater reflection on the scholastic path the student is on. Counselors can enhance their interaction with students by tapping into students’ portfolios for advisement. Course work and assignments could be checked and commented on by instructors with further suggestions for improvement. Due to the ability to store securely on institutional servers, students and teachers could develop a more collaborative association.

A Webfolio, according to Gathercoal, Love, Bryde, and McKeen (2002), is more than simply digitizing a traditional portfolio. Since the portfolio could be made available to external viewers, it could be made an integral part of a curriculum. Serving several purposes, it could be used by students as a “working portfolio generating artifacts only they can view, a developmental portfolio they share with faculty, and a showcase portfolio they share with the world” (p. 31).

Using the Web as a storage medium and then manipulating artifacts to fit appropriately into a variety of portfolios as the need arises permits portfolio creators to be more adaptive and flexible. The base portfolio, perhaps created during student years and stored on the Web, could become a lifelong touchstone for professional and career advancement.

Multimedia Use: Pros and Cons

Some career documentation is most effectively delivered via multimedia or motion media such as audio, video, or animation. This type of documentation is
usually not appropriate for inclusion in an e-mail attachment as the file size will likely exceed the one megabyte recommendation.

Multimedia can be effective when delivered on CD or sometimes through a hyperlink to the Web. Whatever delivery method is chosen, the important consideration is the software or plug-ins that are required on the user’s computer in order to view the multimedia files in the sender’s portfolio. If the end user computer lacks the programs needed, then the multimedia portfolio files cannot be viewed. If users get an error, they may stop viewing the portfolio altogether. Therefore, including multimedia can be risky.

To avoid problems, preview the portfolio on the broadest possible range of computers, operating systems, and installations. Multimedia is safest used in presentations made directly from a laptop or computer during an interview, guaranteeing that there will be no problems with plug-ins or missing software.

CONCLUSION

Compiling the digital portfolio is a strong asset to the student’s learning path as well as providing a business professional with a means of collecting and preserving valuable projects. It serves not only as an archive for precious material that may otherwise be lost over the years but it also serves as an organizing principle, according to Campbell, Cignetti, Melenyer, Nettles, and Wyman (2004). Learning theory reminds us that people remember what they do and what they produce instead of what others have done for them; therefore, portfolios provide a memory jog with a record of quantitative and qualitative growth over time. Portfolios capture a moment in time when students were acquiring the skills and competencies needed for their careers. However, having had the experience of creating a portfolio, the student-turned-professional can build upon it and add to it during their business careers.

The reflections made when collecting and archiving projects allow students to make cohesive connections between concepts learned in various courses. Business personnel also capture significant documents, projects, images, reports, recommendations, and programs. Prior to developing a formal portfolio, these artifacts are often misplaced physically as well as being forgotten at just the time when the employee needs all the support possible to shore up a request for promotion or to keep a job.

The portfolio provides concrete evidence of learning, improvement, and successes. It serves as a snapshot of knowledge-growth and experiences attained. Overall, it serves as a proof to claims of skills and competencies for potential employers and provides students with concrete evidence of some of their achievements.

REFERENCES


KEY WORDS

Artifact: Object created or designed for presentation. Examples of portfolio artifacts are text documents, Web pages, presentations, research papers, assessment instruments, original projects, academic or external teamwork projects, internships, presentation videos, certificates of achievement, spreadsheets, databases, digital images, and multimedia demonstrations.

Career Growth Portfolio: Created by an employee, consisting of demonstrations of work performed and growth achieved in skills and responsibilities while on the job; used for promotional justification.

Initial Job Inquiry Portfolio: Created by an employment applicant, consisting of resume, references, and supporting examples of work to show competence for the desired position.

Interview Presentation Portfolio: Created by a job-seeker, consisting of artifacts tailored to the particular needs of the company to validate claims of technical or professional expertise.

Learning and Assessment Portfolio: Created by a student, consisting of artifacts from student’s coursework or projects used to assess or to track academic growth.

PDF: Acronym for Portable Document Format, which is a universal file format that preserves all the fonts, formatting, images, and color of a source file, regardless of the application or platform used to create it. Compacted PDF files can be exchanged, viewed, navigated, and printed with free Adobe Reader software.

Templates: Master or pattern from which other similar things can be made. Can be built in any software and become portfolio pages containing text, video, images, and links.
INTRODUCTION

To be described as digitally literate involves the ability to find, interpret, comprehend, understand, evaluate, restructure and re-purpose the wide variety of media types that can be stored, retrieved and manipulated using a computer.

The 21st century has created an environment where the very meaning of the expression “to be literate” has come to mean much more than it did in the past. Literacy still encompasses the traditional reading, writing, and numeracy, but now includes visual and digital literacies that empower the individual to effectively communicate about, and use information (Jones-Kavalier & Flanagan, 2006). Literacy now incorporates an ability to critically evaluate information, communicate concepts, and express ideas in a variety of media, all mediated by computers. Earlier definitions of digital literacy tended to focus on technological skills (Bruce & Peyton, 1999; Davies, Szabl, & Montgomerie, 2002). However, the current focus has moved to a more pedagogical view that integrates technical, cognitive, and sociological skills (Eshet-Alkalai, 2004). What can the student do with information in digital form? The assumption now is that the student knows how to use the tools, and all that is needed is a focus on metacognitive and pedagogical needs. However, the case study presented in this article suggests that this is not so, and skills need to be integrated with meaningful tasks in order to become part of the lexicon of student learning modes.

Bawden (2001) lists a number of skills and practices that could be used to define digital literacy (referred to as literacy for the remainder of the article). The key element of which was the ability to make informed judgments about online information, irrespective of media used. Key elements included the ability to:

- Distinguish between content and presentation
- Develop understanding from nonlinear hypertext environments
- Evaluate a wide variety of content from different sources, without bias
- Demonstrate well developed search skills
- Filter messages and use Internet agents
- Create a personal information strategy
- Operate in a community of practice
- Define a problem and develop questions
- Judge the completeness of information

Eshet-Alkalai (2004) in an empirical study with high-school students, university students, and adults (over age 30), identifies five literacies that contributed to digital literacy. They are:

- **Photo-visual literacy** (synchronic matching of words with pictures without an understanding of the underlying syntax);
- **Reproductive literacy** (the ability to integrate information in meaningful and authentic ways);
- **Information literacy** (the ability to find and critically assess information);
- **Branching literacy** (the ability to create powerful mental models, concept maps and other abstract representations); and
- **Socio-emotional literacy** (able to engage in digital communication without being conned by those people who misrepresent themselves in cyberspace). (p. 94)

The skills and knowledge suggested by Bawden (2002) and Eshet-Alkalai (2004) need to be developed in preservice teachers (PSTs) in order to train teachers who can engage and motivate the new generation of digital natives (Prensky, 2001). The case study in this article builds upon the evidence that suggests that students who are able to develop complex, well integrated concept maps which involve visual literacy, information literacy, and technical literacy, also engage in deeper approaches to learning and develop a deep understanding of the domain knowledge (Novak, 1990). In effect, students who are more digitally literate are better able to find information, develop better mental models, and represent those models in a concept map, exhibiting a deep understanding of the content domain.
Specifically, the case study aimed to investigate the relationships between two measures of student learning, namely,

1. Profile scores (prestructural to extended abstract) of the structure of observed learning outcomes (SOLO) analysis of students’ concepts at various stages in their development of concept maps to represent a specific subject domain (of their choosing); and
2. Students’ moderated grades in the module.

The theoretical framework of the case study is grounded in the literature pertaining to digital literacy and the use of visual representations (photo-visual literacy). In this article these literacies will be subsumed into “digital literacies.” In addition, as the data was generated in Hong Kong, it became clear that the literature on the Chinese learner was highly pertinent and this is also discussed.

VISUAL LITERACY

Visualization is an important instructional variable [and that] not all types of visuals are equally effective in facilitating achievement of different educational objectives. (Dwyer & Baker, 2001)

The research literature about the nature of images and concept mapping for conceptual understanding has a long history, but current research into the affordances offered by the advent of desktop computers, the quantum increase in computing power, and the ability to manipulate images is still relatively limited. In the study by Eshet-Alkalai (2004) individuals with high photo-visual literacy were better able to engage in meaning making from visual sources. What is less clear in the study was the ability of subjects to separate individual elements. Instead, individuals (particularly the younger ones) tended to adopt a holistic view of photo-visual content, more reflective of the graphical user interfaces favored by modern operating systems in computers, where meaning is understood without a need to focus on the constituent parts (e.g., the graphical user interface and the use of icons).

Howard Gardner proposed that there were seven separate forms of intelligence, and suggested that learning environments should endeavor to engage the different cognitive styles represented by these intelligences (Gardner, 1993; Gardner, Kornhaber, & Wake, 1996). The seven domains are 1) linguistic, 2) musical, 3) logical-mathematical, 4) spatial, 5) bodily-kinesthetic, 6) intrapersonal, and 7) interpersonal.

It is the first, third, and fourth components of Gardner’s (1993) framework that are of interest in this study in that, in developing concept maps, students manipulate linguistic elements (1) spatially (4) in order to explain concepts in a manner that emphasizes strong logical relationships (3) through the explicit interlinking of concepts. The study required students to develop highly visual concept maps in a content domain that was familiar (usually in either a major or minor subject area of study) to them. For example, the general studies or science students developed concept maps in science, and language students in languages, and so forth. In this way, the development of the visual representations was in a domain that was familiar and nonthreatening. The development of the concept maps was integrated into the learning design of the modules as a hurdle assessment requirement rather than a graded component.

Concept Mapping in Teaching and Learning

The use of concept mapping for teaching and learning is well established in the literature. The development of concept mapping was a logical consequence of Ausubel’s learning theory (1968), in which he challenged some of the conclusions of Piaget (Ausubel, 1968; Novak, 1990; Novak & Gowin, 1984) in indicating that Piaget’s theory of cognitive development has “only limited relevance to learning in school settings” (Novak, 1984, p. 608). The concept map was originally developed as an evaluation strategy (in place of interviews) for assessing changes in cognitive structure as a consequence of meaningful learning and as a mechanism for assessing the current level of knowledge construction (Novak & Gowin, 1984).

Concept maps link two or more concepts to form propositions. Propositions then become the units of psychological meaning. As such, concept maps incorporate elements of branching, photo-visual, digital, and information literacy. Concept mapping also has the potential to support communication between students, as students discuss their representations with peers. Concept maps can help achieve a congruence
of understanding amongst students of the conceptual needs of a particular content domain (Kennedy, 2002). Kennedy (2002) in an earlier study illustrated how concept mapping may be used to show key relationships between knowledge, knowledge construction, and student learning outcomes.

In this study, the concept maps developed by PSTs included text, images, and sound. Concept maps that scored highly provided evidence of digital literacy.

**Methodology of Case**

The research plan involved creating a performance measure of student learning involving students’ concept maps in the discipline domain of their studies and a performance measure of students’ understanding of the content of the modules, applied to their discipline domains (i.e., a grade derived from an explicit rubric).

Four groups of students were involved in the project over two years (total of 57 students). These groups are smaller than the ideal for the study, but are adequate for undertaking a meaningful statistical analysis. The four modules followed a similar curriculum in which students developed multimedia or e-learning for a content domain of their choice (undergraduate and post-graduate, core and elective modules). The course grades were obtained from a number of components in each module. The assessment framework for one of the modules is outlined in Table 1.

**Classification of Concept Maps**

Concept maps are nonlinear representations and cannot be assessed easily or usefully in a quantitative manner. They are better regarded as holistic units and assessed accordingly in a qualitative manner. An often-used classification scheme for qualitative data is the structure of observed learning outcomes (SOLO) taxonomy. The SOLO taxonomy is based in the study of outcomes in a variety of academic content areas. It was developed by Biggs and Collis (1982), and the application of it is very well described by Biggs (2003). The categories are shown in Table 2.

The final concept maps were submitted after a number of iterations. E-mail records and an instructor reflective diary record that most students went through several drafts before submitting their final versions. The progressive versions illustrated in broad terms

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**Table 1. An example assessment framework for a sample module**

<table>
<thead>
<tr>
<th>%</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Participation</td>
</tr>
</tbody>
</table>
| 20 | The Multimedia Project. There are **FIVE** components.  
1. An analysis of the existing learning environment and reasons for developing a particular multimedia resource (in a discipline of relevance) either as a CD-based material or online. |
| 15 | 2. A design document storyboard. This document is in the form of a story board or other resource that provides a detailed outline. |
| 20 | 3. A multimedia product/resource of your choice.  
4. You are expected to write a **basic** lesson plan for the use of your multimedia-based project or Web site for **TEACHERS**.  
5. A 500-word (minimum) design document that addresses the underlying educational philosophy, selection of multimedia resource tools, and intended educational context in which the multimedia project will be used. |
| 10 | 6. A **CRITIQUE** of a peer multimedia project. |
| 5 | 7. Oral presentation of the multimedia project to the class using PowerPoint. |

**Table 2. Classification categories related to the SOLO taxonomy**

<table>
<thead>
<tr>
<th>SOLO Taxonomy categories</th>
<th>Explanation of SOLO categories</th>
<th>Grading assigned to concept maps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prestructural</td>
<td>Misses the point</td>
<td>1</td>
</tr>
<tr>
<td>Unistructural</td>
<td>Single point</td>
<td>2</td>
</tr>
<tr>
<td>Multistructural</td>
<td>Multiple unrelated points</td>
<td>3</td>
</tr>
<tr>
<td>Relational</td>
<td>Logically related answer</td>
<td>4</td>
</tr>
<tr>
<td>Extended abstract</td>
<td>Unanticipated extension</td>
<td>5</td>
</tr>
</tbody>
</table>
that the complexity and number of hierarchical links and cross-links in concept maps improve with time and coaching, and that creating a concept map was not something in which students were previously literate. The SOLO scores of the final concept maps were moderated during formal discussions with peers who were experienced educationalists. The measure used to compare the SOLO scores of the concept maps was the moderated grades in the modules.

**Concept Mapping and the Relationship to Overall Grades Achieved**

The work involving the relationship between students’ ability to produce meaningful representations in the form of concept maps and their performance in the overall course produced significant statistical outcomes. In Figure 1 each point is a plot for an individual student (or a number of students with the same result) with the SOLO score assigned to the final concept map vs. the final course grade obtained for the module.

The relationship between the SOLO scores for concept maps and the course grades was examined by using the Pearson correlation coefficient rather than a simple rank order correlation for two reasons:

1. There are many levels for the two variables. Also, it is acceptable to treat a variable measured on a five-point scale as a continuous variable.
2. When using a rank order correlation, there will be many ties in the transformed data for the SOLO scores. This will significantly reduce the accuracy of the estimate of the variation of the rank order correlation.

A positive moderate correlation between the two variables (SOLO scores and course grades) was observed ($r = 0.623$) which is statistically significant ($p < 0.000$). With a more robust and complete data set, alternative curve fitting strategies may be of more value.

**Ramifications for Learning Design and Digital Literacy**

It is reasonable to suggest that students with better levels of digital literacy would produce better concept maps. The results, while limited to a relatively small sample, are indicative of the need for incorporating digital literacy into preservice teacher programs. Preservice teacher education is undergoing rapid change worldwide and there is an assumption that “digital natives” are technologically literate, if not digitally literate. This study indicates that there is still a strong need to incorporate appropriate strategies into teaching and learning that enhance and develop literacy in university

**Figure 1. Relationship between SOLO scores for concept maps and course grades**

![](chart.png)
students as up to 16% of the students scored two or less for their final concept maps. However, at least two of the students in this group performed at a B grade.

In the first instance, the modules were intended to emphasize information technology knowledge and skills, preparing preservice teachers with the background to teach the subject of computer and information technology in secondary schools. The second thrust was pedagogical—how to use information and communication technologies (ICTs) more effectively in a range of subjects. The modules undertaken as part of this study were intended to support students in the adoption of more flexible and innovative approaches to using technology in a range of content domains. Concept mapping was introduced in order to encourage deeper approaches to learning and address the need to improve visual and technological literacies. That is, in preservice teacher education, being digitally literate also includes the ability to create learning environments, rather than merely restructuring and repurposing content.

There were a number of issues that may have confounded the outcomes of the project. When building concept maps, students need to take the discipline knowledge they have learned over many years and organize it into a coherent framework. The relationship between concepts is emphasized in such a task and students’ learning is likely to be reinforced by the explicit construction of a representation of their understanding.

There is little research evidence about how Hong Kong students operate with this type of task and what, if any, impact the highly structured school system they have gone through might impact on their abilities to construct relational, personal constructions of knowledge. A book on the “Chinese learner” (Watkins & Biggs, 1996) explores what has become known as the paradox of the Chinese learner. Observers noted Chinese learners using approaches to learning which led to poor outcomes in the West; yet Chinese students performed very well in comparisons with international counterparts. The book on teaching (Watkins & Biggs, 2001) explores this paradox from the perspective of teachers. They note the strict, stern, or authoritarian approach adopted by Chinese parents and teachers following Confucian tradition (Ho, 1996) and considered what impact this early educational environment might have on student learning. In this study, students almost universally stated that they had never undertaken the development of a concept map prior to their current module, and in spite of a highly idiographic written language, struggled with the integration of visual and textual information.

**FUTURE RESEARCH**

The aim of this research was to investigate the relationship between the development of visual representations indicative of digital literacy and a range of learning outcomes of students. The intention was to develop a better understanding of how the development of visual representations by students may be an indicator of a deep approach to learning and their digital literacy. The research involved the instruction in, and development of, concept maps by students as a design and development tool to articulate their understanding of designing of information-rich environments for teaching and learning.

The research established a positive moderate correlation between the scores used to classify the coherence and completeness of the concept maps, and the course grades; this correlation is statistically significant. The data in this small study suggest that digital literacy may not be as complete or widespread among digital natives as believed and should be incorporated into courses of study in ways that encourage more active engagement. This goal is worthy of further investigation.

**REFERENCES**


**KEY WORDS**

**Branching Literacy:** The ability to understand and use nonlinear forms of digital information. (Eshet-Alkalia, 2004)

**Digital Literacy:** Digital literacy involves the ability to find, interpret, comprehend, understand, evaluate, restructure, and repurpose the wide variety of media types that can be stored, downloaded, and/or manipulated using computer hardware and software.

**Digital Natives:** Term used to describe young people who have been brought up in a technologically-rich environment (generally thought to be those born around or after 1984).

**Emotional Literacy:** The ability to operate in a digital world without being subjected to scams or fraud, while simultaneously deriving benefit from the advantages of digital communication (Eshet-Alkalia, 2004).

**Information Literacy:** The ability to find, interpret, understand, evaluate critically, and repurpose information from a wide variety of media types.

**Technological Literacy:** The ability to understand and use (computer) technology to communicate, find and evaluation information, and articulate ideas. Additionally, a technologically literate person understands the impact of technologies on society. It should not be confused with technological competence which relates specifically to the skills needed to use software and/or hardware.

**Visual Literacy:** The ability to critically understand and use images to articulate knowledge and communicate ideas.
INTRODUCTION

In teacher education programs, there is a consistent need to locate and to recommend to teacher educators, teacher candidates, and in-service teachers, viable technology tools and concepts that can be used in the classroom. Digital storytelling is a concept that is growing in popularity and one which offers versatility as an instructional tool. This chapter presents information and ideas on how to facilitate learning, productivity, and creativity through a variety of digital storytelling classroom uses.

BACKGROUND

Storytelling is nothing new and has indeed been a tradition in many families and cultures. However, in an evolving technological age, the trend of storytelling is becoming digital. Digital storytelling uses multimedia software and hardware and “incorporates all available multimedia tools—graphics, audio, video, animation, and Web publishing—into the telling of stories” (Mellon, 1999, p. 46). As the Institute for New Media Studies (2004) notes, “The digital frontier is a dynamic new space for storytelling but its potential has yet to be realized” (¶ 1). Taking a series of still images or moving images and combining them with a narrated soundtrack in order to tell a story is a crucial component of a well-told digital photo story (The Institute for New Media Studies, 2004; Kajder & Bull, 2005).

In teacher education, digital storytelling can be used in many ways including as a tool to promote self-reflection, to illustrate historical perspectives, to promote inquiry, and as a method of technology integration and ongoing instruction. In a K-12 classroom, visual images combined with technological applications have the capability of changing the often teacher-centered, transmission dominated classroom. However, any integration of technology should take place with careful preparation and thought by teachers and students. According to Mason, Berson, Diem, Hicks, Lee, and Dralle (2000), technology should: (a) be “introduced in context”, (b) “extend learning beyond what could be done without technology”, and (c) “be used to encourage inquiry, perspective taking, and meaning making” (p. 108). Weis, Benmayor, O’Leary, and Eynon (2002) make the claim that advances in multimedia and digital technologies have the ability to change teaching and learning as these forms of media enable students to become researchers, storytellers, and historians.

USES OF DIGITAL STORIES

Through past experiences in using digital storytelling tools across content areas/disciplines and classroom levels, the author proposes three primary categories in which a digital story may be categorized: personal, historical, and reflective. Each of these categories is briefly explained and some examples for classroom implementation are given.

Personal Digital Stories

In a personal digital story, an individual may use pictures, video, or other media to tell a story, visually depicting personal history or personal observations of an incident or historical account. This concept for learning could be extended into several classes and content areas for teaching and learning. For example, a student in a psychology class may add his/her voice to a digital story depicting an individual who exemplifies one of Gardner’s multiple intelligences. Or, a foreign exchange student may build a digital story to illustrate her impression of visiting an American school.

In another use, Mellon (1999) developed a digital storytelling assignment using an online conference center in which the instructor could set up a topic or thread. Students added entries and could review others’ entries. She developed threads for storytelling, including threads for “a family member who made an impact on your life and an early childhood memory” (p. 47). Mellon concluded that “students are willing to
create and share stories that reveal their deep personal feelings, stories that they probably would not choose to present orally” (p. 50).

**Historical Digital Stories**

While one may also categorize some personal digital stories as historical, the examples presented here are those types of stories in which, as Tracey Weis noted, “Students become more conscious of, and reflective about, the power and responsibilities of historical synthesis and interpretation” (Weis, Benmayor, O’Leary, & Eynon, 2002, p. 155). In her project, Weis’ students visit online sites and use archival research to learn history, while constructing digital stories which synthesize and interpret what they have visited and reviewed. She notes that the “...objective of this exercise is to encourage students to compare and contrast the content and tone of interpretations presented by public historians in historical sites and academic historians in scholarly journals” (p. 155).

Students may also develop historical accounts of their research through timelines of events and present a multimedia digital story versus the traditional term paper. The *Historical Fieldtrip of Alabama Landmarks* project is such an example (http://www.citejournal.org/articles/mc1.html). In this project, pre-service teachers visited online sites and used archival research to learn history, research, and then report on its historical significance through a digital story. These stories were later used throughout the state by history teachers.

Such assignments are important and illustrate the various ways digital storytelling can be used. Lee (2002, ¶30) further notes: “The availability of these new resources and methods [digital technologies] make for a unique and powerful opportunity to shift the focus of history and social studies instruction from a teacher-centered transmission model to a model that encourages student’s inquiry.”

**Reflective Digital Stories**

Self-reflection is an integral part of teaching and learning; when paired with visual imagery, it allows one to see his/her progress (Salpeter, 2005) and to better link theory with practice. Reflection is a key element in teacher expertise, but this comes by having the ability to notice one’s role, which is often done through the means of video technology (Sherin & van ES, 2005).

With easy access to multimedia tools, an emphasis on learning how to use and integrate technology in teaching and learning, and an increased interest in digital storytelling in many disciplines, it seems that a natural method of reflectivity lies in the use of digital stories. For example, in teacher education preparation, students completing internships or clinical hours may take digital photos of their experiences at beginning, mid-, and end points of their experience. Then, using a program that combines photos, text, music, and narration, the student can create a digital story reflecting upon their growth as a teacher over the course of that semester. Kajder and Swenson (2004) encourage students and teachers to use digital images as “readers and as writers” (p.18), engaging with both “visual and print texts” digitally to allow students and teachers to “envision, understand, and communicate meaning” (p. 18).

**CONCLUSION**

Current technologies offer user-friendly software to quickly and easily create digital stories, with many programs offered free or at low cost, such as Microsoft’s Photo Story 3 or iPhoto from Apple Computer. Further, growth in digital camera ownership makes it easier (and more convenient) for teachers to implement digital storytelling assignments in a classroom. Personal, historical, and reflective digital stories can be used to engage students, encourage inquiry and meaning making, and extend learning all important to technology integration efforts (Mason et al., 2000). As noted by Weis, Benmayor, O’Leary, and Eynon (2002), digital technologies can enable students to become researchers, storytellers, and historians.

**REFERENCES**


Digital Storytelling in Teacher Education


**KEY TERMS**

**Digital Story:** A digital story takes the art of storytelling to a digital medium, utilizing and combining media such as audio, photographs, video, and graphics to tell the story.

**Inquiry:** The act of questioning, probing, examining to obtain information.

**Multimedia:** The process of combining multiple media such as graphics, audio, video, photographs, and animation to create a product.

**Reflection:** Expressing thoughts, perceptions, and expressions of experiences, knowledge, and/or skills evidenced through encounters or events.

**Self-Reflection:** Engaging in reflection of one’s own experiences and encounters (practice) to monitor and measure growth.

**Storytelling:** The art of telling and relating real or fictitious events through the form of a story.
Discussion Groups

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INTRODUCTION

Quality in distance education has been researchers’ and critics’ major concern. The increase in access to digital and online technologies represents not only convenience, opportunities, and flexibility, but also a new challenge for educational institutions. To ensure quality in distance education, a plethora of buzz words have appeared in the realm of distance education: course design, support services, and interaction, as well as administrative practices that can encourage students to fulfill their educational goals. Among the many factors that contribute to the quality of distance education, researchers have suggested that the importance of communication tools stands out from other aspects of the distance learning experience (Diebal, McInnis, & Edge, 1998; Ferrari, 2002; Gibson, 1998; Rangecroft, Gilroy, Tricker, & Long, 2002; Steffensen, 2003; Zhao, 2003). Nowadays, due to the nature of innovative technology, a distance education course without communication tools such as discussion groups will be considered incomplete. Students will miss the “live” human interaction that can enhance the quality of distance education. Moore (2002, p. 69) argues that quality is accomplished in part by promoting interaction “with instructors, classmates, the interface, and through vicarious interaction.” Further, Moore (1989) identified three kinds of interaction in distance education and provided detailed explanations: learner-content, learner-instructor, and learner-learner. Learner-content interaction indicates that construction of knowledge occurs when the learner interacts with the course content and changes in one’s understanding occur when the new knowledge is integrated with preexisting knowledge. Learner-instructor interaction reinforces the learner-content interaction using engagement and dialogue exchange to promote the teaching/learning process with examples, discussion, and so forth. Learner-learner interaction is vital in distance education if participation in class discussions is to take place (as cited in Wickersham & Dooley, 2006, p. 186). Among communication tools such as e-mail and chat rooms, discussion groups are considered an effective tool that allow students to interact with other students and with the instructor. There is no doubt that discussion groups will enhance quality in distance education. Why are researchers interested in the relationship between discussion groups and quality in distance education? This is because they wish to measure learners’ critical thinking skills. It is commonly argued that relevant/robust discussion among discussion groups can lead to learners’ critical reflection. It is Westerners’ belief that it is in relationship with others that we learn. How has this belief been deeply rooted in people’s minds? Some background information will help explain this.

BACKGROUND

Researchers (Irani & Telg, 2001, 2002; King, 1999; Spotts, 1999; Telg, 1995) have emphasized that adequate distance educational instructional design should be provided to those developing distance education courses to sustain a quality program. Instructional design principles were widely studied in the 1950s and 1960s in the United States. Gagne (1985) indicates that factors that collectively influence learning are called the conditions of learning. He further suggests that some of these conditions pertain to the stimuli that are external to the learner. Discussion groups can be considered external stimuli that can ultimately influence learning. According to Gagne, Briggs, and Wagner (1992), good principles of instructional design refer to controllable instructional events. The designer of instruction, and also the teacher, can readily devise situations that include these principles such as contiguity, repetition, and reinforcement (Gagne et al., 1992, p. 8). Gagne et al. (1992) argues that the events of instruction involve the following kinds of activities in roughly this order, relating to the learning process:

1. Stimulation to gain attention to ensure the reception of stimuli
2. Informing learners of the learning objective, to establish appropriate expectancies
Discussion Groups

3. Reminding learners of previously learned content for retrieval
4. Clear and distinctive presentation of material to ensure selective perception
5. Guidance of learning by suitable semantic encoding
6. Eliciting performance, involving response generation
7. Providing feedback about performance
8. Assessing the performance, involving additional response feedback occasions
9. Arranging variety of practice to aid future retrieval and transfer (pp. 11-12).

Discussion groups are considered one of the important events of instruction. It is expected that teachers will control these in order to achieve quality in distance education. To fail to initiate meaningful discussion in distance education is to fail to understand principles of instructional design. Based on principles of instructional design, there is a plethora of techniques that instructors should follow in order to facilitate discussion groups.

TECHNIQUES IN FACILITATING DISCUSSION GROUPS

Some of the generic challenges associated with developing discussion in distance education are as follows: instructors’ and students’ technical skills, constraints on writing skills, reticence, and access to technology (Hammond, 1997). Hammond (1997) also found that adding structure may reduce flexibility and the sense of being “distant” may contribute delays in participation. From their study from their online class, Chase, MacFadyen, Reeder, and Roche (2002) identified nine emergent themes:

1. An online culture developed reflecting the values of the developer of the Web environment. That culture was maintained by the guidelines created and by the facilitators and participants.
2. Formal and informal participation was affected in the online environment and distinct communication pattern differences were apparent between the two.
3. Individuals varied with their level of comfort in online discourse.
4. Individuals created their own online identity.
5. Technical issues and formatting influenced communication.
6. Participant expectations of the course, the instructor, and the medium influenced the environment.
7. Facilitator expectations also affected the learning environment.
8. Differences in communication related to the use of academic discourse vs. the telling of stories or narratives were observed and created variation in participation in online debate.
9. Explicit and implicit assumptions about time were evident.

Based on the common issues, challenges, and principles of instructional design, meaningful discussion that leads to students’ critical reflection can be arranged. Instructors need to take into consideration levels of communication. Levels of communication include lower levels of communication and higher levels of communication. Some researchers (Sorensen & Baylen, 2004) call the lower levels of communication initiating and supporting and higher levels of communicating challenging, summarizing, and monitoring. Sorensen and Baylen (2004) argue that higher-level communication may facilitate not only an in-depth discussion of issues but also promote metacognition, that is, thinking about thinking, which is a critical thinking skill.

To facilitate discussion groups, it is not a bad idea to apply Bloom’s (1956) taxonomy by asking the right kinds of questions based on levels of communication needed. Bloom (1956) identified six levels within the cognitive domain, from the simple recall or recognition of facts, at the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation. Verb examples that represent intellectual activity on each level are listed:

1. **Knowledge:** Arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce, state.
2. **Comprehension:** Classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate.
3. **Application:** Apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write.
Based on the levels of communication, Bloom’s taxonomy and principles of instructional design, instructors should ask six levels of questions to generate meaningful discussions in distance education. To generate knowledge, questions can go like this, “Who, what, when, where, how...?” To encourage application, a question can be formulated like this, “Retell...” To encourage analysis, ask the following questions, “How is...an example of...? How is...related to...? Why is...significant?” For students to achieve synthesis, questions can be formulated like this, “What are the parts or features of...? Classify...according to... Outline/diagram... How does...compare/contrast with...? What evidence can you list for...?” For synthesis, these are useful questions, “What would you predict/infer from...? What ideas can you add to...? How would you create/design a new...? What might happen if you combined...? What solutions would you suggest for...?” For the last level, evaluation, questions can be posed like this, “Do you agree...? What do you think about...? What is the most important...? Place the following in order of priority... How would you decide about...? What criteria would you use to assess...?”

Techniques in facilitating discussion groups in distance education are not limited to the above mentioned ones. However, from levels of communication to Bloom’s 1956 taxonomy, theoretical bases regarding developing discussion groups can be found.

CONCLUSION

One way of increasing and enhancing quality in distance education is by providing relevant/robust discussion groups between instructors and students. Good discussions reflect good principles of instructional design on the part of the instructors. Teachers must develop controllable discussion groups and meaningful discussions according to principles of instructional design. Instructors cannot assume that their students know how to discuss or behave in a discussion format (Sorensen & Baylen, 2004, p. 125). Discussion groups and discussion should be structured according to levels of communication and Bloom’s taxonomy. Interaction will be meaningless if it aims to have activities for the sake of activities only. Interaction will be meaningful if it aims to enhance students’ thinking about thinking, hence critical thinking skills. Information technologies can only serve as tools. It is the teachers who can really make a difference in ensuring quality in distance education by following good principles of instructional design.

REFERENCES


Discussion Groups


KEY TERMS

**Bloom’s Taxonomy:** Benjamin Bloom (1956) created this taxonomy for categorizing levels of abstraction of questions that commonly occur in educational settings. The taxonomy provides a useful structure in which to categorize test questions. Since professors will characteristically ask questions within particular levels, and if you can determine the levels of questions that will appear on your exams, you will be able to study using appropriate strategies. Many teachers apply Bloom’s taxonomy to discussion groups in distance education and Bloom’s taxonomy has proved effective in facilitating discussions in distance discussion.

**Communication Tools:** Communication tools refer to three forms of electronic communication in distance education courses—e-mail, discussion groups, and chat rooms.

**Conditions of Learning:** Gagne (1985) defines conditions of learning as a whole set of factors that influence learning. Some conditions are external stimuli while other conditions are internal conditions. According to Gagne (1985), internal conditions are states of mind that the learner brings to the learning task. They are previously learned capabilities of the individual learner. These internal capabilities appear to be a highly
Discussion Groups

Discussion Groups: Discussion groups make discussions on bulletin boards or via threaded discussions. Some people prefer large discussion groups because they wish to read everyone’s responses while others prefer small discussion groups because they wish to participate more in discussions and ask questions. Some instructors require that participation in discussion groups should be part of their participation grades whereas other instructors do not require this.

Instructional Design: Instructional design is based upon some principles of human learning, specifically, the conditions under which learning occurs. Some time-tested principles of contiguity, repetition, and reinforcement indicate some of the conditions external to the learner that can be incorporated into instruction. The purpose of instruction is to arrange external events that support learners’ internal learning processes. Arranging discussion groups in distance education is one essential component of instructional design.

Interaction: Interaction refers to the act of communicating with someone through conversation, looks, or action. The verb for interaction is interact: The couple interacted wordlessly with their eyes. For discussion groups in distance education, interaction is made possible via information technologies.

Reflection: Reflection is thinking for an extended period by linking recent experiences to earlier ones in order to promote a more complex and interrelated mental schema. The thinking involves looking for:

- Commonalities
- Differences
- Interrelations beyond their superficial elements.

The goal is to develop higher order thinking skills. Many educators consider Dewey (1933) the modern day originator of the concept of reflection, although he drew on the ideas of earlier educators, such as Aristotle Plato, and Confucius. He thought of reflection as a form of problem solving that chained several ideas together by linking each idea with its predecessor in order to resolve an issue.
INTRODUCTION

The father of adult education, Malcolm Knowles (1913-1997), predicted in the 1970s that teaching, especially the teaching of adults in the 21st century, would be delivered electronically (1970, 1975). His prediction came true. Distance education was created primarily to meet the needs of working adults who could not come to campuses to take classes because of work and family responsibilities. Today’s academic institutions are in transition. Although colleges continue to attract 62% of high school graduates onto their campuses immediately following graduation, larger numbers of so-called nontraditional learners also are seeking degrees via distance education (Hammonds, Jackson, DeGeorge, & Morris, 1997; Palloff & Pratt, 1999). In response to Knowles’s prediction, giant online universities have been established to meet the increasing demand of degree-seeking working adults. For example, in 2002, the University of Phoenix, part of the Apollo Group, saw its enrollment surpass 100,000 students, making it the largest institution of higher learning in the United States (Bash, 2003). Without its new electronic delivery system, teaching of such a large number of students would be unimaginable. Thanks to the development of information technology (IT), it has solved many problems by changing the roles of students and faculty.

One of the immediate problems that instructors face with IT in distance education is adult learners’ learning style. Some instructors go the extra mile to accommodate learners’ learning styles. From course syllabi, course design, and media rich delivery systems, they do everything they can to make their courses meaningful to adult learners who may have different learning styles. Other instructors may just dump their courses onto computer screens, making no further efforts to take into consideration learners’ learning styles. In fact, the existence of distance education is, to some extent, justified by learners’ learning styles. Open any books regarding distance education and learning styles, and there will be descriptions about introverted and extroverted students. Introverted students are believed to become confident at expressing themselves and providing more thoughtful responses to their assignments (Bradshaw, 1997; Klemm, 1997; Palloff & Pratt, 1999; Wang, 2002). On the other hand, extroverted students may not like the asynchronous nature of distance education. Without a doubt, there is an intricate relationship between distance education and learning styles. Although the debate has been revolving around the differences between face-to-face interaction with students and online learning and technology enhanced instruction, distance education learners may achieve the same learning results as traditional classroom learners if their learning styles are better accommodated. For those who have been critical of distance education, this article provides a good opportunity to find out more about distance education and learning styles.

BACKGROUND

Distance education, with its roots in correspondence education, has had more than 150 years of history in the United States (Gibson, 2006, p. 148). As IT further develops, colleges and universities have applied these advancements to distance education (Rhoda, 2005, p. 149). Students, who enroll in college courses, complete their degrees that are offered online, by CD-ROM, or in studios through ISPN (integrated services packet network) lines or IP (Internet protocol) video. As Rhoda (2005) notes, “most institutions of higher education have concentrated their efforts on the conversion of their face-to-face to an online format. It is this delivery mechanism, offered in anytime, anywhere virtual classroom, that has attracted increasing numbers of students” (p. 149). It is not surprising when a university president reports that its university has put one-third of all of its courses online. Developing countries also started distance education from correspondence courses. Because they have a large population, developing countries have successfully used radio and TV to deliver courses to students and learners. As technology
adoption penetrates into every society, even developing countries have started to deliver courses via IT.

As distance education became more and more popular, researchers began to study learners’ learning styles to find out whether instruction matched students’ learning-style preferences and whether students’ learning outcomes can be improved because of this kind of accommodation of students learning styles. To date, a plethora of scholars and researchers have provided practical insights into learning styles. For example, Dunn’s (1984) learning styles focus on five (environmental, emotional, sociological, physiological, and psychological) strands that affect each individual’s learning. Gregorc’s (1982) style delineator approach (SDA) is based on studies into the functions of the left and right brain hemispheres. His system of learning takes into account the different ways of perceiving and ordering information. Table 1 above contains a detailed explanation about Gregorc’s SDA.

Such zealous interest in learning styles is not without a solid reason. Researchers and practitioners want distance education like any other forms of education to be learner-centered education. Learner-centered distance education must strive to accommodate learners’ learning styles in order to maximize learning.

**THE ROLES OF FACULTY AND LEARNING STYLES**

To say that learners basically have three learning styles—visual, auditory, and tactile—is to oversimplify learning styles. One’s learning style is such an individual and complex process that it may defy any one learning style inventory. Learning style is commonly defined as the way in which each person absorbs and retains information and/or skills. It refers to the way in which each individual collects, organizes, and transforms information. Among other things, it influences the setting in which people learn best, the kind of subjects they want to learn about, and how they will approach the learning situation (as cited in Wang, 2006, p. 156). Because adult learners are capable of self-directed learning, instructors have to be a guide on the side instead of being a sage on the stage (Brown, 2006). For distance education to be effective, instructors can no longer teach the way they were taught. In fact, principles on learning styles have been generated. Distance education instructors need to follow these principles accordingly. Among these principles, Friedman and Alley (1984) developed the most authoritative principles:

- Both the style by which the teacher prefers to teach and the style by which the student prefers to learn can be identified.
- Teachers need to guard against teaching by their own preferred learning styles.
- Teachers are most helpful when they assist students in identifying and learning through their own style preference.
- Students should have the opportunity to learn through their preferred learning style.
- Students should be encouraged to diversify their style preference.
- Teachers can develop specific learning activities, which reinforce each modality or style.

Grow’s (1991) study indicates that distance education instructors must change their roles in order to accommodate learners’ learning styles as learners may go through four different stages ranging from “dependent” to “self-directed.” Table 2 illustrates the situational roles of distance education instructors in relationship to learners’ learning styles. Wang (2004, 2007) points
Distance Education and Learning Style

Table 2. Grow’s stages in learning autonomy

<table>
<thead>
<tr>
<th>Stages</th>
<th>Learner</th>
<th>Educator</th>
<th>Methods/Styles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Dependent</td>
<td>Coach</td>
<td>Coaching with immediate feedback, drill. Informational lecture</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Interested</td>
<td>Motivator</td>
<td>Inspiring lecture plus guided discussion. Goal-setting</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Involved</td>
<td>Facilitator</td>
<td>Discussion facilitated by teacher who participates as equal.</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Self-directed</td>
<td>Consultant</td>
<td>Internship, dissertation, self-study</td>
</tr>
</tbody>
</table>

Figure 1. Model of learning styles and teaching methods

out that the order of learners’ stages of learning may not be sequential. Some learners may not necessarily go through Stage 1 and Stage 2 before they reach Stage 4. However, going through stages of learning is indicative of their varying learning styles. And instructors’ roles must be changed accordingly.

Wang’s (2004, 2007) study further confirms that learners’ learning style is only one of many other factors that determine instructors’ roles and teaching methods. Other factors such as philosophies, learner needs, learner experience, and learner motivation all affect the way a distance education instructor may choose to teach a class. The following model (Figure 1) is also indicative of the fact that learning style is closely related to other factors such as learner experience and learner needs.

CONCLUSION

The mission of distance education is to help students develop a positive attitude toward lifelong learning, acquire skills to be self-directed, and achieve self-actualization by taking responsibility for their own lives (Wang, 2004, 2007). Adult learners are a heterogeneous group. Therefore, their learning styles differ. Instructors are most helpful in delivering effective instruction via distance education if they take into consideration learners’ different learning styles. As Reiff (1992) notes,

*We all have unique fingerprints. We all sign our names in different ways. We don’t expect people with high blood pressure to take the same medicine. Neither should we expect all students to learn the same way or all teachers to teach the same way (p. 5)*.

IT does have the potential to solve many problems in distance education. However, like all other factors, learners’ learning styles call for accommodation from distance education instructors. Unless instructional methods match students’ learning style preferences, learner-centered education cannot be expected to occur in distance education. Like in the 1990s, the 21st century will witness renewed interest in the relationship between distance education and learning style.
REFERENCES


KEY TERMS

Correspondence Education: Correspondence education is commonly defined as a method of providing education to nonresident students, who receive lessons and exercises through mails and, upon completion, return them for analysis, criticism, and grading to the college or university concerned. It is being increasingly used by students, business and industry in training programs, by men and women in the armed forces, and by the governments of many nations as part of their educational programs. It supplements other forms of education and makes independent study programs readily available.

Emotional: This strand refers to motivation, persistence, responsibility, and structure. For example, some people must complete a project before they start
a new one, and others work best on multiple tasks at the same time (persistence element).

**Environmental:** The environmental strand addresses elements of lighting, sound, temperature, and seating arrangement. For example, some people need to study in a cool and quiet room, and others cannot focus unless they have music playing and it is warm (sound and temperature elements).

**Psychological:** The elements in this strand represent the following types of psychological processing: hemispheric, impulsive or reflective, and global vs. analytic. The hemispheric element refers to left and right brain processing modes and the impulsive vs. reflective style describes how some people leap before thinking and others scrutinize the situation before moving an inch. Global and analytic elements are unique in comparison to other elements because these two elements are made up of distinct clusters of elements found in the other four strands. The elements that determine global and analytic processing styles are sound, light, seating arrangement, persistence, sociological preference, and intake. Global and analytic processing styles will be discussed in detail in the next section.

**Physiological:** The elements in this strand include perceptual (auditory, visual, tactile, and kinesthetic), time-of-day energy levels, intake (eating or not while studying), and mobility (sitting still or moving around). For example, many people refer to themselves as night owls or early birds because they function best at night or in the morning (time-of-day element).

**Sociological:** The sociological strand includes elements related to how individuals learn in association with other people: (a) alone or with peers, (b) an authoritative adult or with a collegial colleague, and (c) learning in a variety of ways or routine patterns. For example, a number of people need to work alone when tackling a new and difficult subject, while others learn best when working with colleagues (learning alone or with peers element).

**Style:** According to *Newbury House Dictionary of American English*, style is both a countable noun and an uncountable noun, meaning the particular way that something is done. For example, her writing style very simple and clear.
**INTRODUCTION**

Time and space no longer separate learners from their instructors. The emergence of distance-learning technologies, especially the Internet and networking technologies connect learners with their instructors. Instructional resources such as training courses, instructional job aids, reference materials, training guides, and lesson plans, as well as teachers, trainers, and other learners that were traditionally available for traditional classroom settings are now attainable via distance-learning technologies by anyone, anywhere, and anytime. As the growth of new information in the digital age accelerates (Gagne, Wager, Golas, & Keller, 2005), the debate revolving around distance-learning essentials has become even more heated among the academic circles. One side of the debate, represented by senior faculty, indicates that distance learning is inferior to traditional classroom learning because it lacks the necessary “face-to-face” interaction. The other side of the debate, representing current researchers and junior faculty, contends that distance learning is no better or no worse than traditional learning, given the fact that distance learning offers both advantages and disadvantages. The same thing is true about traditional classroom learning, which also offers benefits and disadvantages. Regardless of the debate, distance learning is revolutionizing education and training, along with so many other aspects of our lives (Gagne, et al., 2005). Open any job ads for a faculty position and there must be a description requiring a potential faculty member to be able to use distance-learning technologies. Those faculty members who cannot use distance-learning technologies are truly at a disadvantage nowadays.

Indeed, today’s academic institutions are in transition because of distance-learning technologies (Wang, 2005). As colleges continue to attract 62% of high school graduates onto their campuses immediately following graduation, larger numbers of so-called nontraditional students also are seeking degrees (Hammonds, Jackson, DeGerga, & Morris, 1997). According to Twigg (1994), traditional undergraduates represent fewer than one fourth of the students on college campuses. In a similar fashion, the most recent National Center for Education Statistics (NCES) survey of adult education participation indicates that the overall of participation in formal educational activities was 46% (Merriam, Caffarella, & Baumgartner, 2007, p. 56). This rate does not include those nontraditional learners who participate in informal educational activities (those that do not involve an instructor). To accommodate the learning needs of nontraditional learners, more and more institutions of higher learning have begun to use distance-learning technologies to deliver courses at a distance as well as to enhance educational programs that are delivered on campus (Wang, 2005, p. 36). Like other forms of learning, distance learning is geared toward intellectual growth and development (Merriam, 2004). Some background information regarding distance learning will assist both educators and learners in better understanding distance-learning essentials, hence strategic approaches in distance learning.

**BACKGROUND**

Distance learning, with its roots in correspondence education, started 150 years ago in the United States (Gibson, 2006). At about the same time, correspondence education surfaced in other parts of the world. Later, in the 1940s, 1950s, and even 1960s, radio and TV broadcasts were used to deliver courses to learners in other countries. For example, distance education has appeared in eight types of higher education in China:

- Radio/TV universities
- Correspondence departments of regular institutions
- Evening colleges attached to regular institutions
- Workers’ colleges
- Independent study examination for higher education
- In-service colleges for administrative staff
Distance Learning Essentials

- In-service teacher-training colleges
- Peasants’ colleges (Yu & Xu, 1988).

However, in the United States during the late 1980s and early 1990s, the Internet grew at a rapid pace (Gagne, et al., 2005). The Internet was originally designed in the early 1960s by the U.S. Department of Defense, and the network was widely used in the 1980s by the military and universities connected through telephone lines (Gagne, et al., 2005). By 2002, the Internet had become an international platform with over 680 million users (Global Reach, 2003). Even universities in developing countries began to deliver courses via the Internet. The Internet has truly become the chief delivery mode of distance learning around the globe. It is not surprising to anyone nowadays if a university puts one third of its courses online. In response to this rapid development of distance-learning technologies, giant online universities have emerged in the United States. As noted by Bash (2003, p. 50), “in 2002, the University of Phoenix, part of the Apollo Group, saw its enrollment surpass 100,000 students—making it the largest institution of higher learning in the United States.”

As distance-learning technologies continue to revolutionize education and training, researchers constantly ask what may be the strategic approaches of distance learning in order to ensure learning at a distance. The following section attempts to address distance-learning essentials. Distance-learning essentials are meant to guide both instructors’ and learners’ action in the distance-learning environments. Without a better understanding of distance-learning essentials, teaching and learning in the distance-learning environment will lead to mindless activism. Mindless activism will not result in active learning. To put this in plain language, mindless activism will not lead to learners’ intellectual growth and development. Therefore, it is imperative that both instructors and learners familiarize themselves with distance-learning essentials and strategic approaches. In the next section, distance-learning essentials and strategic approaches are used interchangeably.

STRATEGIC APPROACHES TO CONSIDER

Like traditional learning, distance learning also uses strategies such as decentralization and centralization. Some institutions encourage their faculty to apply decentralization while other institutions encourage their faculty to apply centralization, depending on an institution’s vision regarding distance learning. A vision statement addresses expectations in terms of the ideal way in which decisions will be made and how the distance-learning organization will operate (Gagne, et al., 2005). Decentralization via distance learning is characterized by syllabus-based projects, learning activities, and teaching tools that are designed to create collaborative learning environments and relevant experience for students, whereas centralization is characterized by a mostly teacher-centered, information-based and test-driven instructional format (Wang & Kreysa, 2006).

It is generally agreed that those who are involved in helping learners learn via distance-learning technologies need to develop knowledge of learning theories and instructional strategies. No two people learn in exactly the same manner, and instruction must vary in order to ensure active learning at a distance. Decentralization features student-centered learning, whereas centralization features teacher-directed learning. Other approaches that work well with decentralization are constructivism and problem-based learning (PBL) models. According to March (1995), constructivism suggests that truly comprehensive understanding of a complex topic comes from learners stitching together the facts, relationships, perspectives, variations, and non-examples from an array of contextually rich inputs. Brookfield (2000) explains the constructivist approach as focusing on helping learners realize their own experience in a collaborative but critical way. Distance learning is enhanced by problem-based learning models (PBL) that differ from lecture-based classes, and are usually predicted on a great deal of self-directed learning and collaboration. Learners are supposed to teach themselves what they need to know to solve a problem (Duch, 2005). Decentralization characterized by constructivist approaches and PBL models allows learners to take a greater responsibility for learning (Golas, 2000) by actively creating their own learning, and relating the information to real-world problems (National Research Council, 1997; Siegel & Kirkley, 1997). Decentralization will not be possible without a thorough understanding of adult learning theory, where learners are expected to voluntarily enter an educational activity with a life-centered, task-centered, or problem-centered orientation to learning (Long, 2004).
Centralization on the other hand, features teachers as the information disseminators, knowledge dictators. Lecture is the chief delivery mode of centralization. Learners are expected to assume a submissive role of following their instructors. Centralization stems from the theory of pedagogy upon which learners are considered incapable of self-direction in learning and that teachers must be in control. Then the next question arises that may ask when to use decentralization vs. centralization in distance learning.

The answer depends on the thorough understanding of the distinction between the theory of andragogy and the theory of pedagogy. Andragogy specifies that learners are self-directing, deriving only positive benefits from prior experience, possessing great readiness to learn, voluntarily entering an educational activity with a life-centered, task-centered, or problem-centered orientation to learning and internally motivated (Long, 2004). Once learners are identified as andragogical learners, decentralization is a must via distance learning. Other approaches may frustrate learners who yearn for andragogical methods. However, this is not to suggest applying only decentralization to andragogical learners only. Even andragogical learners expect centralization when they are inexperienced with a subject matter and when they have learned to be dependent learners. The best time to use centralization is when learners are categorized as dependent learners with little prior experience. They are ready to learn only when their teachers tell them to learn. They learn in order to pass and their teachers prescribe a fixed curriculum. These learners are usually externally motivated instead of internally motivated. This is the so-called theory of pedagogy (the art and science of teaching children whereas andragogy is defined as the art and science of “helping” adults learn). Traditional learners normally fall into this category.

Yet, the best approach is flexibility. Writing in 1990, Brookfield describes flexibility as:

The teaching and learning process is a complex interaction between the learner, the instructor, and the variables in the environment. Effective instruction must be adaptive to unexpected or unknown characteristics of the situation. It can be as simple as the willingness to repeat or rephrase an explanation or as complex as the redesign of a segment of instruction, based on the needs of a particular group. Flexibility can facilitate learning by better meeting the needs of the audience. These are often characteristics of the learners that the instructor is not aware of until instruction is in progress (pp. 63-64).

Applying Brookfield’s approach, flexibility also means that instructors need to move freely from centralization to decentralization and vice versa. Only when instructors are in a position to do this in distance-learning environments, have they mastered the strategic approaches in distance learning, hence distance learning-essentials.

CONCLUSION

As more and more institutions turn to distance-learning technologies to enhance learning at a distance in the 21st century, it is imperative that distance-learning educators be familiar with learning theories and salient instructional approaches in order to ensure that learning can occur at a distance. Distance-learning educators are ill-equipped when they fail to apply distance-learning essentials, namely, learning theories, learner characteristics, and instructional approaches that are derived from learning theories and learner characteristics. As the growth of new information in the digital age accelerates, learners access knowledge via multiple access points. And technology is without a doubt one access point that leads to knowledge. Distance-learning educators are charged with the responsibility of helping learners learn at a distance. Since distance-learning educators are faced with a heterogeneous group of learners, distance-learning educators should design activities that address various modes of learning in order to provide significant experiences for each class participant. This can best be accomplished by utilizing multiple instructional strategies. Instructional strategies should be derived from distance-learning essentials. Distance-learning essentials offer guiding principles to both distance-learning educators and learners. Distance-learning essentials are meant to offer both personal and professional insights to educators and learners. With knowledge of distance-learning essentials, distance learning may prove to be a cost-effective enterprise in the educational arena in the 21st century.
REFERENCES


KEY TERMS

Andragogy: The term was first coined in 1833 in Europe by a German grammar teacher. It was first introduced to North America in the early 1970s by the father of adult education, Malcolm Knowles (1913-1997). Knowles defines the term as the art and science of helping adults. There are six principles attached to andragogy. Instructors of adults are supposed to be learning facilitators, linking students to learning resources. Students are not supposed to assume a submissive role of following their instructors. Learners are allowed to negotiate course contents and assignments with their instructors. Involving learners in the learning process.
is recommended in adult learning. Instructors are supposed to use informal evaluation to evaluate students’ work. Since Knowles emphasizes the helping role of instructors, teachers are supposed to be a guide on the side instead of a sage on the stage. The principles of andragogy work best with distance education.

**Centralization:** This refers to the process of concentrating authority and decision making in the center, or at the top of the hierarchy, of an organization. When this concept applies to teaching, it may mean that teachers make the curricula for the students. The teachers select instructional methods according to their own preferences. The teachers make a decision as to how much students need to learn from them and the curricula, and the evaluation method is normally formal. In some other cultures such as in China, centralization may mean that teachers teach to tests, expound on required textbooks. Teaching is characterized by the teacher-dominated mode of instruction.

**Constructivism:** This refers to the process whereby perceptual experience is constructed from, rather than being a direct response to the stimulus. This approach to teaching and learning is based on a combination of a subset of research within cognitive psychology and a subset of research within social psychology, just as behavior modification techniques are based on operant conditioning theory within behavioral psychology. The basic premise is that an individual learner must actively “build” knowledge and skills and that information exists within these built constructs rather than in the external environment.

**Decentralization:** This refers to the process of moving from one larger center of activity, authority, and so forth, out into several smaller centers. When this concept applies to distance education, it may mean that teaching is student-centered. In other words, instruction via distance education may be syllabus based and content-centered. Instructors may assume the role of learning facilitators, linking students to learning resources. In some instances, students may determine as to what to learn, how to learn, and when to learn. Some instructors may allow students to negotiate assignments with them in order to increase students’ involvement and participation in the learning process. This concept is often applied in democratic countries. Educators in authoritarian countries may not like the idea of decentralization in teaching and learning.

**Distance Learning:** Distance learning (DL) is defined as learning via telecommunications. The term telecommunications embraces a wide variety of media configurations, including radio, telephone, television, and the Internet. The Greek root word “tele” means “at a distance” or “far off.” Heinich, Molenda, Russell, and Smaldino (2002) define distance education as a form of education characterized by the following:

- Physical separation of learners from the teacher
- An organized instructional program
- Technological media
- Two-way communication (p. 268).

**Flexibility:** The literal meaning of this word means the ability to adapt prearranged and prepared procedures to the circumstances. In distance education, learners are a heterogeneous group and possess different characteristics. Plus, these learners may have different learning styles. Most of distance-education learners are adult learners. According to the principles of andragogy, adult learners are normally self-directed learners. They are internally motivated learners. Their learning is usually contextual. However, this is not to say that instructors can only be learning facilitators. When adult learners are inexperienced with a subject matter, for example, computer science, instructors need to be knowledge dictators in order to help learners lay a solid foundation. When learners are self-directed, instructors can assume the role of learning facilitators.

**Knowledge Dictator:** When a teacher is labeled with this name, the teacher usually sticks to one method of teaching such as lecture. The teacher believes if he/she does not do most of the talking, learners will not learn. A knowledge dictator normally assumes the roles of a coach or director. And their relationship with learners is directing rather than helping. A knowledge dictator believes that if he/she is not in control, learners will not learn. Communication with learners is one way, for example, top-down.

**Problem-Based Learning:** Problem-based learning starts with a problem, or a query, that the learners wish to solve. It has been introduced into profession preparation, helping learners problem-solve actual practical cases in an attempt to overcome the theory-practice divide. This approach started originally in the medical world. Later it was introduced to law enforcement and other fields, including adult education and
distance education. According to principles of adult learning, adult learners possess great readiness to learn, voluntarily enter an educational activity with a life-centered, task-centered, or problem-centered orientation to learning. Therefore, adult learning is contextual to some extent. Problem-based learning seems to be one of the best approaches that should be applied to adult learning. Since most of the learners are adult learners in distance education, this approach works best with distance education as well.
Distance Learning Specialists

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INTRODUCTION

As Rhoda (2005) notes, “advances in technology have transformed the way in which the academy offers its curricula” (p. 149). Further, the proliferation of advanced technologies for teaching and learning has been said to help provide better access, convenience, and flexibility as a way to support learners’ educational opportunities (Conceicao, 2006). Nowadays, simple physical separation between the teacher and learner is no longer an effective way of describing distance education. Scholars try to define distance education from every imaginable angle they can think of due to the nature of innovative technology. For example, King (2006, p. 16) defines distance education as any of the following:

• The working mother in rural Nebraska completing her bachelor’s degree online through her local state university while her children sleep at night.
• The single young man in New York City studying for the GED exam via public television and telephone tutoring.
• The midcareer business woman executive pursuing her doctorate in education via a hybrid online and residency program in order to change careers.
• The retired bus driver engaged in a collaborative Webinar for his class through a University of Beijing class on the Eastern perspective of global issues.

Although distance education has successfully increased higher education opportunities, an ongoing research question in this field has been whether advances in technology can result in quality distance education programs. Some of the easy solutions point to such factors as course design, support services, and interactions, as well as administrative practices that can encourage students to fulfill their educational goals. Much of the research related to distance education has focused on the changing role of the instructor, teaching tasks, faculty planning, design, and delivery. However, research on what has contributed to the changing role of the distance learning specialist is limited. Behind the changing role of the distance learning specialist lies a plethora of pedagogical and andragogical issues associated with the quality distance education programs. Yet one line of scholars are familiar with pedagogy, the art and science of teaching children; the other line of scholars are well versed in andragogy, the art and science of helping adults. Very few researchers realize that it is these pedagogical and andragogical principles that define the changing role of the distance learning specialist. And the changing role of the distance learning educators ultimately leads to quality distance education programs. Technologies alone can only enhance quality instruction. It is the distance learning specialists that are the deciding factors of quality distance learning programs.

BACKGROUND

Critics assert that online learning and even classroom-based technology-enhanced instruction either misses or somehow compromises essential human interaction (Brown, 2006, p. 97). It is true that it is in relationship with teachers (others) that we learn. However, both critics and scholars pay less attention to either pedagogical or andragogical principles that are the driving forces behind the teaching of distance education specialists. Although assumptions about teaching children (pedagogy) evolved between the 7th and 12th Centuries in the monastic and cathedral schools of Europe out of teachers’ experience in teaching basic skills to young boys (Knowles, Holton, & Swanson, 2005), it is adult learners that have enjoyed distance education since its early inception in the 1800s. Therefore, principles regarding how adults learn and how they should be taught over the information highway need to be investigated. Most Western scholars seem to buy into Rogers’ (1951) hypothesis in that we cannot teach an adult learner directly; we can only facilitate his/her learning. Rog-
Distance Learning Specialists

ders based this hypothesis on his personality theory that “every individual exists in a continually changing world of experience of which he/she is the center” and “the organism (the adult learner) reacts to the field as it is experienced and perceived.” This hypothesis requires a shift in focus from what the teacher does to what is happening in the student. In its modern sense, scholars have translated this paradigm shift into “distance learning specialist moving from the sage on the stage to the guide on the side” (Brown, 2006, p. 102). In the contemporary literature of distance education, the term “facilitator” instead of the “guide on the side” is found, no matter what type of technology is used (as cited in Conceicao, 2006, p. 27). At any rate, this is the actual application of Rogers’ (1951) hypothesis derived from his personality theory.

Other scholars took Rogers’ hypothesis one step further by using analogies. It is true in this information age, technology provides multiple access points to knowledge. Scholars’ use of analogies is greatly justified. For example, Jarvis (2002) argued that teachers including distance learning specialists are not the “fount of all wisdom” (p. 20). Based on his application of Rogers’ hypothesis, distance learning specialists no longer:

- Have a monopoly on transmitting knowledge;
- Determine or legislate on matters of knowledge but they may be interpreters of different systems of knowledge;
- Deal with truth but they certainly teach truths;
- Teach with unchanging knowledge, but now they deal with scientific knowledge that is transient;
- Are confined to the classroom, but like the ancient teachers, they may have to function where their learners are;
- Teach only theoretical knowledge but now they also help learners acquire practical knowledge;
- Can assume that their learners know nothing about the subjects that they teach, but must learn to build on knowledge acquired by their learners from a wide variety of sources.

This analysis of Rogers’ (1951) hypothesis seems to have addressed critics’ concern regarding human interaction. A closer examination of Jarvis’ (2002) analogy reveals a different kind of human interaction between distance learning specialists and adult learners other than the kind of interaction critics have expected.

DEFINING THE ROLE OF DISTANCE LEARNING SPECIALISTS

Numerous scholars (Anderson, Rourke, Garrison, & Archer, 2001; Conceicao-Runlee & Reilly, 1999; Easton, 2003) have tried to define the role of distance learning specialists from different angles. None of their definitions deviate too much from Rogers’ (1951) hypothesis derived from his personality theory. Conceicao-Runlee and Reilly’s (1999) study describes the role of distance learning specialists as facilitators who move from the center of instruction to the sidelines. Anderson et al. (2001) described the role of distance learning specialists as designer of the educational experience, facilitator, and cocreator of a social environment, and subject matter expert. Upon the basis of how scholars define the role of distance learning specialists, the literature on distance education characterizes teaching as learner-centered, that is, the teaching activity focuses on the learner and learning. Brown (2006) calls this a focus on moving from teacher and content-centered to learning-centered instruction.

It was Coppola, Hiltz, and Rotter (2002) who identified three faculty roles: cognitive, affective, and managerial. The cognitive role is connected with the mental processes of learning, information storage, and thinking. The affective role is influenced by the relationships between students, faculty, and the classroom environment. The managerial role relates to class and course management. Evidently, this was the first time the relationship between students and faculty was discussed. However, Wang’s (2005) study took one step further this teacher-learner relationship. He argues that it is either the helping relationship (andragogical principles) or the directing relationship (pedagogical principles) in the context of distance learning settings that leads, in Mezirow’s (1990, 1991, 2000) terms, to adult learners’ critical reflection. Wang’s (2005) research indicated that the roles of distance learning specialists must correspond with Grow’s (1991) stages in learning autonomy. It must be pointed out that the order of learners’ stages of learning may not be sequential: some adult learners may not necessarily go through stage 1 and stage 2 before they reach stage 4. Some may not even go through all four stages. Table 1 illustrates the corresponding roles of distance learning specialists as determined by learners’ stages in learning autonomy.
Distance Learning Specialists

CONCLUSION

Quality distance learning programs come out of the hands of distance education specialists. Their changing role of moving from the “sage on the stage” to the “guide on the side,” and vice versa does affect learners’ learning, hence critical reflection. Because of the nature of information technologies, for distance learning specialists to assume the role of a facilitator is not incorrect based on Rogers’ (1951) historical hypothesis regarding how an organism reacts to the field as it is experienced and perceived. However, the teacher-learner relationship cannot be overlooked. It is this teacher-learner relationship that predetermines human interaction with which most critics and scholars are concerned. The relationship between teachers and students can be pedagogical and can be andragogical. As more and more information technologies are used to enhance teaching and learning, it is imperative that researchers look further into these pedagogical and andragogical principles that are the driving forces behind one’s teaching and learning. From Grow’s (1991) stages in learning autonomy to Wang’s (2005) research on the teacher-learner relationship, we see a new direction in this academic endeavor: whether the role of distance learning specialists is situational is truly worth investigating.

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Table 1. Grow’s (1991) stages in learning autonomy

<table>
<thead>
<tr>
<th>Stage</th>
<th>Learner</th>
<th>Educator</th>
<th>Methods/Styles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Dependent</td>
<td>Coach</td>
<td>Coaching with immediate feedback; drill; informational lecture</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Interested</td>
<td>Motivator</td>
<td>Inspiring lecture plus guided discussion; goal-setting</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Involved</td>
<td>Facilitator</td>
<td>Discussion facilitated by teacher who participates as equal</td>
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<td>Stage 4</td>
<td>Self-directed</td>
<td>Consultant</td>
<td>Internship; dissertation; self-study</td>
</tr>
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</table>
Distance Learning Specialists


**KEY TERMS**

**Andragogy**: Andragogy refers to the art and science of helping adults learn. The word “helping” is heavily emphasized to differentiate the theory of andragogy from the theory of youth learning. Some scholars refer andragogy to a set of assumptions; others refer it to a set of guidelines. Still others refer it to a philosophy. However, Knowles et al. (2005) refers it to a theory, which has been widely accepted in the field of adult education and training. According to andragogical leaders in North America, the theory of andragogy sparked a revolution in adult education and training simply because previously every learner was taught pedagogically.

**Critical Reflection**: King and Wang (2007) consider critical reflection as the theory of reflectivity as used by Europeans and it is defined by Mezirow (1990, 1991, 2000) as having 10 stages that progress from a characteristic “disorienting dilemma” that uses an experience of imbalance in one’s life as an opportunity for considering new perspectives.

**Distance Education**: Distance education refers to instruction that occurs when there is a difference in time, location, or both. There are a variety of distance education delivery systems: correspondence, broadcast, teleconferencing, computers and digital technologies, and the Internet and World Wide Web. Distance education is defined as learning via telecommunications. The term telecommunications embraces a wide variety of media configurations, including radio, telephone, television, and the Internet. The Greek root word “tele” means “at a distance” or “far off.” Heinich, Molenda, Russell, and Smaldino (2002, p. 268) define distance education as a form of education characterized by the following:

- Physical separation of learners from the teacher
- An organized instructional program
- Technological media
- Two-way communication.

**Human-Computer Interaction**: Human-computer interaction (HCI) or, alternatively, man-machine interaction (MMI) or computer-human interaction is the study of interaction between people (users) and computers. It is an interdisciplinary subject, relating computer science with many other fields of study and research. Interaction between users and computers occurs at the user interface (or simply interface), which includes both software and hardware, for example, general purpose computer peripherals and large-scale mechanical systems such as aircraft and power plants.

**Information Technology**: Information Technology (IT) is concerned with the use of technology in managing and processing information, especially in large organizations. In particular, IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit, and retrieve information.

**Pedagogy**: Pedagogy refers to the art and science of teaching children. According to Knowles et al. (2005), pedagogy assigns to the teacher full responsibility for making all decisions about what will be learned, how
it will be learned, when it will be learned, and if it has been learned. It is teacher-directed education, leaving to the learner only the submissive role of following a teacher’s instructions (p. 62).

**Sage:** To be a sage is to become an authentic person (King & Wang, 2007). An authentic person must have no arbitrariness of opinion, no dogmatism, no obstinacy, and no egotism.
E-Commerce Models and Consumer Concerns

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INTRODUCTION

Electronic commerce (e-commerce) refers generally to all forms of buying, selling, transferring, exchanging products, services, or information over computer networks (Carter, 2002). Business activities such as communication, business transactions, and data transfer, including both organizations and individual, are conducted online. The “electronic” or “e” in e-commerce or e-business refers to the technology/system; the “commerce” refers to the traditional business models. Things like funds transfer, order booking, data interchange, automated inventory management, and online marketing all come under the purview of e-commerce (Erber, Klaus, & Voigt, 2001). For instance, people and organizations can shop around the Web to find the products, prices, and services that suit them best and order and pay for items without a physical presence of either the shopper or the merchandise.

E-commerce is the largest growth area of today’s economy and is likely to remain so for many years to come. It has grown to manage significant portions of both business-to-business (B2B) and business-to-consumer (B2C) transactions in just a few years. In fact, each year both its volume and percentage of all business transactions keeps increasing dramatically. The idea of e-commerce is all about using the Internet to do business better and faster. It is about giving customers controlled access to vendors’ computer systems and letting people serve themselves. It is about committing companies to a serious online effort and integrating their Web sites with the heart of business.

BACKGROUND

During the 1960s, the emergence of electronic data interchange (EDI) allowed companies to perform electronic dealings with each other. A research project of Advanced Research Projects Agency (ARPA) funded by the U.S. Department of Defense created a packet switching network known as the ARPANET.

 According to Bach and Erber (2001), Timothy Berners-Lee, a British physicist and computer scientist, developed the World Wide Web (WWW) in order to replace file transfer as the application used for most Internet traffic. In the early 1980s, a group of academic computer scientists formed the Computer Science Network, which used TCP/IP protocols. Other government agencies extended the role of TCP/IP by applying it to their networks.

Then in the 1980s, as large commercial companies began to use TCP/IP to build private Internets, ARPA investigated the transmission of multimedia—audio, video, and graphics—across the Internet. Restrictions on who could use the Internet were lifted by the U.S. government, and commercialization of the Internet mushroomed. The Internet quickly expanded to include universities, companies of all sizes, libraries, public and private schools, local and state governments, individuals, and families.

During 1995, two of the biggest names in e-commerce were launched—Amazon.com and eBay.com (Hiser, Lanka, Li, & Oliver, 2004). The Internet plays an important role in today’s business. Over one-third of U.S. residents use the Internet and nearly 40% use it as a business medium (Lee, Lee, & Park, 2006). As the percentages continue to increase, so does the need to understand why and how people choose to adopt e-commerce instead of off-line channels; this would help researchers and e-commerce providers get a better understanding of how to facilitate future adoptions of e-commerce.

MAIN FOCUS

The Variety of E-Commerce Methods

Choosing the best type of e-commerce method can become quite complicated for a company. As mentioned, the most typical types of applications currently running in the WWW are: business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer (C2C),
mobile commerce (m-commerce), and peer-to-peer (P2P) (Reid & Sanders, 2007). With so many models to choose from, a company must be aware of the particular impacts of each model and the selection criteria for choosing the best model for that company.

Business-to-Business (B2B) E-Commerce

In B2B e-commerce, company A sells to company B, or vice versa, products and/or services. Fellenstein and Wood (2000) explain that a key economic area that is driving the global economy to grow is the B2B market segment. They classified this segment into three categories: (1) online wholesaling, which is businesses selling products and services to other businesses throughout the Internet; (2) Internet corporate purchasing, which represents various public and private sector enterprises doing online purchases of office materials, manufacturing supplies, and other supplies using the corporate intranet; and (3) supply chain trading over the Internet, which involves businesses working together by using the Internet to automate the transfer of goods for production and distribution.

There are a number of basic economic propositions underlying B2B applications, such as content aggregators, auctions/exchanges, and B2B specialists. Content aggregators help the buyers in fragmented markets to select the products by providing up-to-the-minute price and product information and single contact point for services. This focuses on bringing together the buyers and sellers who are in the same industry but trade in a variety of products or services. In auctions, auctioneers offer a channel for sellers to get rid of damaged or surplus goods and services at the possible prices, and buyers to get bargain prices. Finally, B2B specialists are concerned less with specific goods and services and more with the process of setting up electronic markets.

In line with Vulkan (2003), there are some advantages for automating the purchasing process. Three advantages are: (1) increased efficiency; (2) cost savings; and (3) better control. First and foremost, business e-commerce increases efficiency. For example, most electronic procurement systems are capable of automatic searches, comparing attributes such as price and quantity. Vulkan explains that it is useful to think of business e-commerce as a natural extension of the automation process that started in the 1970s. First, databases and back office operations were automated, then came front office automation, and now it is the interactions between organizations being automated. Second, and along the same lines, there are substantial cost savings from employing a business e-commerce system. It is significantly cheaper than using human employees to do the same work. To set up an e-procurement system is expensive but once it is in place the running cost is very low, so over time the cost savings increases. Finally, an e-procurement system not only reduces the cost of purchasing, but also allows an organization to take better control over its spending strategies. That is why many firms continue to buy at the same price from the same suppliers because it is too costly and difficult to be constantly searching for new ones and/or re-negotiating existing agreements.

Business-to-Consumer (B2C) E-Commerce

In B2C e-commerce, the most familiar of e-commerce business models, businesses sell their products and services to customers via the Internet (Zabel & Mohnahi-Lankarani, 2002). The B2C model includes: (a) auctions; (b) online stores; and (c) online services. Electronic auctions offer an electronic implementation of the bidding mechanism found in traditional live auctions. These actions also offer integration of the bidding process with contracting, payments, and delivery. It gives the participants convenience, as a bidder can stay at their home or office and still participate in the bidding just as in traditional auctions. Online auctions provide flexibility and allow the bidding to last days or weeks, which offer more flexibility to the bidders. Online stores refer to marketing of a company’s products through the Web (Fellenstein & Wood, 2000). It can either be done by promoting a company and its products and services or sell its products and services through this virtual store. One of the best examples is Amazon.com, which started selling books online and gradually has extended to other product categories. Finally, another area where companies can exploit the Internet is through online services. Many companies provide customer services online; one good example might be the service sector banking and stock trading. Companies like eTrade.com have brought the ease of trading stocks to customers’ PCs.

In theory, there are different models that online businesses use to generate revenues. For example, the advertising revenue model, where a Web site provides information on products and
services to its users and also provides an opportunity for providers to advertise their goods. Of course, in order for providers to advertise over a specific Web site, they have to pay fees for advertising. Companies such as Yahoo.com derive its revenues from selling advertising such as banner ads. In the subscription revenue model, a Web site that offers content and services charges a subscription fee for accessing the Web site. For example, a consumer report online provides access to its content only to subscribers at a set rate of money per month. In others such as the transaction fee model, a company receives fees for transferring or executing a transaction. For example, Montclair State University uses the Tuition Management System, an online organization that helps students to make payment transactions over the Internet to the university with an additional fee over the amount paid. Another example is when a consumer wants to reserve an airline ticket, let’s say through www.orbitz.com, Orbitz will charge a small fee to the consumer when the airline reservation is executed. In the sales revenue model, companies sell goods, information, and services directly to consumers. For instance, Amazon sells books and music to customers, and www.doubleclick.com sells information gathered from online users to other companies. Finally, the affiliate revenue model, is a model where companies receive referral fees for directing business to affiliate companies or receive some percentage of the revenue resulting from a referred sale.

**Consumer-to-Consumer (C2C) E-Commerce**

C2C are the most common online auctions, where customers buy and sell their products directly to each other, for example, auction sites such as eBay. In C2C e-commerce, the sellers prepare the product for market, place the product on sale or make available for sale at an auction, and depend on the market maker to provide the search engine and transaction capabilities so that the product is easily displayed or found, and paid for. Of course, the company receives commissions on the sale of the client’s product.

**Mobile Commerce (M-Commerce) and Location Commerce (L-Commerce)**

In m-commerce, consumers use the radio-based wireless devices such as cell phones and personal digital assistants (PDAs) to conduct e-commerce transactions over wireless communication systems (Zabel & Monahedi-Lankarani, 2002). There are many companies nowadays that use wireless mobile devices. The potential of these m-commerce applications has increased rapidly recently, leading many organizations to spend millions of dollars on these technologies. Delivering location commerce (l-commerce), a value-added, interactive, and/or location-based mobile service (e.g., banking, content download, emergency/roadside assistance, etc.) to customers seems to be increasingly important in gaining a competitive edge by strengthening relationships with key customers. However, the collapse of large numbers of dot-com companies required managers to relearn that profits matter and that traditional marketing laws still applied to m-commerce.

In order for wireless-based applications to be effectively used in the m-commerce environment, mobile service (m-service) providers must not only attract new customers but also be able to retain them to ensure profitable repeat business. In m-service industries, the high cost of acquiring customers can render many customer relationships unprofitable in the early years. But, without customer loyalty, even the best mobile business will fall apart (Lin & Wang, 2006).

**Other Models of E-Commerce**

Business-to-business-to-consumer (B2B2C) is defined as using B2B to help support and rejuvenate companies attempting B2C (Peterindia, 2007). This is due to the fact that B2B has been an overwhelming financial success, and B2C has not performed up to the expectations. This model is poised to do well as it capitalizes the success of B2B and the potential demand of B2C.

Consumer-to-business-to-consumer (C2B2C) involves consumers conducting transactions with other consumers using a business as an intermediary. www.autotrader.com is the best example for this sort of application. This site facilitates the transactions of selling used cars between consumers, but also contains an inventory of used cars to sell to the consumer.

Peer-to-peer (P2P) e-commerce links individual users allowing them to share files and computer resources without a common server. P2P helps individuals make information available for anyone’s use by connecting users on the Web. For example, Napster.com and MP3.com generate revenues by using the subscription
model and technology that allows consumers to share files and services.

Government-to-business (G2B) is the online non-commercial interaction between local and central government and the commercial business sector. Government-to-citizen (G2C) is the online non-commercial interaction between local and central government and private individuals. In this way, public services and information can be accessible to all citizens. Citizen-to-government (C2G) is the online relationship between an individual and all of the various government departments that serve the individual. Also, e-learning is the unifying term to describe the fields of online learning, Web-based training, and technology-delivered instruction. More and more models of e-commerce are emerging.

**Consumer Concerns**

There are many advantages and disadvantages for customers, business, and non-profit organizations to apply electronic commerce. Through the Internet, different levels of product information can be accessed online globally, which makes it easy for customers to compare and evaluate. Businesses can provide a wide range of choices to extend markets and opportunities. With digital goods and services, customers save delivery time, and businesses reduce operating cost and increase profit.

On the other hand, security and information privacy is a major disadvantage in setting up electronic commerce (Bayles, 2001). There are many different types of security risks that could affect an online store before, during, or most often, when the sale has been completed (Carrol & Broadhead, 2001). If someone can break into an online store, that person probably has the capability to change the prices or product information. Or, that person might commit one of the most scary and malicious crimes—infest the system with a virus. They can damage or delete data on anyone’s computer, modify files, steal passwords, and even transfer files from a business’s computer to other computers on the Internet, often without the knowledge of the owner. A business owner can infect his/her computer with a virus with just opening an infected e-mail or a computer file that has already been infected by a virus. So, companies conducting e-commerce are twice as likely to have their servers attacked by hackers. The best way to protect a business against viruses is to regularly update the virus protection software on the computers. Just think of all the data collected from a customer such as customer records, order history information, credit card numbers, product data, and more. It would be a disaster if this information gets lost due to a virus (Nabi, 2005).

A second security breach occurs when someone wants to hijack a business computer. *Hijacking* usually occurs when someone transfers ownership of a company domain name to another individual without the company’s consent. So, when hijacking occurs, the hijacker is able to take control over the business Web address so that when a customer types the company’s Web site address into his/her browser, he/she is re-routed to another Web site, such as that of a competitor.

Finally, cyber-extortion happens if a hacker or criminal, breaks into a company’s Web site and promises to destroy data, steal credit card numbers, launch a denial-of-service attack, or commit some other act unless a ransom is paid. So privacy and security should be one of the most important topics for companies that want to increase profit by putting an online store through the Internet. Every year as new technology comes to the market, business owners should be aware that protecting the privacy of their customers is the most valuable asset for companies; otherwise setting online stores would become a place for criminals.

**FUTURE TRENDS**

Creators of e-commerce Web sites are always looking for ways to make their Web sites more user friendly and easier to navigate. Information technology is developing so rapidly that it is difficult to predict correctly the future of Internet-based e-commerce. However, expert predictions show that Internet-based e-commerce will dramatically change the way of conducting business in the near future. Some examples of future trends related to e-commerce include: advance forms of text messaging and chat, automatic purchases of goods and services whenever the need arises, and so forth. One effective way that e-commerce companies market their Internet commerce applications and platforms is through integrated strategic alliances.

In a famous paper entitled, *Internet II: Rebooting America*, Malone (2001) postulated that Internet II will have an impact across the board, from chips to wireless to information technology to a *great global grid,*
providing a wealth of opportunities for entrepreneurs, consumers, and investors. It will come in the form of universal broadband access, unlimited network server availability, global virtual malls, real-time enterprise computing. It’s the firstborn offspring of the Internet, only it will be sleeker, smarter, and more agile and obedient than its predecessor. For now, let’s call it Internet II, or the ultranet, or meganet.

CONCLUSION

A combination of both, computer and communication network has paved the way for a technological-driven economy, especially in developed countries such as the U.S. in the last 20 years. E-commerce is the way for companies to do business through the use of the Internet. Consumers and business owners benefit immensely by providing them convenience, flexibility, shareability, conformity, and variety. It appears that through astute transitioning, firms may achieve competitive advantage in an e-commerce era. E-commerce constitutes rapid change and thus requires continuous improvements and breakthrough innovation.

Organizations are able to create efficient services and products, resulting in competitive markets, leading to the specialization of products and concluding in higher profits and enhanced services. In addition, the growth of e-commerce obliterates the production-focused economy of the industrial age and extends the information age to new heights through business services offered using the Internet. Entrepreneurs should have good security systems to protect information, particularly small business which may lack skilled personnel to manage virus protection systems to prevent losing data.

Definitely, e-commerce’s future is boundless. Who could imagine the potential power and fancy functionalities of Web 3.0, 4.0, or n.0?

REFERENCES


**KEY TERMS**

**Business-to-Business (B2B):** Businesses doing business with each other via the Internet. Or the interactions between firms that take place electronically via digital media.

**Business-to-Consumer (B2C):** Businesses sell products and services to customers via the Internet.

**Computer Virus:** A self-replicating program that spreads by inserting copies of itself into other executable code or documents.

**Consumer-to-Consumer (C2C):** Consumers sell to each other with the help of an online market maker.

**Customer Loyalty:** A deeply held commitment to re-buy or re-patronize a preferred product or service consistently in the future, thereby causing repetitive same brand-set purchasing despite situational influences and marketing efforts having the potential to cause switching behavior.

**Hacker:** A programmer who breaks into computer systems in order to steal or change or destroy information as a form of cyber-terrorism.

**Hijacking:** Used when spyware and a virus write itself in a computer program in such a way that whenever that program starts to work, besides its normal duties it does other things too, which the creator of the virus or spyware meant it to.

**Mobile Commerce (M-Commerce):** E-commerce transactions, conducted through mobile devices (e.g., cellular phones, hand-held or palm-sized computers, and even vehicle-mounted interfaces), using wireless telecommunication networks and other wired e-commerce technologies, are termed mobile commerce (m-commerce).

**Online Auction:** A model use to make business in which participants bid for products and services over the Internet.

**Peer-to-Peer (P2P):** Users share files and computer resources without a common server.
INTRODUCTION

In education, providing access to instructional materials and resources is important for any type of learning to occur. If students do not have access to the resources necessary for them to complete projects, perform research, retrieve data information, communicate with others, and so forth, then learning will be impaired. Universal access is a concept that describes the usability and accessibility to content and information by the largest range of people (Mills, 2006; Roblyer, 2006). Applied to the learning environment, universal design requires that the curriculum includes alternative methods for information access by individuals with different backgrounds, learning needs, abilities, and disabilities in various learning contexts. When this concept is applied to the design and development of Web pages, universal design is known specifically as Web accessibility. This overview discusses the importance of providing access to specific forms of computer and Internet technologies. In addition, the discussion will define technology accessibility (or universal access), why such access is needed, means of ensuring such access, and methods of evaluating accessibility.

BACKGROUND

Definition and Educational Role

Accessibility involves two key issues. The first is by investigating how users with disabilities (or without) access electronic information. The second issue is directed more toward Web designers in that they need to provide Web-based content to function with assistive devices or make the content available to everyone (Macromedia, 2007). When general computer use is concerned, certain operating systems such as Windows and Apple have integrated universal access features right into the system that learners can enable and use in conjunction with a variety of applications from the system itself and from other developers (Apple, 2006). These features can create learning experiences that are appropriate for individual learners that would maximize their abilities to progress through the curriculum. Accessible Web sites, on the other hand, ensure that a smooth transformation exists between the information and services to guarantee that the content is easily navigable and understood. In a sense, accessible Web sites can be perceived, navigated, utilized (with a keyboard or any other device than the mouse), and easily understood and read (Usablenet, 2006). Web-enhanced learning should accommodate the needs of all learners by providing “easy resource selection and delivery, alternative pathways to information, connections to experts and mentors, access to a variety of materials, multiple ways to publish work, and placement of widely varying content in structured curricular frameworks” (Mills, 2006, p. 19). Thus, accessibility encompasses meeting the needs of all learners that may have visual, auditory, physical, speech, cognitive, and neurological difficulties (Web Accessibility Initiative, 2006).

Justification

Technology is increasingly more evasive in the lives of learners today. Computer technology and the Internet play an important role in information retrieval that is necessary to complete course-related work. In a larger scope, accessibility is essential for ensuring equal opportunity to all learners and assumes a social responsibility on the part of educational institutions to make the information available to the public (Web Accessibility Initiative, 2006). In addition, accessibility not only affects learners who have certain limitations, but also helps improve access to those individuals without disabilities. For instance, accessibility is built upon the concept that the Web and associated software should be flexible enough to meet the needs of many different learners, their particular preferences, and physical situations. Therefore, if a person has a very slow Internet connection or uses older technology, principles used in designing accessible Web pages (e.g., using text descriptions for images in case the user turns
them off for faster downloading) can help supersede low-bandwidth connection. Another example is when a person breaks an arm or shoulder and uses the speech-recognition software such as Dragon Naturally Speaking to temporarily assist with software applications. Thus, accessibility options can help all users whether they are disabled or not.

Finally, in relation to education, providing accessibility is required by law. Section 508 of the U.S. Rehabilitation Act mandates that all federal institutions that buy, develop, maintain, or use electronic and information technology must make these resources accessible to people with disabilities (Foley & Regan, 2005; Irwin & Gerke, 2004; WebAIM, 2006). Accessibility to computers, software, and electronic equipment such as faxes, copiers, and telephones must also be made available to individuals with disabilities. This act also applies to federal agencies that develop and design federally-funded Web sites (e.g., a college Web site). The standards under Section 508 address how different components of Web sites need to be designed to make the information more accessible. There are sixteen standards used to define Web accessibility that highly affect post-secondary institutions of higher learning because they are federally-funded. Another law that affects educators is the Individuals with Disabilities Education Act (IDEA). This act primarily affects general education classrooms in pre-K through 12 grade levels (Roblyer, 2006; Solomon, Allen, & Resta, 2003) in that special needs students must be accommodated with assistive technologies for augmenting their academic achievement. Thus, because laws direct educational institutions to provide accessibility, this is an important issue to consider during technology planning.

**CREATING ACCESSIBILITY IN EDUCATION**

**Methods and Tools**

There are many different tools that educational institutions can use to ensure accessibility. In regard to basic computer use, computer systems have embedded within their systems accessibility tools that provide access to content and software applications. Windows XP, for example, has many different accessibility wizards and options to help those with or without disabilities (Windows XP Accessibility, 2006). For instance, there is an Accessibility Wizard in Windows XP that can enable and disable certain options for different users. For those who are vision impaired, the Wizard allows learners to set options such as setting scrollbar functions and window sizes, using high contrast color schemes, and changing the appearance of the mouse cursor. Sound options can be set as well such as giving visual alerts to auditory impaired learners (e.g., SoundSentry) or by providing caption displays for speech and sound (e.g., ShowSounds). Finally, those with limited physical movement can adapt different types of key movement (e.g., StickyKeys) and adjust the cursor size, movement (e.g., ClickLock), and color options. Other useful features that can be adapted for Internet use in the Windows environment are formatting the Web pages to use a custom style sheet, selecting alternate colors for visited and unvisited links, and turning on or off the playing of animations, sound, and videos. A learner can also make adjustments to the taskbar, sound schemes, and utility managers, and initiate the onscreen keyboard, the use of a narrator and screen magnifier, and adjust the speech options such as text-to-speech.

For Apple users, there are several accessibility features that a learner can enable (Apple, 2006). Universal access features for the Mac OS X system includes vision, hearing, and motor tools for those who require them. Vision options include magnifying the screen or specific objects on the screen (e.g., Zoom) and adjusting the display characteristics to make content easier to read. Talking alerts and spoken items provide an audible method for obtaining feedback from the computer. Mac OS also includes a scalable cursor option to increase the size and appearance of the mouse cursor so that it will be easier to locate and follow. Hearing tools include Visual Alert that flashes across the whole screen to let the user know that a window or dialog requires attention. Physical/motor options include slow keys that prevent multiple keystrokes, using the numeric keys instead of the mouse, speech recognition or talking alerts, and modifying key repeats and delay rates on the keyboard. Thus, computer systems allow learners to amend and enable tools to help them gain access to the information.

In terms of making certain that Web pages are accessible, a designer needs to create features on the page that are accessible with any type of assistive technology used by a disabled learner (Moss, 2004). For instance, blind users may utilize a screen reader such as JAWS that reads the content on the Web page.
Educational Accessibility to Technology

Therefore, images and animations should be assigned text descriptions that screen readers can read (called alternative text). Some users may employ touch screens, head pointers, or other assistive technology devices that requires Web page designers to create components that do not depend upon a mouse. Elements such as rollovers, menus, and interactive components often rely upon the click of a mouse to activate. The designer should try to ensure that keyboard-defined events are included to avoid mouse dependency. A good resource to help Web page designers design accessible Web pages is called *Dive into Accessibility* (2002) written by Mark Pilgrim. This resource begins by describing several scenarios of individuals with different needs. From there, descriptions of what the designer needs to do in terms of HTML coding is given along with an explanation of which individual presented earlier would benefit by the coding and why. This resource is a nice “cook book” for Web designers who are concerned about accessibility issues.

**Evaluation**

When an individual designs a Web page, evaluating accessibility early and throughout the developmental process can help reduce extra work later. Evaluation/accessibility tools are available to help designers assess Web pages for accessibility. Accessibility tools perform automated checks of Web pages that the designer runs through to determine whether the Web page is accessible. Some of these services include Wave 3.0 (http://www.wave.webaim.org/index.jsp), Cynthia Says (http://www.cynthiasays.com/fulloptions.asp), and WebXACT Quality & Accessibility Check (http://webxact.watchfire.com). Page validators also exist to help designers make certain that links, markup codes, and so forth are functioning. These services include W3C MarkUp Validation (http://validator.w3.org), W3C CSS Validation (http://jigsaw.w3.org/css-validator), and W3C Link Checker (http://validator.w3.org/checklink). Other miscellaneous tools that can help a designer evaluate Web pages are VisCheck Color Blindness Simulator (http://www.vischeck.com), Load Time Check (http://1-hit.com/all-in-one/tool.loading-time-checker.htm), Readability Test (http://juicystudio.com/services/readability.php), and Screen Size Simulator (http://www.anybrowser.com/ScreenSizeTest.html). Examining Web pages through these tools is a good method to evaluate the pages for accessibility and should be done periodically to avoid later complications.

**FUTURE CONSIDERATIONS**

Issues that may affect educational accessibility in the future are the increasing access to mobile and/or newer forms of technologies, professional development of educators, and access to the hardware/software. As the technology becomes smaller in scope and size, new standards will be implemented to assure universal access. Different concerns will develop in terms of access that will soon follow with innovative methods to help disabled users utilize these technologies. Another area of concern is professional development and teacher preparation. Because educational institutions have laws and regulations to follow in terms of adhering to accessibility standards, training of educators and ensuring professional development play a critical role in whether all learners will receive the same access. Finally, because financial funding has always been a concern in education, the monies to purchase appropriate software/hardware, along with establishing an adequate support staff, must be planned thoroughly. Accessibility may improve with the development of newer technologies, but unless educators are adequately trained in providing universal access, problems will arise.

**CONCLUSION**

Universal access is important when it comes to technology use. Ensuring that all learners receive the same access to instructional materials and resources will create an effective educational environment. In addition, learners who may not have been able to access certain electronic information without the help of assistive technologies, accessibility features, and so forth, now have the opportunity to do so. Technology is an important medium for searching and receiving information, as well as providing information and interacting with others. Thus, making technology accessible provides equal access and equal opportunity for all people to interact. This plays an important role in education because learners do learn from one another, and allowing learners to access technology makes certain that the communication exists.
REFERENCES


KEY TERMS

**Accessibility:** Means of ensuring that people with visual, auditory, physical, speech, cognitive, and neurological difficulties can access electronic information, software applications, Internet, and so forth.

**Accessibility Tools:** Enabling certain options, features, and wizards in different computer systems to help disabled users use the computer.

**Universal Design/Access:** A concept that addresses educational access to all forms of technology and making certain that students with specific needs are accommodated by using alternative forms of instructional delivery and/or methods of instruction.

**Web Accessibility:** Addresses access issues concerning Web pages so that users with visual, auditory, physical, speech, cognitive, and neurological issues can view, retrieve, and interact with Web page components.
Educational Geotrekking

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INTRODUCTION

Geocaching is a civilized treasure-hunting activity enjoyed by hundreds of thousands of people all over the world. Geotrekking takes geocaching to the next level. It expands the educational potential of geocaching by combining this enjoyable physical and mental activity with the purposeful examination of multiple geocaches (traditional, virtual, or online through Google Earth™) designed and/or collected to provide clues, resources, and scaffolding to support learners as they work on a larger problem-based learning (PBL) challenge or set of challenges. It is expected that engaging students with this type of authentic PBL activity will support improvements in student attitudes towards the related subjects along with increased engagement and learning (e.g., Baker & White, 2003).

Geotrekking can also be seen as an instructional design model supporting the creation of engaging learning opportunities and promoting the integrated development of geographical, mathematical, cultural, scientific, and other literacies. By interweaving meaningful problem-based learning challenges (Jonassen & Rohrer-Murphy, 1999; Kolodner et al., 2003) with appropriate authentic and contrived learning resources (scaffolding) and by addressing multiple learning modalities (e.g., visual, aural, kinesthetic) teachers can add useful variety to an educational program thus meeting a broader range of student needs. Challenging students to design, implement, and test geotreks as an activity to teach prior learning goals and to support their current learning goals may have additional educational benefits (i.e., learning by writing and learning by teaching) (Resnick, 2002).

This paper begins by describing geocaching, the common types of caches, and the protocols used within the geocaching community. With this background information, the nature of geotrekking is discussed and the educational potentials of three types of geotreks are examined: portable, fixed-location, and online (Google Earth™). Finally a Web site, geotrekking.net, is described as one possible resource to support the sharing of geotreks within the educational community.

GEOCACHING

Geocaching is a modern-day treasure-hunting activity that engages participants of all ages with a broad range of recreational goals including physical activity, mental challenges, learning opportunities, shared experiences, and solitude (Chavez, Schneider, & Powell, 2004; Hauser, 2003; Lary, 2004). The distinguishing feature of geocaching when compared to other hide-and-seek types of activities (e.g., letterboxing, orienteering, etc.) is the use of GPS (global positioning system) and GPS devices to locate a place according to latitude/longitude (Lat/Lon) coordinates (Stern, 2004).

The first geocache was set in Washington State in May 2000, shortly after the U.S. government discontinued its intentional degradation of GPS signals. By September that year, a Web site was set up to support this new hobby. Geocaching.com appears to be the most popular online resource center for the rapidly growing geocaching community (Groundspeak, 2006a). It provides a system to create, maintain, and archive caches as well as a communication forum to support a worldwide geocaching community. In June 2006, there were more than 280,000 active caches located around the globe. Collectively members enter tens of thousands of geocaching experiences each day (e.g., more than 180,000 entries in 7 days in June 2006) describing what they found, telling about the experiences that they had locating a cache, or sharing other relevant information.

A typical geocache is presented with a descriptive name, a Lat/Lon location (which may either be the location of the cache or a nearby starting point) and a
description of the cache plus some clues for finding it. Additional hints may also be provided in an obscured format such as ROT13 (a commonly used simple cipher) to limit unintentional review of hints (Von Rospach & Spafford, 1993) and through comments left by previous visitors (plain or in ROT13). New public caches are set up according to a set of common-sense rules (e.g., not too close to another cache, with permission of the property owner, near a trail, not buried, waterproof, etc.) and maintained by an “owner” (a person or group with membership in the geocaching.com community). Caches may be as small as a film canister or magnetic key holder or as big as an old ammo box. They usually contain a log book for recording visits and trinkets or other exchangeable items (treasure!).

Geocachers follow a common sense protocol when searching for caches (no trespassing, stay on the trail as much as is practical, avoid disclosing the cache location to non-participants (aka geo-muggles), log your visits, etc.). If a prize has been left in the cache for a particular visitor (e.g., first-to-find, tenth-to-find, etc.), then the honor system applies and the appropriate finder takes the prize, otherwise participants are encouraged to exchange some object that they may have brought for something of similar value in the cache. For many geocachers, the thrill is in the hunt and a common log report is that they “took nothing and left nothing” (TNLN). Finally, geocachers log their exploits on the geocaching.com Web site—reporting any interesting events or maintenance issues.

There are various enrichments to the standard geocaching process that have been designed to enhance the activity for the participants or the community. Geocaches may occasionally contain other objects such as travel bugs—registered objects which have been set loose within the geocaching system to be picked up, logged, and transferred to other geocache. This allows owners and other participants to track the progress of the travel bug. Another enrichment to the hobby is the Cache in Trash Out (CITO) program—either as a formal event or informal practice. Here participants are encouraged to pick up litter they find on their geocaching activities as a gesture of goodwill and a contribution to the community.

Finally, another type of geocache is the virtual geocache. With virtual geocaches, the participants seek for a location of interest or some special feature found at a location and may retrieve some information from it. Once the virtual cache is located, any required information is noted and reported back to the cache owner for confirmation. To separate these non-cache locations from true caches (and to clarify the nature of the respective activities), the developers of geocaching.com closed the site to virtual caches in 2005 and opened a new site called waymarking.com to support the sharing of locations and descriptions when there is no container (Groundspeak, 2006b). Although there is no physical logbook to sign, a record is maintained on the waymarking.com Web site where participants can log their visit and review the successes, experiences, and observations of others. This type of cache can be designed with minimal impact and is often a better choice when the site is particularly sensitive to damage or when too many geo-muggles are typically present to allow a cache to be hidden and retrieved effectively.

**GEOTREKKING**

Geotrekking synergistically combines the engagement associated with the physical activity and problem solving aspects of geocaching, the satisfaction associated with successfully addressing a meaningful challenge, and the learning associated with authentic expansion of various literacies including:

- **Geographical Literacy:** Understanding the “where” and the “why there” issues with respect to the earth and its natural and cultural features.
- **Mathematical Literacy:** The ability to deal with the quantitative aspects of life, the ability to evaluate and accept or reject mathematical statements of others, and the skills and foundational concepts to support effective reasoning and problem solving.
- **Cultural Literacy:** The ability to converse fluently in the idioms, allusions, and informal content which creates and constitutes a dominant culture.
- **Technological Literacy:** Knowledge about, and ability to apply, technology in everyday life.
- **Scientific Literacy:** Dispositions, skills, and knowledge that support learning, problem solving, and communicating with respect to the world around us.

A geotrekking activity will typically include an
overarching challenge or group of challenges and a
collection (sequence or Web) of traditional, virtual, or
online geocaches that are intended to provide learn-
ers with an integrated collection of relevant learning
opportunities and appropriate scaffolding to support
the students as they address the challenges presented.
Geotrekking is a flexible instructional design model
that can help teachers to plan, create, and implement
meaningful, engaging, and enriching learning oppor-
tunities for their students and share successful plans
with others.

Geotrekking activities may be classified as portable
gotreks, fixed-location geotreks, or Google Earth™
(GE) geotreks. As geotreks are developed and shared
by teachers, students, or others, they may be revised,
expanded, or otherwise transformed into other types of
gotrek activities. These transformations will depend
upon the types of resources needed (i.e., the location,
the features unique to the site, and the geocaches pre-
sented) as well as the creativity of the authors.

Other geotreking-like opportunities may make use
of GPS-based geographical locations and resources to
help readers to see the relationship between what is
being presented and a specific location on the earth.
Such opportunities may allow students to observe
expeditions (quasi-synchronously or asynchronously)
through informative blogs that are interlinked with GE.
These events might be used to support and enhance
classroom discussions and activities and may provide
a motivation or a starting point for a new geotreking
activity. An example of this type of expedition is “Proj-
ect Thin Ice: Save the Polar Bear”, where in 2006, two
explorers regularly documented their progress as they
undertook to achieve a trek to the North Pole in the
summer (GreenPeace, 2006).

Portable Geotreks

Portable geotreks are designed to help students dis-
cover, develop, or review a collection of concepts or
skills from the curriculum that are not dependent upon
a particular location and which may be easily trans-
posed to any suitable convenient location. Generally
the location will be a schoolyard or a convenient park
where students might have sufficient space to address
the challenge.

Some portable geotreks may be cacheless—that
is, the challenge may not require any fixed locations.
Such a geotrek typically will only require a place that is
suitable for the student groups to roam as they identify
convenient temporary waypoints (points of reference
entered into their GPS devices) and carry out experi-
ments to gather data and information so that they may
work out a solution to their challenge.

Other geotreks may require the teacher (or sup-
porting volunteer) to set up temporary caches (either
traditional or virtual) as resources to help the students
master the challenge. These geocaches might take the
form of a stake driven into the ground, a telephone
pole, a fire hydrant, or any other convenient feature of
the landscape. The geocache instructions may include
directives for the students to examine an attached label
(temporarly attached or permanent) for a clue, or ob-
serve a feature visible from that spot (near or distant),
or perhaps to open some container and retrieve some
resource, evidence (e.g., token), or reward, or to use
some implement provided to accomplish a task that
will support them in their trek.

Fixed-Location Geotreks

Fixed-location geotreks are designed to lead groups of
students through or around a location of interest (e.g.,
park, monument, city block, etc.), to discover some
important features and to participate in some learn-
ing challenge or problem solving activities where the
location provides some relevant resource to support
this learning. Although fixed-location geotreks are
not directly portable, they can be used as exemplars
to support the development of similar geotreks for
other locations, and often can be transformed into GE
geotreks.

Some fixed-location geotreks may be cacheless—
having only the range or boundaries specified to supply
the students with an opportunity to explore, observe,
and log the features of some particularly informative
natural or cultural site of interest. Other fixed-location
geotreks will have geocaches (real and/or virtual) that
are designed to provide information or resources to the
participants. Examples of a real cache might be a box
containing a tool that supports the examination of a
feature at a particular location, a document to explain
to students how to make observations or to support
their deciphering of the meaning of some artifact, a
resource that presents a new skill to be practiced to
support understanding, or a mini-challenge where the
physical context provides the necessary resources. Each
of these geocaches can be thought of as being just-in-
time-and-place (JITAP) resources supporting learning in a context where it might be most efficient and useful. Many fixed-location geotreks will incorporate both types of approaches—with the presented geocaches providing scaffolding and the challenge requiring additional cacheless activities to complete.

**GE Geotreks**

GE geotreks are virtual geotreks that can be accomplished on a computer using Google Earth™ (GE). A GE geotrek will typically include a goal or set of challenges supported by a collection of resources and possibly some GE geocaches. GE is an Internet-based tool that maps satellite imagery and other information onto a virtual globe that may be manipulated. Because GE may be augmented with privately created collections of marked locations, labels, location specific data and images, and links to additional content on the Web (Google, 2006), it is possible to set up and accomplish many geotrekking challenges partly or completely on a computer (i.e., a GE geotrek).

Although the benefits of the integration of physical activity with other curricular goals and the kinesthetic learning opportunities may be diminished or eliminated, GE geotrekking may be a practical alternative when weather, time, or other resources (e.g., GPS units) are limited or unavailable. GE geotreks also have the potential to cover very large and/or distant geographical areas and thereby support activities and learning outcomes that may not be practically addressable within the context of portable or fixed-location geotreks. Note that the term GE geocache is used to describe caches located in the GE environment in order to avoid using the existing term “virtual geocache”, where the cache is virtual (i.e., something to look at but no box of treasures or log book), but the activity is outdoors.

GE interlinks a manipulatable globe of satellite reference imagery with the dynamic display of the cursor’s Lat/Lon location and an optional grid display. This allows GE geotrek designers to easily scan, locate, and place GE geocaches and provides a meaningful mechanism for students to explore geographic features and search for GE geocaches. By using this tool in authentic ways, students may build a strong sense of earth-scale and Lat/Lon coordinate understanding (e.g., the constant nature of distances between lines of latitude and varying nature of the distances between lines of longitude). The GE “measure” tool provides a mechanism to measure the length of a line or a path (sequence of selected locations) on the Earth using either metric or customary units. This tool allows the GE geotrek designers and participants to measure distances with a similar level of accuracy (and possibly with a greater reliability) as that found with handheld GPS devices and again supports the development of understanding in many different curricular areas (e.g., geographical, scientific, technological, mathematical).

Geotrek designers can create GE geocaches as a series or Web of placemarks and image overlays anywhere on the globe (located within a very small range or scattered across the globe) for students to search for, zoom in on, and examine. In GE a placemark is an object that includes a location, an auto-scaling user-selectable icon (placed on the Earth or floating at any altitude), a label, and a pop-up description field (this may include text, html, URL links, and images). A GE image overlay is an image that can be scaled as needed (even reduced to miniscule proportions relative to the globe) and placed at any location on the globe (or above it at any altitude) along with a description field.

Each placemark or image overlay (whether created by a GE geotrek designer or a student) may be assigned a specific snapshot view where the location, altitude, and angle of the view can be manipulated to support efficient access or review of the relevant information. To further support student explorations, reporting of discoveries, or challenge solutions, Google Earth™ has a tour function that takes the viewer through a tour of placemarks and image overlays (either individually selected or all elements collected within a folder). Another feature of GE is that any view generated can be easily captured and printed, published on the Web, or transmitted via e-mail to support the problem solving process, the explanation of the process, the sharing of a solution, or as an artifact to be included in a portfolio.

When an individual designs a GE geotrek and creates a folder of GE geocaches to support the trek, they may choose to save their work as a KMZ file. A KMZ file is a compressed keyhole markup language (KML) data file that supports the sharing of GE folders, places, and image overlays. This KMZ file can then be easily transferred to other computers within a school or shared along with other supporting documentation as part of a downloadable GE geotrek resource on the Web.
Transforming Geotreks

Portable geotreks may be the simplest to transform into GE geotreks. Many geotreks that have no preset caches can be adapted with only minor adjustments to the documentation (i.e., the challenges, hints, reflection questions, learning outcomes, and teacher resources). If a portable trek requires some geocaches and the associated resource can be adapted to a virtual presentation (i.e., the resource to be found in the geocache can be presented as an image or some Internet-based resource) then they can be placed as very small “image overlays” at the locations specified so that the students can locate and use these images or Internet resources to support their efforts in achieving the overall geotrekking challenge. Because of the differences in scale involved between walking on Earth (1:1) and the satellite images, transforming portable geotreks into GE geotreks might involve adjusting the scale of the geotreks to spread the GE geocaches over much larger geographical areas (i.e., so that all of the other image overlays associated with other GE geocaches are not immediately visible when you visit one GE geocache).

Fixed-location geotreks also have great potential as GE geotreks, and indeed creating such may support the efficient sharing of unique local resources and learning opportunities. Again, for this type of transformation to work the resources contained within the geocaches involved must each be amenable to sharing in the form of image files or other Web-based resources. Because of their relatively large range, GE geotreks are less likely to be transformed into portable or fixed-location geotreks—although ideas, examples, and challenges might be adapted to support the development of other geotreks.

Geotrekking.net

Geotrekking.net is a Web site that has been established as a resource for educators interested in developing or sharing educational geotreks. It provides descriptions of the various types of geotreks and several sample geotreks of each kind integrating various curricular topics. Other resources available on the Web site include definitions and background information on such things as latitude and longitude and GPS use, teacher instructions, and a template to help persons interested in developing their own geotreks. It also includes a section where educators may share the geotreks that they have developed.

Although the pedagogical and attitudinal benefits associated with the meaningful and authentic use of GPS technologies appear to be sound and hints of such have been presented (Baker & White, 2003), further research is necessary to support these hypotheses, eliminate barriers, and encourage further adoption by teachers (Whitham Bednarz, 2004). It is expected that educational benefits are greatest when the technology being adopted is low threshold (i.e., it is easy for the teacher and students to master) and low friction (i.e., the overhead associated with the continued use of the technology is minimal). GPS technologies fit these criteria, so have great potential to make meaningful changes in teaching and learning of mathematics, science, technology, social studies, and geography.

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Educational Geotrekking


KEY TERMS

**GE Geotrek:** A virtual geotrek accomplished on a computer using Google Earth™ (GE).

**Geocache:** Typically a hidden container and logbook that is discovered with a GPS receiver using latitude/longitude coordinates. Participants may choose to record their visit and trade trinkets with objects found in the container.

**Geocaching:** A treasure-hunting activity using a GPS device, latitude/longitude coordinates, and optional additional clues to locate a hidden item (cache) or find particular locations of interest.

**Geotrek:** A problem-based learning challenge typically utilizing a collection of traditional, virtual, or online caches to provide information or other resources.

**Global Positioning System (GPS):** A satellite-based navigation system supported by a network of satellites that circle the earth twice a day transmitting signals to earth. GPS receivers take this information and use triangulation to calculate the user’s exact location, typically reported as latitude/longitude coordinates.

**Just-In-Time-and-Place (JITAP) Learning:** The learning that occurs when learners are presented with opportunities to efficiently acquire information and conceptual understanding at the moment and place they seek for it.

**Problem-Based Learning (PBL):** A learning model where students acquire knowledge by tackling authentic ill-defined problems. Typically the learners will have to persevere and make and justify assumptions to achieve their goal.

**Virtual Geocache:** A virtual geocache is a cacheless geocache where a specific location is sought for the purpose of retrieving information to answer a question, to learn about the location, or to complete a task.
Electronic Textbook Technology in the Classroom

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INTRODUCTION

One of the most underutilized technologies available to the school systems of this nation is the e-book. Although the technology has been available for five years or more, school boards overwhelmingly choose paper-bound sources for their textbook needs over electronic texts. In today’s technically savvy world where BlackBerries, iPods, and laptops are commonplace, even given to students as in the case of Quaker Valley School District, electronic textbooks should be considered as a valid alternative to traditional learning media.

BACKGROUND

What is an e-book? To put it simply, an e-book is a device about the size of a traditional paperback in which digital forms of printed material can bedownloaded and read. They are light, “…portable, and have a much larger capacity than a book of comparable weight and size…” (Ask Bruce!, n.d.)

Palm Pilots, BlackBerries, SmartPhones, and other small personal devices are readily available to the public at a wide range of prices. As with all hardware, a software program is required to allow the technology to function for its intended use. Microsoft Reader, Acrobat Reader, and PDF formats are currently the most popular reading configurations available to users. Books can be purchased from online sources and downloaded in memory cards or on the internal memory of the devices. An e-book “…can hold a whole library on a device no bigger than a paperback” (Fildes, 2003). One can think of no better fit for this technology than a learning institution.

ADVANTAGES OF ELECTRONIC TEXTBOOKS

There are many advantages to this technology and its uses seem endless in a school setting. “An e-book can give you lots more than a paper book. You can store lots of books on your computer, for example. You can mark your page with an electronic bookmark and jump straight to it when you open the book. Some e-books have built in dictionaries so you can click on a word and find out what it means. And non-fiction books may come with extensive collections of references and footnotes” (Ask Bruce!, n.d.).

Instead of heavy backpacks, students would be able to electronically carry all of their textbooks in a small two-pound device.

Accessible from anywhere by a simple touch of a screen, the complete text of every course could be available to the student. With three-dimensional pictures, interactive tools, visual and audio links, comments by the author, Web links, and small video demonstrations learning experiences would be enhanced. “Imagine a biology e-book showing video of DNA’s double helix coming to life, rather than the two-dimensional illustrations typically found in printed books. Or think of a math book with a built in calculator or spreadsheet so students can try out formulas as they read” (CNN.com, 2006).

To the student it may seem as if they have taken the instructor home with them.

Instead of waiting for a new text to be printed, updating materials found in texts would be seamless. “While traditional textbooks in many areas are outdated once they are written, one advantage of an e-book or course pack is that up-to-date information is only a click away. This provides students with more current information
than they would receive in a more traditional manner” (Birnbaum, n.d.).

Fluid courses such as technology and science education can remain current “…because publishers can update e-books at any time…” (Campus Technology, n.d.). Students would have the capability to write memos, ask questions, or fill out study guides on the personal device. They may be able to download the study guides or the instructor’s chapter notes from the school’s Web site. Reference books would be easy to navigate because e-books “…already embody the idea of hypertextual reference, which is currently cumbersome for the reader who has to turn pages to get to the notes…” (Taylor, n.d.). If the student prefers the feel of paper beneath his or her fingers, printing the necessary pages would be possible.

Cost and Savings of Devices, Software, and Texts

In 2001 e-readers sold for $200 on Web site stores. PDA’s, BlackBerries, and SmartPhones generally range in retail prices from $200 to $400. Most have reading software already installed in the device. Digital downloads of textbooks from publishers are beginning to be discounted to whet interest in college bookstores. In an article published the beginning of this school year, it is reported that publishers are extending expiration dates on their textbooks, and lowering the price, “…the downloads (textbooks) were to be sold for 33 percent off the cost of a new, printed copy…” (Borland, 2006).

The small size of the reader would free up storage space in both school and homes. Currently shelf upon shelf of space is dedicated to textbooks that are often out of date. If an English class’ required reading for a six-week period was A Brave New World, the student would only have to download the book for a short time. When finished, the student could delete the file, making room for another resource for the course.

Problems of Electronic Reading Media

Among all the advantages that would accrue to schools, there are disadvantages of e-technology to consider. As we all know, computers crash. All electronic devices have an inherent vulnerability not present in paper and binding. It may be a frustration to a student whose device fails to work on the one critical weekend before a big project or a final is due, or it could be used as another form of “my dog ate my homework.”

Destruction of property may be another potential high cost bill. However fines for this may inhibit this offense on the part of students.

School-wide introduction of the technology may not be feasible. Elementary students may still need hardback copies of written material from which to study.

Electronic Textbooks and Online Resources in Schools

In Korea implementation of electronic material has already begun. In The Korean Times dated the 8th of February 2006, fifth and sixth grade students are receiving digital math textbooks. Starting last May, the Ministry of Education and Human Resources has “…developed electronic textbooks in math targeting fifth and sixth graders of elementary schools. The digital math textbooks are the first among regular subjects to be taught for one year” (Ah-young, 2006).

In enumerating the advantages of electronic textbooks a ministry official said, “The e-books are specially designed to maximize educational effects by offering three dimensional experience programs, highlighter tools and feedback systems unlike simply having contents” (Ah-young, 2006).

In today’s public schools we have online software connections such as Ebsco Host, a library resource. Ebsco Host can access many different books and magazines in the library loan system. All the student needs is his or her school ID number. Another type of software allows questions to be asked by the student in the classroom in IM format. The instructor can then answer the student’s question without disrupting the rest of the class. Wireless technology is currently available in many schools.

What’s Holding the Schools Back?

So why with all its advantages, hasn’t the electronic textbook already become a staple in schools across the country? One reason might lie in a school board’s reluctance to spend taxpayer money on new technology that traditionally has a short obsolescence factor. Or it may be because of a shortsighted view of the technology’s far reaching implications in today’s society. “Learning curves associated with new technologies often act as
serious impediments to their widespread implementa-

The Korean Ministry official, however, holds a dif-

ferent view, “As one of the information and telecom-

munications powers, we will step up efforts to develop

e-books to better keep the so-called ubiquitous

educational environment in place. It will also improve

educational infrastructures by providing personal com-

puters to every student” (Ah-young, 2006).

Even if a school board would be willing to spend the

money to provide a reading device for every second-

ary student, the problem of standards still exists. With

competing formats, the uncertainty that your purchase

will read all of your texts could cause apprehension

for any taxpayer or board member. Publishers, device

manufacturers, and software producers need to come
to an accord in order to reach this lucrative market.

“Three major factors will be required to make eBooks

successful generally and also in higher education:

content, accessibility, and readability” (Looney &

Sheehan, 2001).

Recently there was a move by textbook companies

to provide college students with electronic choices.

Some complain that publishers are too “…conserva-
tive, doing little more than adding some hyperlinks and

search capabilities” (CNN.com, 2006). It appears that

until now publishers only put halfhearted effort into

the introduction of this format for their texts.

CONCLUSIONS

As exciting as this technology may seem, work still

needs to be done to change the currently entrenched

school system dinosaur, the paper-bound book. Software

manufacturers seem to have a standard for reading

text. Device manufacturers need to spend time and

resources in order to develop a cost efficient alterna-
tive to the tomes still in schoolrooms. Quoted in the

CNN.com article was C. Sidney Burrus, a former Dean
of Engineering at Rice University. “…technological

changes typically come in two phases: Replication

of older technology, followed by innovation” (CNN.
com, 2006). Publishers have a great responsibility to

provide the customer with educational choices. Finally,

school boards must look to the future and the welfare

of their students. With the increase of technology in
every aspect of today’s world, the school systems of

this country should seriously consider doing away

with the books of the past and look to the electronic

technology of the future.

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Electronic Textbook Technology in the Classroom


KEY TERMS

**Blackberry**: Wireless handheld device with phone, e-mail, fax, text messaging, and Web browsing capabilities.

**EbscoHost**: Provides database and bibliographic content services. Widely used by libraries and schools.

**Electronic Reading Media**: Hardware used to view a digital version of a book. Also known as an e-book reader.

**Electronic Textbooks**: Electronic, digital version of a textbook downloadable to an e-book reader or a computer.


**Hypertextual Reference**: Clickable links between text and reference material presented in current documents, other documents, or Internet resources.

**PDF (Portable Document Format)**: A file format created by Adobe and used for desktop publishing.
INTRODUCTION

Since the onset of technology as a tool in our personal and professional lives, we’ve progressed through at least two waves or stages of computing. The concept of ubiquitous computing names the third wave of computing, still in its infancy stages. The first wave consisted of mainframe computers shared by numerous people. The majority of society is presently in the second wave of the personal computing era, where people and machines interact through a predominantly iconic environment. The third phase of computing, referred to as ubiquitous computing, or the age of calm technology, takes place when technology recedes into the background of our daily lives. Alan Kay of Apple calls this the “third paradigm” of computing, while Weiser coins it as the “third wave” of computing (Weiser, 1996).

In Weiser’s (2006) third wave of computing, we achieve a vision of multiple computers per person in which “technology recedes into the background of our lives” (p. 1). To reach this point, each individual would need a personal computing device. Studies have shown that students are increasingly gaining access to computers outside of school, whether it be in their own home, a neighbor’s house, or the public library. However, schools have yet to even achieve a ratio of one computer per student (Bull & Ferster, 2005-2006).

During this time, we have experienced distinct phases of computing that include: (1) the strife for one-to-one computing, and (2) portable devices with wireless access. Each of these phases has revealed some insights into future ubiquitous technologies and research. According to America’s Digital Schools (ADS) 2006 five-year forecast, “the transition to mobile computing will help facilitate the transition to ubiquitous computing, which is not practical in desktop computer environments” (Hayes Connection & Greaves Group, 2006, p.1).

The ADS 2006 forecast further defines this one-to-one ubiquitous computing environment as one in which each student and teacher has an Internet-connected wireless computing device for use both in the classroom and at home that is not shared with others. For the purposes of this article, this is how ubiquitous computing will be defined.

BACKGROUND: NEGOTIATING THE WAVES

In the next section of this article, we will take a historical look at how each of these phases has contributed to the embedded ubiquitous environment within educational settings.

One-to-One Computing: Origins and Goal-State

Throughout the 1980s and 1990s, it was common for schools to place all computers in a centrally located lab or media center (Means & Penuel, 2005). These labs were found to be somewhat effective for students (Kulik, 1994). However, limited access is one reason why the integration with technology as an instructional tool was minimal in many classrooms (Cuban, Kirkpatrick, & Peck, 2001; Sheingold & Hadley, 1990). To make technology more powerful in regards to student learning, it was and still is deemed that students must be able to use computers more than once or twice a week in a school lab setting (Kozma, 1991).

Some of the major recommendations by researchers for educators and decision makers towards effective one-to-one initiatives include distributing a few computers throughout all classrooms, providing more time for teachers to collaborate across subject areas, and providing adequate technical staff to maintain computers and high-speed Internet access (Cuban, 2001). Providing such technology access and support within a networked environment at the classroom level in the 1980s and 1990s demonstrated major shifts in the learning environment, such as whole-class to small group instruction and lecture and recitation to coaching (Collins, 1991; Dwyer, Ringstaff, & Sandholtz, 1991; Sandholtz, Ringstaff, & Dwyer, 1997).
Portables with Wireless Access

In order for teachers to be effective in providing real-world connections, they need to understand and utilize the new wave of communication tools posed to future generations of mobile users and learners. Small group instruction and coaching can easily lead to creating a community of learners (Rogoff, 1994). A more interpersonal environment in which students and teachers become learning partners and experience role-reversals in terms of knowledge experts regarding content and technology. Considering the emerging mobile learning milieu, the community of learners environment becomes more important in terms of how students view information, communication, and community. This is a very different view from prior generations (Kleiman, 2004).

According to the America’s Digital Schools (ADS): A Five-Year Forecast Report (2006), schools have rarely changed as quickly as we find them today transitioning from a desktop world to a mobile world. This mobile world includes laptops, tablets, and student appliances, but not cell phones. In the 2006 ADS report, researchers found:

- Students’ use of mobile technology is currently at 19.4%, while 52.1% are projected to be mobile in 2011;
- 1:1 computing is currently found to be in process in 24% of school districts, versus 4% in a 2003 report;
- Academic improvement results were tracked to show 87% of the schools with moderate to significant positive results and 13% reporting no or poor results; and
- Online learning is growing at the rate of a 26.3% compounded annual growth rate;
- Professional development to support 1:1 initiatives is seen as extremely important by 65% of superintendents, yet only 16.9% of district curriculum directors believe their current professional development is prepared for such support; and
- Student appliances (113%), tablet computers (82.7%), PC laptops (25%), and Mac laptops (23.7%) will grow significantly over the next five years (Hayes Connection & Greaves Group, 2006).

These statistics indicate rapid technological growth for today’s professional educators. Mobile, ubiquitous education is imminent and will change the face of learning environments through alterations in space, different areas of life, and time (Vavoula & Sharples, 2002). Literature reveals that teachers need assistance in learning how to integrate technology into their curricular plans (Kanaya, Light, & Culp, 2005; Schwab & Foa, 2001). Ubiquitous learning also necessitates teachers’ assistance in learning how to integrate such portable technologies.

CATCHING THE UBQUITOUS TECHNOLOGY WAVE: EMERGENT UBQUITY ISSUES

It is too early to indicate if the changes being brought about by embedding ubiquitous technologies to the curriculum will provide solutions to problems and questions posed throughout educational technology history. Therefore, more focused and inventive in research and development efforts within the field of educational technology becomes paramount.

A number of researchers have argued that ubiquitous computing with wireless connectivity has the potential to change learning environments and outcomes (Roschelle, Penuel, & Abrahamson, 2004). Yet, other researchers have found that “the No Child Left Behind legislation and the economic situation of the past few years have been slowing, and in some places, reversing, progress in these types of uses of educational technology,” as well as causing educators “to focus on how technology can be used to increase test scores” (Kleiman, 2004, p. 250). More innovative, constructivist-based activities that better prepare our students for the 21st century exist and provide great learning motivation for students and educators.

In the author’s opinion, further research and development is needed because of the slow or apprehensive overall migration towards progressive ubiquitous learning environments within elementary, secondary, and post-secondary educational settings. In light of what current research tells us, the following will be presented: (1) administrative guidelines for supporting ubiquitous technologies; (2) a practical ubiquitous learning design guide; and (3) suggestions towards ubiquitous technology research frameworks.
Embedding Ubiquitous Technologies

Administrative Guidelines for Supporting Ubiquitous Technologies

Administrative support can be a leading success factor in effective integration of technology within learning environments (Cuban, 2001; Johnson, 2006; Kleiman, 2004; Penuel, 2006). The most frequent administrative recommendations are to: (1) provide ubiquitous access to resources for students, and (2) support and expect teachers to integrate technology into instruction.

Provide Ubiquitous Access to Resources for Students

“The power of devices is nothing unless it is paired with applications, infrastructure, and access (Johnson, 2006, p. 31). With the advent of Web 2.0, applications and data reside on the Web itself, thus providing ubiquitous access from the Web and allowing students to continue working in other locations (Bull & Ferster, 2005-2006). Students should be able to bring their own devices into a school and not be locked in by a vendor, operating system, or platform. Uniform resource accessibility needs to be supported in order to maintain a truly ubiquitous technology environment.

As students bring in their own devices, security, ethics, and curricular integration will continue to be issues that need to be addressed and supported. “Schools need to invest the time and effort in constructing technology, policies, and procedures that allow student-owned devices to be deployed and repurposed educationally” (Johnson, 2006, p. 31). This will also demand teachers and students to explore effective curricular uses for such technologies.

Stronger communities of learners (Rogoff, 1994) will result through greater provision of ubiquitous access to resources for students. This community of learners is needed for peer-to-peer support and reverse mentoring of students coaching teachers in technology trouble-shooting and use. This reverse mentoring, in turn, helps teachers’ professional development (Burns & Polman, 2006; Penuel, 2006).

Support and Expect Teachers to Use Technology

Varied forms of staff development and professional training opportunities within one educational setting are also recommended throughout research (Penuel, 2006). Collegial interactions in which teachers share their successes and failures with technology provide shared knowledge and possible collaborative efforts (Christiansen, 2002; Rockman, 2003). Educational conferences change the ways educators communicate with other professionals, while teacher workshops provide needed skills, but more importantly, help teachers integrate technology into their instruction (Burns & Polman, 2006). More recent advances in professional development programs include online courses and workshops in addition to the online discussions and resources as an extension from college courses to onsite workshops (Kleiman, 2004). Staff development needs to be provided at hours and places that are convenient for teachers (Cuban, 2001; Kleiman, 2004).

Another administrative support recommendation on the rise is that of institutionalized funding. Given the fact that ubiquitous technologies are becoming cheaper as time progresses, creative funding efforts are worth noting. Such efforts include textbook funds allocated for e-books and service-based subscriptions to software and resources (Johnson, 2006).

Administrators need to expect their educators to utilize technology. There has to be both insistence on and examples of technology’s use in daily tasks, since “access is typically not enough to create a cultural shift in adults” (Johnson, 2006, p. 31). Teachers who use computers first for administrative tasks, such as grade books, lesson plans, and parent interaction have been noted as being quicker to adapt technology effectively in their classrooms (Burn & Polman, 2006; Cuban et al., 2001; Johnson, 2006). Therefore, administrators must insist upon the use of technology in administrative tasks as well as support training of technology for instruction, since “day to day professional use lays the most successful foundation for the curricular use of technology” (Johnson, 2006, p. 31).

Practical Ubiquitous Learning Design Guide

Burns and Polman (2006) noted several studies that identified a pattern of technology adoption: (1) teachers first familiarize themselves with the new technology; (2) teachers may begin to adapt it to their own productive use in the classroom, where less than 30% of the teachers will utilize computers for instruction; and (3) teachers begin to fully integrate computers and
perhaps transform classroom practices (p. 365). These studies have indicated that it can take up to five years to achieve such a level of integration (Sheingold & Hadley, 1990). Burns and Polman (2006) debate this amount of time, based upon their research that once a teacher makes the connection to established teaching practices, it is easy for them to transform into using technology (p. 373). Given the rapid deployment of ubiquitous technologies, learning environment design models for ubiquitous technologies are in order.

Such ubiquitous technology learning environment design models are not currently found within the literature. Mobile learning is a similar concept that has provided a hint of a design model. Characteristics of mobile learning (Chen, Kao, Sheu, & Chiang, 2002) provide “adaptivity towards contextual life-long learning, which is defined as the knowledge and skills people need to prosper throughout their lifetime (Kinshuk, 2003). These characteristics are enumerated in Table 1.

Given the characteristics of mobile learning and the author’s professional experiences, the following design guide and associated questions are posed for any elementary, secondary, and post-secondary educators desiring to construct learning designs within a ubiquitous learning environment.

The ubiquitous learning environment design guide is designed for practitioners within a ubiquitous technology learning environment. Addressing the ques-

Table 1. Ubiquitous learning environment design guide (Elwood, 2006; Adapted from Chen, Kao, Sheu, & Chiang, 2002)

<table>
<thead>
<tr>
<th>Ubiquitous Learning Environment Design Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urgency of learning need</strong></td>
</tr>
<tr>
<td>• Have the learners formulated their own curriculum framing questions based upon methods of inquiry and project-based learning?</td>
</tr>
<tr>
<td>• How are the learners' needs dependent upon ubiquitous access to technology?</td>
</tr>
<tr>
<td><strong>Initiative of knowledge acquisition</strong></td>
</tr>
<tr>
<td>• What face-to-face and virtual environments and resources exist to foster individual and collaborative exploration and learning?</td>
</tr>
<tr>
<td>• How do the learners' resource and knowledge acquisition needs necessitate ubiquitous technology resources?</td>
</tr>
<tr>
<td>• Ask students and Web community: What ideas can you contribute to this activity or project in regards to information literacy, communication skills, global awareness, creativity, collaboration and other Web community resources?</td>
</tr>
<tr>
<td><strong>Mobility of learning setting</strong></td>
</tr>
<tr>
<td>• How can learner location affect their access to and sharing of prime research and resources?</td>
</tr>
<tr>
<td>• Is your project dependent upon people and resources beyond your immediate control and therefore creating learning and interactivity needs?</td>
</tr>
<tr>
<td><strong>Interactivity of learning process</strong></td>
</tr>
<tr>
<td>• How will the learners need to interact with information asynchronously and synchronously?</td>
</tr>
<tr>
<td>• How will the learners need to interact with other learners, educators and content experts asynchronously and synchronously within a community of learners environment?</td>
</tr>
<tr>
<td><strong>Situating of instructional activities</strong></td>
</tr>
<tr>
<td>• What instructional activities can be devised to necessitate the use of one or more of the following: a wireless network, Internet connectivity, real-time collection and/or analysis of data, electronic collaboration or additional ubiquitous resources?</td>
</tr>
<tr>
<td>• How will this project fit into your school’s culture and organization?</td>
</tr>
<tr>
<td><strong>Integration of instructional content</strong></td>
</tr>
<tr>
<td>• Does the instructional content design promote ubiquitous technology use?</td>
</tr>
<tr>
<td>• How can online collaborative learning tools best be utilized in building upon instructional content to further foster the community of learners environment?</td>
</tr>
</tbody>
</table>
tions within the characteristics of the mobile learning environment will help educators more effectively plan and utilize the power of ubiquitous learning environments within their own project-based learning environments.

This design guide can also serve as a point of reference for researchers studying ubiquitous learning environments. Given the current research on ubiquitous technologies as defined earlier in this article, researchers need to conduct future evaluation studies investigating the “potential effects of [such technologies] and establish the reliability and validity of a wide variety of outcome measures as part of their research” (Penuel, 2006, p. 342). This guide can provide questions that possibly act as a springboard for future outcome measures.

Suggestions Towards Ubiquitous Technology Research Frameworks

Researchers have noted contradictory findings in the area of teachers and ubiquitous technology (Hill & Reeves, 2004; Winschitl & Sahl, 2002). Further research on interactions of beliefs and practices with ubiquitous technologies, reducing anxiety in teachers as they begin implementation, contextual factors, and administrative expectations are needed (Burns & Polman, 2006). These recommendations directly tie to the culture of the educational environment.

“The issue of why 1:1 computing is not working has nothing to do with the technology, but rather the educational processes and culture around it . . . for any technology initiative to be truly successful, you must address the culture . . . ” (Hall, 2006, p. 9). Hall (2006) continues to define culture as “the beliefs and values that drive the behaviors of an organization and community” (p. 9). Galloway (2004) notes that ubiquitous computing desires to see technology as invisible in our lives, while socio-cultural theories of everyday life have always been interested in rendering the invisible visible and exposing the mundane. Thus, it has been well-noted that we need to explore ubiquitous technology efforts through a greater focus on the educational culture.

FUTURE TRENDS

Smart media-based cognitive traits devices are being developed that record a learner’s memory capacity, inductive reasoning ability, and information processing speed. These types of smart media will allow learners to any learning environment and receive instant adaptation (Lin, Kinshuk, & Patel, 2003). This allows promise for individual learning plans for every student, according to that student’s learning styles and learning needs.

Such research is currently being conducted at the Robotics and Games (R&G) Laboratory at Griffith University, Gold Coast campus, as depicted by Jones and Jo (2004). The R&G team is developing ubiquitous robots with sensor technologies to assist in determining user needs, as well as communication between robots without the need for user interaction. Jones and Jo (2004) propose a ubiquitous learning environment (ULE) model similar to the interactive guides currently employed within museums. Components of the model include microprocessors with sensors to activate information push as users come within proximity; ULE servers for greater interaction and feedback needs per individual within the learning environment; and Bluetooth and WiFi wireless technologies.

Concepts of ubiquitous computing go beyond handheld devices. We are rapidly approaching the calm technology or smart technology era in which computers will become “invisible” and will be embedded in all aspects of our daily lives (Weiser, 1996). This will take the form of wearable computers and embedded microchips. Public access screens and home TV displays will be the future “monitors” for our hand-held or wearable personal servers. “Using the personal server concept, we’re virtualizing the hard disk through a wireless connection to whatever computing device is nearby and available” (Want, 2003).

CONCLUSION

The realization of the third wave of technology in our educational settings is imminent. Calm or smart technologies that use sensors, wireless technologies, and ubiquitous learning environment servers are already being field tested and researched. As this new wave of technology approaches, it becomes more important than ever to further research and develop their effective use within educational environments of all ages.

This implies further contemplation for educational researchers and practitioners. Considering the near-future applications of third wave ubiquitous technologies, researchers need to explore the implications of such
technologies. Many researchers point to theoretical frameworks that focus on socio-cultural studies as a needed research lens. Such research will help define educational culture components necessary for practitioners to embrace successful calm technology environments.

Practitioners will continue to need practice and development with inquiry and project-based learning methods and strategies, but with an added focus on ubiquitous environments. The ubiquitous learning environment design guide presented in this article is one attempt at assisting practitioners in developing meaningful curricular goals utilizing the power of ubiquitous technologies within their learning environments.

REFERENCES


Embedding Ubiquitous Technologies


**KEY TERMS**

**1:1 (One-to-One) Computing:** A definition of personal computing access and use defined as “each student and teacher [having] one Internet-connected wireless computing device for use both in the classroom and at home” (Hayes Connection & Greaves Group, 2006, p. 1).

**Calm Technology:** This type of technology aims to reduce information overload by letting the user select what information is at the center of their attention and what information is peripheral. Calm technology is envisioned to not only relax the user, but move un-needed information to the edge of an interface, thus allowing more information to exist there, ready for selection when needed.

**Mobile Education:** “Learning is mobile in terms of space; it is mobile in different areas of life; it is mobile with respect to time” (Vavoula & Sharples, 2002).

**Mobile Technologies:** Devices such as PDAs or smart phones, that can store, access, create, modify, organize, or otherwise manipulate data in various forms from mobile locations. Such devices can be used to store, modify, view, and transfer a wide range of file formats. These same devices can be used to store, access, modify, and remote-connect to databases. They can also fit in your pocket and typically run on rechargeable batteries.

**Reverse Mentoring:** Reverse mentoring relationships are developed to gain technical expertise and a different perspective. They are not necessarily a younger to older person match, but rather more a peer-to-peer relationship where both people have a lot to teach and lot to learn. In an educational setting, this is usually experienced by teachers who have students assist them with technology in either informed curricular design assistance or technical assistance.

**Smart Technology:** Technologies that allow sensors, databases, and wireless access to collaboratively sense, adapt, and provide for users within the environment. Such smart technologies are currently found in housing designs for elderly and educational environments similar to sensors and information feeds within museums.

**Ubiquitous Computing:** This integrates computers into the environment through everyday objects that would enable people to interact with information-processing devices more naturally and casually than they currently do regardless of location or circumstance. For purposes of this paper, the definition is further delineated as a one-to-one computing environment in which each student and teacher has one Internet-connected wireless computing device for use both in the classroom and at home that is not shared with others (Hayes Connection & Greaves Group, 2006)
Ergonomics

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INTRODUCTION

With the many and vast advances of technology across generations and societies, the need to determine the best ways to align and use the human body in coordination with technology has increased accordingly. While occupational hazards and accidents date back to ancient times, and the Industrial Age resulted in accidents related to machinery, the human disabilities and debilities related to technology may emerge more subtly over time before they become acute.

It is the field of ergonomics that addresses the appropriate alignment and use of the body in all sorts of activities. The fundamental perspective is primarily that of proactive human behavior. However, it really has only been given the limited notice that it has because of the pain and debilitation that has arisen when it is not followed. Thus, a proactive perspective has gained recognition in a reactive environment.

Due to the efforts of the U.S. Department of Labor, and more specifically the Occupational Safety and Health Association (OSHA), the field of ergonomics has received increased press and familiarity with the general public in recent years. However this identity has mostly been in regards to either (1) simple body position and alignment issues or (2) workplace safety.

Therefore, the general public oftentimes does not realize the long term affects of improper postures from using increasingly ubiquitous office/computer technologies because it is not associated with heavy manual labor (Bright, 2006). Nagourney (2002) is but one study which demonstrates that even simple corrections to posture and equipment positioning can result in improved physical health for computer users (see also ECCE, 2006).

At the next level of consequence is the fact that numerous studies have documented that leaving small repetitive injuries uncorrected, those which result from improper posture from using technology and other office equipment, have been found to culminate into health problems over time (Ullrich & Ullrich Burke, 2006). Because of these findings and the direct benefits of changing position and movement, public, workplace, and formal education needs to be improved.

Rather than isolated or temporary injuries, individuals in these conditions experience compounding effects of improper postures results in continuing, repetitive (oftentimes unnoticeable) injuries. Therefore, OSHA and a broad base of professionals need to continue to educate the general public so that they understand that ergonomics is more than health and safety codes for manual labor and or what may be generally perceived as physically “harmful” workplace situations. At the same time, both personal and a public responsibility for health and safety need to be exercised in communicating information and solutions and then implementing them in the many aspects of our lives in which we use technology.

Ergonomics Example

What does ergonomics mean on a day to day basis for people in 2006 and onward? In a word: responsibility. Bringing ergonomics into a very practical example for most readers, Kay’s (2001) article discusses the dilemma we face with the opposing merits and drawbacks of using laptop computers. Kay describes the merits of the laptop computer, presents the drawbacks in its improper use, and then identifies the ergonomic solutions:

The laptop computer is a valuable tool when portability is much needed function. It may not be the best choice when considering the ergonomics of the workstation. ...It is always advisable to use add-on devices such as an external keyboard, mouse and monitor. These items are considered essential equipment for users wanting to achieve ergonomically correct positioning their laptop computer. (para 1)

Rather than an oversimplified solution, this model provides several illustrations as to how to position oneself to use a laptop computer. The document also provides explanations as to why these positions are ergonomically effective.
As mentioned previously, the key here is responsibility. Contrary to what we may assume, we cannot just take a computer out of a box, sit it on any table or our “lap” and continue to type for 6 hours. We have to consider ergonomic issues or else our health, and ultimately our ability to work and to enjoy our recreation time, will suffer.

**BACKGROUND**

**Definition**

The word ergonomics is derived from the Greek word for work, “ergo,” and thereby means the “study of work.” The commonly accepted definition of ergonomics is usually stated as the science of designing working environments and the tools in them for maximum worker health and safety and maximum work efficiency.

Furthermore, ergonomics as a field is very much application focused on the study of human physical characteristics and needs. Based on research that seeks to learn about a variety of human characteristics (capabilities, limitations, motivations, and desires), the most appropriate human-made environments are desired to craft living and working environments (Kroemer, 2002).

Kroemer (2002) continues to explain that the information is not confined to the simple solutions the general public might be familiar with in typical public education efforts. Instead, the research supports complex technical systems or work tasks, equipment, and workstations, in addition to the more commonplace tools and utensils used everyday in the workplace, home, and during recreation.

**Ergonomics Perspectives Mature**

Providing an insightful current perspective on the needs and issues of ergonomics, Kroemer (2002) summarizes the field as being “human-centered, transdisciplinary, and application-oriented.” This characterization accurately moves the description of the research, development, and educational/intervention work of the field of ergonomics circa 2006.

Rather than being solely focused on the issues of machines and positions, perhaps those of kinesiology and mechanics, ergonomics has matured into a field that necessitates the sharing of understanding across several disciplines. The focus of those who work in this field is very much “human centered” in contrast to what may appear in the early literature, publications and even to those viewing the work from the outside. Ergonomics is not so much concerned with equipment and conditions as it is concerned about human interaction, human needs, and human responses to those and other environmental surroundings and interactions.

Human factors specialists are united by a singular perspective on the system design process: that design begins with an understanding of the user’s role in overall system performance and that systems exist to serve their users, whether they are consumers, system operators, production workers, or maintenance crews. This user-oriented design philosophy acknowledges human variability as a design parameter (National Research Council, 2002, para 3).

The transdisciplinary nature of ergonomics is easily identifiable in each study and educational material that is reviewed. For instance, a review of the material that is found at the U.S. Department of Labor’s (2006b) site, http://www.osha.gov/SLTC/etools/computer-workstations, reveals that this introductory page and OSHA’s eTool site together describe how users should evaluate their position and use of desktop computers and keyboards (http://www.osha.gov/SLTC/etools/computerworkstations/positions.html).

Examination of these diagrams and information reveals concerns that derive from the disciplines of biology, anatomy, and physiology. More specifically, the issues of visual acuity, eyestrain, spinal alignment, disc compression, and nerve damage become apparent as one reviews the points that need to be considered about positioning oneself or others at a computer workstation. In this way, the medical specialties of optometry, ophthalmology, orthopedics, chiropractry, and neurology would all be relevant in determining the accuracy of the information to be presented to the public in ergonomics informational materials, educational publications, or presentations.

In addition, once one considers the problems that can arise when people engage in activities when the best ergonomics conditions are not followed, transdisciplinary specialists and expertise are again indispensable. For instance in the case of spinal disc compression which might be aggravated by spending long periods of time sitting erect at a desktop computer, specialists in physical therapy, orthopedics, and pain management could be involved in treating the immediate difficulties and
trying to alleviate the pain and discomfort. Once this treatment is established, occupational therapy becomes involved in order to engage with the user and develop new ways to do their work that will not cause, or at least reduce the risk of, continued physical problems.

**MAIN FOCUS OF THE ARTICLE**

For this article, the emphasis on ergonomics is in relation to instructional technology. The examples of how people need to be aware of their workspace, body position, and work process are critical in identifying appropriate positions for working with technology.

Two major examples for teaching and learning today are the use of laptops and desktops. Both of these computer configurations provide unique challenges.

The U.S. Department of Education has addressed the need to publicize, educate, and guide workers in how to correctly position their desktop computer workstations. Through the use of an interactive Web site with “eTools” and guiding questions that lead to menus of choices, users are able to better understand how they might consider their workspace and physical needs.

The following quote from the U.S. Department of Labor (2006a) Web site regarding the “Computer Workstation” illustrates the general philosophy and guidance provided:

To understand the best way to set up a computer workstation, it is helpful to understand the concept of neutral body positioning. This is a comfortable working posture in which your joints are naturally aligned. Working with the body in a neutral position reduces stress and strain on the muscles, tendons, and skeletal system and reduces your risk of developing a musculoskeletal disorder (MSD).

**FUTURE TRENDS**

**Research and Development**

Future developments in ergonomics are expected to be in many areas. Special attention is being made to legislative matters so that employers, medical professions, and private individuals will have better definitions of the medical conditions that may arise from physical alignment in activity or use of equipment. For example, the standard definition of musculoskeletal disorder was repealed by the U.S. government in 2001. Reasons for the action depend on the constituency that is answering the question. For instance, in an official ceremony on March 20, President George W. Bush quashed 10 years of OSHA rulemaking with the swipe of his pen, signing Congress’s repeal of the ergonomics standard. It was the first time ever that Congress and the White House teamed to strike down a finalized workplace safety and health rule.

“In exchange for uncertain benefits, the ergonomics rule would have cost both large and small employers billions of dollars and presented employers with overwhelming compliance challenges,” Bush said in a statement.

White House spokesman Ari Fleischer said recent economic woes made Bush’s action more timely. “In this time of fragile economic circumstances, he does not want to take any action that would hurt economic growth and cost small businesses and other businesses billions of dollars,” Fleischer said (Bell, 2001, para 1-4).

An opposing perspective indicates that this lack of definition leaves individuals without support that they need.

This statement was released by the Department of Labor at the same time:

The safety and health of America’s workers is vital to our nation’s overall well being and is my first priority. As Secretary of Labor, I am encouraged by the progress employers and workers alike are making in reducing workplace injuries and illnesses.

The new data released today by the Bureau of Labor Statistics covering 1999 (US Department of Labor, 2001) shows us where our efforts are succeeding and where we need to direct our focus as we move toward developing a 21st Century Workforce.

One interesting point in the study is that as more Americans were in the workforce than ever before, the number of ergonomics-related injuries continued to decline. However, musculoskeletal injuries accounted for nearly one-third of all the injuries. This finding demonstrates the need for a solid, comprehensive approach to ergonomics. It also points to a need to address injuries before they occur, through prevention and compliance assistance, rather than just rely on reactionary methods. I am committed to joining with unions, employers, safety professionals, and Congress
Ergonomics

to develop an effective strategy to further reduce these injuries. This is a serious problem. We are addressing it head-on, and we intend to find a solution that works (U.S. Department of Labor, 2001, para 1-3, emphasis added.)

The directive of the action and subsequent reports of the National Advisory Committee on Ergonomics (U.S. Department of Labor, 2004) is that we need to solve the problem. However, the impact of the action by the U.S. Government is to leave medical professionals, medical insurance companies, and private individuals with an unresolved definition and minimal guidance in how to link physical conditions with experience or conditions.

Ergonomics in Education

Considering issues of ergonomics in education one has to examine the educational equipment and environment for K-12 students and adults. In K-12 education, classroom furniture is specifically designed for the proportionate body size. In the same way, computer equipment and furniture needs to be appropriately sized and positioned.

The Ergonomics for Children in Educational Environments professional association provides Web-based resources and conferences about such issues (ECEE, 2006). This site includes recommendations for practice and purchases. It also has a comprehensive list of research that has been done on the specific topic of ergonomics in education (http://education.umn.edu/klss/ceee/suntab.html) which includes area topics from computers and vision, to school furniture design, backpacks, safety issues and design for children, to issues for teachers.

Why is ergonomics with computing of particular importance for instructional technology? One prominent example is the laptop computer. One-to-one computing has been on the scene since the 1990s and has gained even greater emphasis in 2005 forward. Look around classrooms, across all ages, and you will see a wave of laptops coming through the doors. From classrooms, to airports, conferences and staff meetings, the laptop is becoming the computer configuration of choice because of the small size and mobility.

However, the severe tradeoff that accompanies the laptop computer is that most users will “hunch” over the keyboard and squint at the monitor (Bright, 2006). This position is a classic description of how ergonomics reveals the problems behind human behavior. Rooted in anatomical, physiology, and neurology reasons, the “hunch” position aggravates and overtime can severely damage spinal discs, nerve roots, and spinal nerves in not only the hands and arms, but the neck and lower back. Ergonomics reveals that through proper equipment positioning, repetitive stress injury can be reduced and this damage can be avoided.

Public Awareness and Education

Some of the issues that need to be address in the field of ergonomics in general and also as it applies to education include:

- **Effectiveness:** Studying various ergonomic devices and the health benefits in their use in educational settings (ECCE, 2006).
- **Motivation:** Identifying issues of ergonomics that will attract teachers, learners, and others people to become interested in the health benefits of controlling their workplace, learning, or recreational environments (Eissinger, Hicks, Bright, & King, 2006).
- **Communication:** Identifying effective strategies and content to communicate the benefits and processes that are included in ergonomics.
- **Materials:** Creating and evaluating training materials that will be effective in increasing the awareness of ergonomic needs, safety issues, and training across specific sectors of the general public (ECCE, 2006; Eissinger et al., 2006).

CONCLUSION

As we consider the field of ergonomics and its place in instructional technology, our responses could be several and the opportunity is great. Based on this research as a researcher, instructional technologist, and educator, I recommend: Seek, Know, and Communicate.

- As technology users and lifelong learners we need to continue to seek out the newest information on this topic, as new technologies continue to develop, so will our physical risks. And as research continues, we will better understand risks and solutions.
- As technology users, we need to know how to
use technology in ways that we can preserve our health.

- Finally, as responsible educators, we need to understand the issues and communicate proper practice to the students we work with.

The consequences are clear. If we do not take action on our behalf and on behalf of the learners with whom we are working, our technology-powered societies will end up paying for the long term affects of our actions.

In 2006, adults are only bearing 10-15 years of misuse of these technologies in their bodies. The questions are yet to be answered as to the severity of conditions when people have been subjected to such physical strain and injury for 30-50 years.

Herein lies the opportunity to convert potentially drastic consequences into a new ergonomic paradigm of Seek, Know, and Communicate. Instructional technology can be empowered through ergonomics to optimize the human body rather than tearing down that frame.

ACKNOWLEDGMENT

Dr. Kathy King, author of this article, expresses appreciation to Greg Bright for the substantial literary research that he provided in the research of this publication.

REFERENCES


**KEY TERMS**

**Department of Occupational Safety and Health Administration (OSHA):** A branch of the United States Department of Labor which oversees workers issues (http://www.osha.gov).

**Ergonomics:** The commonly accepted definition or ergonomics is the science of designing working environments and the tools in them for maximum worker health and safety and maximum work efficiency.

**Musculoskeletal Disorder (MSD):** Still not completely defined by SHE. The following definition was repealed in 2001:

A disorder of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels, or spinal discs…. this definition only includes MSDs in the following areas of the body that have been associated with exposure to risks factors: neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee, ankle, and foot. MSDs may include muscle strains and tears, ligament sprains, joint and tendon inflammation, pinched nerves, and spinal disc degeneration….http://www.osha.gov

**National Institute of Occupational Safety and Health (NIOSH):** NIOSH is the institution that provides scientific data upon which OSHA makes recommendations.

**Occupational Injury:** Any injury which results from a work-related event or from a single work environment incident. Examples of injuries or disorders that can be work related include: Carpal tunnel syndrome (CTS), rotator cuff syndrome, Tarsal tunnel syndrome, sciatica, tendonitis, Raynaud’s phenomenon, carpet layer’s knee, herniated spinal disc, and low back pain.

**Repetition:** Repetition in the field of ergonomics refers to the number of a similar exertions conducted during an activity. For example, an office worker may insert 40 letters in envelopes during 10 minutes. User and worker discomfort of an injury that has been associated with repetitive motion.

**RSI:** Repetitive Strain Injury

**RMI:** Repetitive Motion Injury

**UECTD:** Upper Extremity Cumulative Trauma Disorders

**WRULD:** Work Related Upper Limb Disorder (Ergoweb, 2006)
Evaluating Online Resources

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INTRODUCTION

In a matter of seconds, a person using the Web will make a decision. Do I stay on this Web site or click to another? There are many reasons for this reaction. For many the decisions are unconscious behavior and for others it is a matter of speed. Still others focus on content. Regardless, the ability to get users to a Web site and keep them there has become big business for both business and educational institutions. According to Internet Usage Statistics (2007), the Internet World Stats Web site, over 1 billion people use the Internet worldwide. The MIT home page is accessed about 2000 time a day from around the world. And use is on the rise. In 2009 the completion of an 18,000 km oceanic cable drop linking South Korea, China, and Taiwan with the United States Internet sends a clear signal that usage and dependency will only increase in the future and spread around the world. This creates an imperative that users are keenly aware of where they surf, what information they share, and, most importantly, if they can believe what they read and see.

Internet search skills go beyond personal preference. Clearly initial reaction will play an important role in surfing the Web. It may be this reaction that the user engages when they click on a Web site for the first time. But understanding the primary reason and purpose for surfing will help the user navigate successfully. In December 2005, a survey from the PEW Internet & American Life Project reports that nearly a third of Internet users go online on a typical day for no particular reason but just for fun or to pass the time. Some 40 million people said they were surfing for fun on a typical day during the month. What is alarming is that this number is up from 25 million in the future when this question was asked. However the Web is a complicated place and sometimes it isn’t a lot of fun. To understand its plethora of options, the user needs to be aware and understand how it works and how individuals, companies, governments, and educational institutions use it.

Educators surf for fun, too, but they also use the Internet for serious professional and personal reasons. They use it to offer online classes, to provide students with instructional resources, to connect with colleagues around the world using data and video, and to plan family vacations and pay bills. It certainly is changing how we teach, learn, communicate, and live our daily lives. The idea that millions of people browse for no particular reason lends credence to our changing lifestyles.

Because of these changes, knowing what is a good Web site and why you are there becomes even more critical. The ability to evaluate online resources requires the convergence of several skill sets. Assessment can be so quick that a user will simultaneously fuse personal choice, experience, technical access, and the awareness of authoritative content to evaluate a Web site and moments later move on to another location. In fact, according to an article in PC Magazine in 2001 the average length of stay on a Web site is 4 seconds; 50% less than earlier believed (Metz, 2001).

We all have a pretty good idea of what we like and don’t like. Our instincts and senses react quickly to what is in front of us. We make these choices based on years of decisions and character development and we have it down. We are organic, crafters, researchers, and lovers of movies, clothes, music, or cars. We shop on the Web, learn on the Web, and chat on the Web and do this all within pockets of the Web that give us comfort and what we need to be happy to return and do it again. The Internet really wants to service our needs and give us that product that we’ll purchase or share with others. Of course this is called sales and consumerism. We all know that it is not the Internet but people on the Internet who offer these opportunities. The Internet is one vehicle that we use to take care of our needs. Using the Web, we are given more choices today than at any other time in history. And even though we know what we like, choosing can get pretty confusing! So to understand why we like certain pages on the Web it is important to go beyond our personal first impressions of color, text, and appearance and consider how the Internet manages and promotes itself.
Why this is important is because we don’t only “take” from the Web, we “give” to the Web. We become part of an international family sharing personal information. It can be as confidential as bank account and credit card numbers and as important as your hobbies, interests, clothes preferences, and travel plans. Once we enter personal information, we are a part of the system. Some feel it is like being managed by the Oz behind the curtain: the all knowing being who guides us to choose their product so discreetly at times that we think it is our own idea. The saving grace is that we do have choices! Understanding our needs and how consumerism works on the Internet helps us to make good choices that are personal and meaningful to our needs. We need to be careful and think first before we give out personal information of any kind.

There are reasons we travel to certain Web pages. An empirical study performed in 2001 by Zhang and von Dran (2002) of Syracuse University helps us understand Web site similarities and differences. They identified six different Web site domains: financial, e-commerce, entertainment, education, government, and medical. Obviously each of the domains serves a different function on the Web and clearly each domain has specific priorities for Web site development. For example, the financial domain data indicated that addressing security was at the top of the list for design and function. The study indicates that there were six characteristics that the user found valuable regardless of the domain. They were navigation, completeness/comprehensiveness of Info, site technical features, currency/timeliness/update, accuracy, and readability/comprehension/clarity. Keeping these elements in mind and fused with our personal preferences will help us understand why and where we surf. Our tolerance threshold for speed or our ability to triangulate data and not assume all information on the Web is correct are examples of how we deal with these features. How important our searches become will also change our reaction to certain Web pages. Surfing for fun does not have the same meaning as surfing for research and specific knowledge sets.

These characteristics are especially meaningful for students using the Internet for research. Because the younger generations are growing up with technology, there is a tendency to assume that they know what they are doing and reading on the Internet. This is not necessarily true. A 2001 study conducted by Deborah Grimes and Carl Boening indicated that students are using unevaluated resources for research. Additionally they don’t always follow teacher directions for using the Web or library resources. In fact most students bypassed library resources completely and went straight to the Web for their research. The researchers used 10 criteria for Web site evaluation. They are (1) authorship, (2) currency, (3) recommendations, (4) perspective, (5) audience, (6) style and tone, (7) quality of content, (8) organization of information, (9) publisher, source, host, and (10) stability of information. The conclusion is that students are superficially evaluating Web sites, if at all (Grimes & Boening, p. 9). The idea that because students grow up with technology infers that they know how to use it does not represent a realistic assessment of student learning. Teachers need to be much more involved with student research and teach students how to use the Internet for research.

Another research study conducted in 2003 measured patterns of information seeking based on domain and Web expertise (Jenkins, Corritore, & Wiedenbeck, 2003). Specifically, the authors measured the ability of nurses with varying degrees of Web experience and osteoporosis (domain) knowledge. They found that nurses with little Web experience (novice) and domain knowledge (novice) search breadth-first and did little or no evaluation of the results. On the other end of the assessment is the domain expert/Web expert who carried out depth-first searches, following deep trails of information and evaluated information based on the most varied and sophisticated criteria (Jenkins et al., 2003, p.1). The study provided additional findings that lead to a better understanding of ability level characteristics and how the Internet can provide help to surfers. One of the most important things that a user wants to know is the accuracy of information on the Web. Because the Web constitutes the work of the most experienced to least experienced people and a wide array of ethical behavior, it is up to the surfer to determine if the information is accurate and current. The results of this study led the authors to believe that the Web novice not only became lost and disoriented while searching but was also misled by graphics. They reported that the graphics were distracting but did not extend their perceptions to information credibility and they often read them wrong. In fact, the perception of graphics and advertisements led the participants, especially the expert Web/domain user, to the conclusion that less credible information was found on the site with graphics. It was also interesting to note that the Web novice groups experience an increased cogni-
tive load simply trying to keep track of their location (Jenkins et al., 2003, p. 19). These conclusions and discussions have a great impact on education and the developmentally appropriate use of the Web for learning in school. Teachers should be aware that the younger the child using the Web, the more the teacher has to be involved with where, why, and how students search specific Web sites.

Web site companies can also learn a great deal from these and other research studies. Providing visual and easily identifiable links that support authorship, credentials, and independent ratings, Jenkins et al. (2003) helps users navigate more effectively.

The PEW Institute is dedicated to research and has been collecting Internet data for several years. Below are the results of some of their surveys. The statements reflect Internet usage and our changing society. Remember to read the dates.

- **1/31/2007:** 28% of Internet users have tagged or categorized content online such as photos, news stories, or blog posts.
- **1/7/2007:** More than half (55%) of all online American youths ages 12-17 use online social networking sites.
- **12/13/2006:** Nearly two in five adult Internet users in the U.S. (39%) have gone online to look for information about a place to live, up from 34% in 2004 and 27% in 2000.
- **11/27/2006:** More than half of Internet users have taken virtual tours—nearly doubling the number who had done so in late 2004.
- **11/22/2006:** Some 12% of Internet users say they have downloaded a podcast so they can listen to it or view it at a later time.
- **11/20/2006:** Fully 87% of online users have at one time used the Internet to carry out research on a scientific topic or concept.
- **9/20/2006:** On a typical day in August, 26 million Americans were using the Internet for news or information about politics and the upcoming mid-term elections.
- **7/19/2006:** A national phone survey of bloggers finds that most are focused on describing their personal experiences to a relatively small audience of readers.
- **6/14/2006:** Online banking is holding steady as a mainstream Internet activity, growing along with Internet use generally, though not accelerating as have some other forms of online activities.
- **5/2/2006:** As more Americans come online, more rely on the Internet for important health information. Fully 58% of those who found the Internet to be crucial or important during a loved one’s recent health crisis say the single most important source of information was something they found online.
- **4/26/2006:** Internet penetration has now reached 73% for all American adults. Internet users note big improvements in their ability to shop and the way they pursue hobbies and personal interests online.
- **4/19/2006:** 60 million Americans say that the Internet helped them make big decisions or negotiate their way through major episodes in their lives.
- **4/11/2006:** Older Internet users may be easy targets for viruses, spy ware, and the like. Younger Internet users take more chances online, but they also take more precautions.
- **12/28/2005:** Men continue to pursue many Internet activities more intensively than women. At the same time, trend data show that women are catching up in overall use and are framing their online experience with a greater emphasis on deepening connections with people.
- **11/27/2005:** One in six Internet users has used the Internet to sell things and traffic to online classified sites has risen 80% in the past year.
- **11/20/2005:** Nearly 60 million online Americans use search engines on an average day.

Many times when we use the Internet we use search engines to gather information and resources for our review. There are many search engines and metacrawlers to help you gather information. Google and Yahoo are two recognizable trademarks. Many of the search engines are getting smarter at giving us what we want fast. Searching Amazon.com for books will bring up your specific requests and related references for your review. If you sign into this and other Web sites they will remember what you purchased and make recommendations based on prior knowledge of your previous visits. Ask.com will allow you to enter full sentences as questions and respond with many answers. Questia.com requires a subscription and contains research documents and data that can be found in journals, newspapers, books, and other media for your review. It will return a search with recognizable categories. All
Evaluating Online Resources

of them want your service. You benefit by gathering information and they benefit by making a profit.

As people on the Internet continue to increase their use of services to address our personal, recreational, financial, and communication needs, Web companies will also continue to grow and gain more influence on our daily workday and private life. They all want to be the Web site that you go to for information. In so doing they increase their visibility on the Web and their profits. Even educational sites know they have to compete. Making the Internet a part of educational experience, both for recruitment and student work, has also become big money for companies that can service the online needs of K-12, private, and higher educational institutions.

While the following quote addresses online learning objects it can also identify what the Web has come to mean to us. As Cafolla’s (2006) online quote from the Wisconsin Online Resource Center aptly suggests, “learning objects must be Just enough, just in time, [and] just for you. This means that learning objects are modular (just enough), searchable (just in time) and customizable (just for you)” (Wisconsin Online Resource Center, 2005). We all want this individualized attention.

Finally, surfing the Web is all about choices and expectations. Individuals will form their own perceptions and companies will try to reach the majority with fast, secure, easy to read, and easy to participate in Web sites. Here is a brief recap of things you should look for when evaluating online Web resources. These are from an article by Fitzgerald, Lovin, and Branch (2003) for Learning and Leading with Technology:

1. **Accuracy:** Information presented is reliable, valid, and authoritative, impartially presented, and current. Biased resources should be avoided.

2. ** Appropriateness:** Vocabulary and concepts should be appropriate for the intended learners’ level. Information and procedures should be relevant to the topic. Extraneous data, overly advanced vocabulary and concepts, and irrelevant activities are not appropriate.

3. ** Clarity:** Of objectives, methods, procedures, and assessments. There should be a clear tie between the purpose (goals, objectives) and the content and procedures suggested. This correlation should be comprehensive and obvious. Redundancy is usually unwelcome and isolated activities without a relationship to objectives are superfluous.

4. **Completeness:** Resources should provide full coverage of essential, current information, as well as include such components as self-contained activities, lists of materials required, prerequisites, information for obtaining related resources, assessment criteria, links to quality indicators, and standards. Logical concept development should be evident and content should be comprehensively covered.

5. **Motivation:** Activities should encourage active engagement of the learner. Desirable activities are challenging, interesting, and appealing. They build on prior knowledge and skills, and emphasize and promote relevant action on the part of the learner. Activities with potential for developing confidence and satisfaction as a result of learner effort are desirable.

6. **Organization:** The resource should reflect logical development and clear actions to be taken by both teacher and learner. It should be easy to use and logically sequenced, with each segment of the resource related to other segments. It should flow in an orderly manner, using organizing tools, such as headings, and avoid use of unrelated elements that are potentially ineffective or overpowering.

If you want to learn more about how to use the Internet, try these Web sites:

- [http://www.safersurfers.org/](http://www.safersurfers.org/)

**REFERENCES**


Evaluating Online Resources


KEY WORDS

- **Completeness**: The comprehensiveness of the information.
- **Currency**: Regularity of the Web page information
- **Internet Navigation**: Moving from one Web page to another.
- **Learning Objects**: Small digital units of learning that can be reused and are tagged with metadata.
- **PEW Institute**: An independent opinion research group that studies attitudes toward the press, politics, and public policy issues.
Evaluating Technology-Based Instruction (TBI)

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INTRODUCTION

Decades ago, instructional evaluation has in most cases focused on the objectives of the lesson, methods of delivering instruction, and outcome learning. This form of evaluation focuses primarily on teaching and learning process within the confines of the classroom and does not include all the factors that impact learning outcome. Instructional practice and its evaluation process are becoming more complex with the application of technology into pedagogy. In order to identify areas of success or failure, all aspects of technology-based instruction need to be evaluated. It is therefore important to evaluate instructional technology as part of a pedagogical process and not as a single, isolated unit. It is also important that technology being used to facilitate instruction be evaluated to determine its appropriateness in meeting the needs of the students and the goals of the instruction.

We live in a technological world and as such education cannot isolate itself from technological advances and influences; to do otherwise will render education outcome obsolete. Therefore, technology integration is not an option; it is a necessary mandate in a world that depends on technological skill. Technology-based learning is a dynamic and complex phenomenon unlike the use of blackboard and chalk in a traditional classroom. Amirian (2003) shows that using technology to facilitate instruction requires changes in instructional plan and the possession of new skills.

BACKGROUND

Evaluation of technology-based instruction does not only involve pedagogy, teachers, students, and groups that have vested interest, it also involves the nature and quality of technical and electronic equipment including the overall quality of the environment where the technology-aided instruction will be implemented. Effective evaluation of technology-based learning must examine each individual component as a unit and then assess them on how well they contribute to the success or lack of success of the technology-based learning activities. Detweiller (2004) and Zemsky and Massy (2004) explain that technology integration has not made positive impact because technology has not fully adapted to the process of pedagogy. Some writers in the field of technology do believe that technology infusion can be used to develop authentic learning setting (Carnevale, 2003; Siegel, Schmidt, & Cone 2004). Reviewing the impact of technologies in teaching and learning, Sexton (2002) argues that using technology to support learning as a social activity meant that participants negotiate among themselves. This view is also supported by Chou (2003). The importance of evaluating all aspect of technology-based learning is to examine the totality of all the pedagogical practices and technological components that may impact on technology-based learning and make changes as necessary. Evaluating one aspect of the technology-aided learning will not provide comprehensive data upon which constructive judgment will be based.

According to Oliver (2000), evaluation is “the process by which people make value judgments about things. In the context of learning technology, these judgments usually concern the educational value of innovations or the pragmatics of introducing novel teaching techniques and resources” (p. 1) Guba and Lincoln (1981) perceive the purpose of evaluation as fourfold: “Improvement of the entity, critique of the entity, adapting the entity to a particular context and certification of the entity in the new content” in Alexander and Hedberg (2007 p. 1) http://ncode.uow.edu.
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au/info/org/alexander.html). Evaluation by nature involves probing, searching, and making judgments based on the purpose of evaluation and sometimes judgment may involve criticisms. Basically, evaluation involves gathering evidence to make informed judgment which could lead to the identification of what works, what does not work, loopholes in the system, and changes that needed to be made for improvement.

Providing meaningful evaluation data requires an assessment of those involved in technology-based instruction and examining resources and materials used for instruction. Evaluation in the field of education has invoked continuous debate. Tyler (1949) focuses on curriculum evaluation which is based on determining the degree to which the instructional objectives are achieved. Alexander and Hedberg (2007) criticize objective-based evaluation as narrow and restrictive, it does not cover all aspects of the program being evaluated. Stufflemean (1975) looks at evaluation from the point of view of how the program is developed and how it can be improved. This type of evaluation is concerned with process and output as a means of program improvement and it is decision-making driven. Due to the complexity of technology-based instruction, evaluation should not be narrowly conceived; it should be inclusive to cover the scope of what is involved in technology-based learning.

EVALUATING PEDAGOGICAL PROCESSES

Pedagogical processes refer to teaching and learning activities which include developing lesson objectives, selecting appropriate instructional methods, providing feedback, engaging in follow-up activities, and providing opportunities for transfer learning. In evaluating technology-based learning, the evaluator should examine how these pedagogical processes complement technologies used for instruction. The teacher must have the skill to make sure that the technology selected supports the instruction planned. A skillful teacher must develop the skill to select appropriate software technologies at the onset of instruction bearing in mind the desired outcome of instruction and methods for reaching such outcome. Evaluation of technology-based learning needs to focus on the relationship among pedagogical practices, outcome learning, and technology. The application of technology in teaching/learning must be based on sound theoretical foundation and it is important to examine such a foundation when evaluating technology-based instruction. Evaluation should also focus on how well various pedagogical practices and activities and technology are coordinated. There should be a harmonious relationship between technology and instructional processes and this should be considered during evaluation. Teachers’ skills to integrate technology into instruction needs to be assessed. Successful evaluation of technology-based learning requires data with which to make judgment about all the aspects of pedagogy and instructional technology.

Teachers’ ability to teach creatively needs to be addressed when evaluating technology-based instruction. Skillful teachers are required to develop course enrichment materials using technology to assist students in exploring issues relevant to the course objectives. Teachers’ ability to select appropriate follow-up activities to help students consolidate what they have learned in the classroom needs to be examined. It is also beneficial that classroom is dynamic, colorful, exciting, interactive, and energetic; this will allow students to take advantage of multimedia technologies as they engage in learning.

Evaluating Software for E-Instruction

Software used for instruction should be evaluated in terms of age appropriateness. It should also be evaluated for cultural and gender bias as well as its suitability for classroom use. Students’ developmental stage should equally be taken into consideration when evaluating technology for instruction. Technologies used in the classroom need to be user friendly and they should be evaluated as such. The level of technical support for each software technology used for instruction should be considered during evaluation. Ability of students to have access to the technology needs to be assessed. If students are not able to have access to computer software technologies outside the classroom, it is difficult for parents and significant others to provide assistance when needed. It is also difficult to continue learning outside the confines of the classroom. Software technologies must be evaluated for cost effectiveness including the cost of updating the technologies. It is very important that schools have relevant hardware technologies that are compatible with the software they intend to use. Majority of the school programs could run on basic computer system or set-up. It is necessary to make sure
that the software being used in the school are compatible with their computer system set-up. If teachers apply constructivist learning theory, software technologies employed for teaching should be evaluated to ensure that they are appropriate in helping students develop critical thinking, and engage in authentic learning and contextual learning, including interactive learning. If teachers want to use a problem-solving method, drill and practice, tutorial, game, or simulation, it is very important that software technologies being used for teaching be evaluated to ensure that they are appropriate for the teaching methods selected.

**Physical Environment of Technology-Based Instruction**

In evaluating technology-based instruction, it is necessary to evaluate the environment where the technology-based instruction will take place. The authors of this article take the position that to provide comprehensive data upon which to evaluate technology-based learning, it is necessary to evaluate the learning environment. The condition of the learning environment will impact negatively on the learning outcome if the environment is considered inadequate. Students cannot learn in an environment that is less conducive to learning.

**Condition of the Instructional Laboratory**

In evaluating technology learning environment, the room temperature should be examined to make sure that computers and their accessories run smoothly with less interruption. The instructional lab must have proper lighting so that the instructor can change the intensity of the light as required. The teacher must be able to control the light and dim it as necessary. For instance, light can be dimmed during electronic presentation. The light must have a color effect to suit various instructional activities. Too much bright light produces excessive heat which may interfere with learning. Flickering light should not be used in the instructional laboratory. Florescent and incandescent lighting is recommended. A lighting control system with dimming capability is also recommended. Electrical cables and wires should kept out of the way as falls and other hazards can cause damage to the equipment.

A computer and its accessories must rest on an even floor for better performance. An uneven floor or wet floor could lead to falls or any other accident or discomfort. Poor ergonomic posture can cause cumulative trauma disorders (CTS). Easy adjustable chairs are recommended. Chairs that can tilt back will help students maintain proper eye contact. Chairs that can be raised or lowered will help students maintain good comfort level while the instruction progresses. The furniture (desks and chairs) must meet ergonomic standards; chairs must be evaluated to make sure that they have arm-rests and can be adjusted by students as needed. Desks should be of comfortable level and computers placed at eye level so that students do not strain their eyes. Such discomfort may hinder meaningful learning. Computers must be placed in a safe place. The mouse should be positioned near the keyboard so that the cord can reach the computer. Technology-based learning environment should also be evaluated for maintenance and supervision; computer labs need to be maintained and supervised regularly to avoid disruption.

**Sitting Arrangement in Technology-Based Classroom**

Sitting arrangement in a technology-based learning must also be evaluated to assess how the classroom is configured in terms of meeting various kinds of lesson objectives and methods of delivering instruction. Therefore, how flexible the classroom structure is must be examined. For instance, U-shape or horseshoe shape is more appropriate in teaching and learning that require discussion and interaction among participants as they solve learning problem. Row class format is suitable for delivering a large body of information using lecture method.

**Computer Network**

Network connection is very important for technology-aided instruction. Students using different workstations must be able to communicate and interact electronically. Computer network enables computers to communicate and users interact. Computer network simply refers to two or more computers linked together. There are different kinds of computer networks. Local area network (LAN) links computers that are close to each other together. Wide area network (WAN) is a computer network that links computers which are geographically far apart from each other together. Computers are connected through various telecommunication technologies which include telephone lines, satellite, and wireless
technologies (Fustin, 1972). In evaluating technology-based instruction, computer network systems must be assessed for proper servicing and maintenance to determine their effectiveness. Students need to interact with other students, consult with teachers, and receive feedback. An effective network system also helps foster community and collaborative learning.

**STAKEHOURS (GROUPS WITH INTEREST) IN THE EVALUATION**

It is important to consider the interest of those who have interest in the evaluation, and those who are connected with it, as well as those who fund it.

**Student Interest Group**

Technology-based evaluation with a focus on the students deals with whether or not the students are satisfied with technology being used for instruction and whether they make progress as they learn with the technology chosen for instruction.

**Teacher Interest Group**

Technology-based evaluation with a focus on the teachers is designed to assess the progress teachers make as they use technology to facilitate instruction. This provides the opportunity to collect data to determine the strengths and weaknesses observed while using the technology, as well as the problems encountered. The idea is to provide data for decision making.

**Evaluator Interest Group**

Technology-based evaluation with a focus on the evaluators deals with whether the changes that are being proposed are feasible and whether they will contribute to improvements in teaching and learning.

**Technical Support Interest Group**

Technology-based evaluation with a focus on the technical support system makes a determination on whether the support system is able to provide support for the changes and sort and maintain all the software and hardware needed to meet the instructional plan.

**Evaluation Funding Interest Group**

Those who fund evaluation are interested in receiving evidence to determine the success of technology-based instruction. Data to make this determination are gathered through evaluation. Budgeting should also be considered in evaluating instructional programs and the technologies that support them. Programs should be evaluated as to whether they receive appropriate funding that enable them to succeed. Evaluation should have a timeline in order to keep everyone concerned focused and in order to avoid unnecessary delays.

**TYPES OF TECHNOLOGY-BASED EVALUATION**

There are different types of evaluation for technology-based instruction. They include contextual evaluation, needs assessment evaluation, and formative and summative evaluation. Contextual evaluation seeks information on whether the knowledge and skill gained from technology-based learning can be used to solve real life problems. Needs assessment evaluation seeks to determine the current situation of the technology program and to assess the strengths and weaknesses as well as areas of improvement and methods of achieving the change.

Formative evaluation summative evaluation seeks to collect data for feedback and to determine whether progress is being made along the way. Summative evaluation is done at the end of instruction to determine the overall success or lack of it. There are other types of evaluation that are not mentioned in this article. Choice of evaluation is determined by what the evaluator or stakeholders are looking for.

**CONCLUSION**

In any meaningful evaluation, it is highly important for the evaluators to be specific in providing identifiers for success or failure and making judgments based on the criteria identified. This makes it possible for the evaluator to determine what type of data to look for and where such data can be located. It is highly important that evaluators are knowledgeable in the
Evaluating Technology-Based Instruction

program they are evaluating so that they can offer constructive feedback for improvement. In a successful evaluation project, team and collaborative effort are necessary for generating the data and the information sort. Data collected must be kept confidential and in a safe place. Guidelines for storing evaluation data must be followed.

REFERENCES


KEY TERMS

**Computer Hardware**: Refers to an electronic device which processes information, stores data, and accepts information. It has input and output devices and generates data at high speeds in accordance with programmed instructions.

**Computer Software**: Computer applications and programs, such as database packages, that can run on a specific computer system

**Integration of Technology**: The use and application of technology into teaching/learning for the purpose of facilitating and enhancing learning. Technology includes all the artifacts and equipment, including software and hardware computer technologies employed in education, in order to facilitate teaching/learning.

**Pedagogical Processes**: These include the selection of the lesson objectives, methods of instruction, methods of assessing instruction, course enrichment programs, follow-up activities, and feedback.

**Physical Environment of Technology-based Instruction**: Refers to the learning setting or classroom where technology-based learning is implemented and the condition of the classroom. It refers to the condition...
of the classroom such as temperature, the condition of the floor, desks, chairs, lighting, space available for instruction, and for storage including the position of the teaching station and so forth.

**Technology-based Evaluation:** The process of judging the success or failure of technology integration. Such evaluation covers theoretical framework upon which the application of technology is justified, including the physical environment of the instructional classroom.

**Technology-based Learning:** Learning in which teachers use technology to teach and learners learn with aid of technology.
Executive Information Systems

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INTRODUCTION

An executive information system (EIS) is a computer-based system that serves the information needs of top executives. Also known as executive support systems (ESSs), EISs are essential for a business to succeed in today’s highly competitive corporate environment. EISs gained popularity in the 1990s and became a staple in almost all large organizations. Today, the focus is more on performance management and things like the ever-popular balance scorecard (Kaplan & Norton, 1992; Smith, 2006). However, even though very few articles are being written about EISs, they still exist because companies, quite frankly, have a need for EISs, as the need for executive information remains. As Power (2003) indicated, EISs may continue to take different shapes over the next few years but the basic principles of an EIS will remain the same.

BACKGROUND

EISs evolved from decision support systems (DSSs) that were originated in 1965 almost in tangent with the development of more affordable mainframe computing. The DSSs were designed to assist managers with their decision-making process. In 1979, John Rockart of the Harvard Business School broke the mold of DSSs when he published his groundbreaking article that led to the development of EIS. Rockart has written many articles on the topic since. Even though leading edge companies like Lockheed-Georgia and Northwest Industries began development of what would be EIS today, at the time fell under the category of DSS or a management information and decision support system (MIDS), John Rockart is credited with creating the concept of EIS, although not without controversy (Bhargava & Power, 2001). EISs are said to have evolved from a single user model-driven decision support system the used predefined information screens that were maintained by analysts for senior executives. The early EISs were DOS and text based. The point and click functionality was not prevalent until the mid 1980s when a company called Pilot Software introduced the first Windows-based EIS platform. The advent of the Internet allowed an EIS to not only gather information from the companies’ existing Intranet but also externally through the World Wide Web, and as a result they became even more useful in the 1990s (Basu, Poindexter, Drosen, & Addo, 2000; Power, 2003).

In keeping with Kelly (1994), the primary purpose of EISs is to support learning about an organization, its work processes, and its interaction with the external environment. Kelly feels that informed managers can make better decisions and supports his conclusion by referencing other related items. He feels that a secondary purpose of an EIS is to allow timely access to information. Although managers may be able to access the same information through traditional platforms, time constraints inhibit a manager from doing so. The third and final purpose of an EIS Kelly (1994) mentions is to point managers to specific areas that need attention or specific business problems. Although he feels that this ability can be commonly misperceived as an opportunity to discipline subordinates, these same subordinates spend time trying to outwit and discredit the system, and, as a result, overall productivity drops. When using an EIS for this purpose, managers must be careful not to focus on things that are irrelevant or that are important, but at the exclusion of things that are equally important.

Watson, Rainer, and Koh (1991) described the following characteristics of an EIS. They are:
Executive Information Systems

- Tailored to individual executive users
- Extract, filter, compress, and track critical data
- Provide online status access, trend analysis, exception reporting, and drill-down capability
- Access and integrate a broad range of internal and external data
- Are user-friendly and require minimal or no training to use
- Are used directly by executives without intermediaries
- Present graphical, tabular, and/or textual information

EISs differ from traditional management information systems because of their ease of use and in the way they are tailored to executives’ needs. They are designed to enable a senior manager to obtain pertinent information at the touch of a button. They are very user-friendly even for the executives with subpar computer skills. An EIS can access data about specific issues and problems that are specific to an executive’s information needs. They can provide aggregate reports, present information in graphical form, as well as provide extensive online analysis tools, including trend analysis, exception reporting and “drill-down” capability. They are intended to be used by executives without assistance and can easily be navigated with a mouse or a touch screen (Kelly, 1994; Marcus, 2006).

MAIN FOCUS

Critical Success Factors

Poon and Wagner (2001) combined the works of Rockart and others to come up with 10 critical success factors of an EIS. They are listed below:

- A committed and informed executive sponsor
- An operating sponsor
- Appropriate IS staff
- Appropriate technology
- Management of data
- Clear link to business objectives
- Management of organizational resistance
- Management of system evolution and spread
- Use of an evolutionary/prototyping approach
- Carefully defined information and systems requirements

Poon and Wagner (2001) used these 10 critical success factors in their case studies of six different companies. They discovered that three companies that meet all of the criteria had successful EIS, one was not resolved and two were complete failures. They also noticed a pattern, the three successful cases managed all of the measures right and the two failures managed all of them wrong. Although the sample set was not large enough to draw any conclusions, it did indicate that meeting one of these measures leads to satisfaction of the others and vice versa. However, in both cases that failed it did appear to Poon and Wagner (2001) that they wanted the system to fail. Although they were able to confirm the applicability of all 10 critical success factors, which include the original 8 from Rockart and De Long (1988), they did feel that organizations may “get it right” simply by managing 3 factors, championing, resources, and linking the system to your business objectives. They also saw that these systems have to be bale to work side by side with the prevailing management system. Companies will likely succeed if they do not rely on an EIS to solve their problems, but use it to translate business goals into corresponding information needs and then into a well managed system.

An EIS is a flexible tool that provides broad and deep information support and analytic capability that help executives make decisions. They also are able to access external information. The data can come from a variety of sources including transaction processing systems, financial reporting systems, commercial information sources, text files, and manual data collection. They contain a variety of information depending upon the organization; they can include financial, marketing and sales, human resources, manufacturing, operations, and various types of external competitive benchmarks. There are many different reasons why executives use an EIS, some use them for performance monitoring or to keep abreast of current developments, other reasons are to do “what-if” analysis, trend spotting, and problem identification and resolution. The investments required to implement and maintain an EIS are substantial and ongoing.

We think that in order for an EIS to be successful it has to provide as much information as fast as possible. It has to be a system that is user friendly and displays data that can easily be explained to others so users do not become frustrated and unhappy with the system. It must be able to mine data from many years so it can
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indicate any trends or downturns and, of course, it must have positive results on the company’s bottom line. All members of the organization must accept an EIS, employees cannot spend company time trying to discredit or work around the results of the EIS. Therefore, it is a good idea to have a diverse group of people on the development team when creating an EIS. Users of an EIS must be able to see the positive effects of using the system or they will stop using it and consider it a waste of time. Executives must be careful not to be misguided by an EIS; for example, scrutinizing employees may improve productivity but may increase turnover, which results in lower earnings. These are all important components of a successful EIS.

Significant Barriers

An EIS is a high-reward, high-risk project and is often developed with high expectations which end in failure. There exist significant barriers to the creation of a successful EIS. However, as more lessons are learned from previous failed attempts, many innovations have been put in place by EIS practitioners to overcome these barriers. Zairi, Oakland, and Chang (1998) presented an empirical study to find out what the significant barriers are and how best practices have been adopted to achieve a successful EIS implementation. By linking the implications of best EIS practice to total quality management (TQM) disciplines, a model of successful EIS implementation was proposed.

An EIS that is embraced by an organization can go a long way in helping that company succeed and outperform its peers. Using an EIS will allow a company not only to be reactive to any issues but can also allow them to stay ahead of the curve by identifying trends in not only their business but the competitions’ as well. From the planning and implementation process to the ongoing maintenance of the system, everyone in the organization must be on board. Having a diverse group of planners that not only know the business but also understand the technical aspect of an EIS can go a long way in the success of the process.

An EIS should include whatever is interesting to executives. While this may sound simple, it is typical of today’s EIS. Government EISs have typically been constructed to track data about ministerial correspondence, case management, finances, human resources, worker productivity, and so forth. Private sectors also use EISs to monitor information about competitors in the news media and databases of public information in addition to the traditional revenue, cost, volume, sales, market share, and quality measures. In order for an EIS to be successful, it must be accepted and incorporated into every employee’s work process both independently and as a team. An EIS will usually begin with just a few measures that are of interest to senior managers and then expand in response to their questions. However, over time, the information provided by the EIS can become stale to the user and diverge from what is strategically important for the organization. As a result, companies need to come up with ways to keep the information and ideas surrounding an EIS fresh.

Theoretical Improvements

A three-mode conceptual model for executive support systems design was proposed by Lee and Chen (1997). It is suggested that most ESSs are designed to support executives’ information and communication needs. The cognitive aspect of executive support has received relatively little attention in the field of decision support systems. The focus is on the cognitive aspect of executive work and three types of executive thinking: retrospective, introspective, and prospective.

EISs may be used in different ways by managers in retrieving information. Two common modes of use are scanning, or general browsing of data, and focused search, or seeking answers to specific questions or well-defined problems. When executives focus their use of EISs to answer specific questions or solve well-defined problems, they help to fine-tune operations and verify assumptions. However, an EIS may also lead an executive to challenge fundamental managerial assumptions and preconceptions when using it to scan through information without having specific questions in mind. In this mode, an EIS may be used to help formulate problems and foster creativity—thereby improving organizational effectiveness. EISs were found to contribute to gains in efficiency much more frequently than to gains in effectiveness (Vandenbosch & Huff, 1997; Young & Watson, 1995).

Information technology plays a significant role in a global organization. Senior executives of these organizations need constant and timely access to global information for making decisions. This information originates in different places worldwide for a global organization and needs to be organized before it can be used for decision-making. The organization and
management of global corporate data presents unique challenges. Kumar and Palvia (2001) discussed the data organization and management related issues for developing a global EIS for senior executives of global companies. The objective of a global EIS is to provide executives with a consistent, integrated, and summarized view of operational data from subsidiaries worldwide. The global EIS also provides access to external data that is captured from different sources. The system facilitates integrating the internal and external data for effective decision-making.

FUTURE TRENDS

Emerge of the Enterprise System

In line with Turban, Aronson, and Liang (2005), the independent EIS has been and will be replaced by the more cost-effective enterprise system with advances in data warehousing and in Web technologies. The current trend is toward increased integration of vast amounts of decision support information by Web-enabling legacy databases. Web portals enable organizations to reach their constituents (e.g., customers, vendors, employees) providing large amounts of information that can be personalized to the needs of the individual.

Increasing Ability and Performance

As time goes by, EISs will become more and more technologically advanced and offer more and more visual effects. Many now include dashboards that are able to offer visual representation of the vital data of the company. Dashboards act like advanced charting software and are able to accept a range of inputs, which are converted to visual objects such as charts, graphs, and maps. Other technology that can increase the easiness and use of EIS are personal digital assistants (PDAs) or pocket PCs. These handheld computers are becoming more and more popular and powerful every day and more and more software is being developed. The types of programs that can be run on these handheld computers are endless and being developed everyday. With the increasing ability and performance of these mini-computers, more and more executives may find greater use for them as they are lighter than laptops, can be carried in a pocket or on a belt, are rechargeable and do not require outside power supply, and can be used at a moment’s notice anywhere. In theory, if not already being practiced, executives could use these PDAs with their EISs and check on anything they wanted from their office, to a subway, to a busy sidewalk, or even during a business dinner. The usefulness and abilities of these handheld computers has barely been touched.

CONCLUSION

Beginning with the works of John F. Rockart and David W. De Long (1988), as EIS gained more and more popularity in the 1980s and 1990s, more researchers jumped on board. They all seem to come up with the same basic conclusions: that in order for an EIS to be successful it must be accepted by all members of an organization and must be in line with the goals of the business. An EIS must also begin with a solid foundation that includes a process owner or a high-ranking executive sponsor that has the ability to lead people along and promote the process along the way. Managers must be able to see the benefits of the system and not try to work around the process to make themselves look better at the expense of the bottom line. As EISs have taken new forms and have been integrated into others systems, we can foresee a popularity of EISs among executives.

REFERENCES


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KEY TERMS

Balanced Scorecard: A method for measuring a company’s activities in terms of its vision and strategies that gives managers a comprehensive view of the performance of a business.

Dashboard: A digital dashboard is a type of computer software that provides a way of monitoring business attributes, functions, or systems through a visual representation. Also known as an “enterprise dashboard,” “executive dashboard,” or “business dashboard.”

Data Management: A broad term that comprises all the disciplines related to the management of data as a valuable resource.

Data Resource Management: The development and execution of architectures, policies, practices, and procedures that properly manage the full data lifecycle needs of an enterprise.

Decision Support System: A class of computerized information systems or knowledge-based systems that support decision making activities.

Executive Information System: A computer program or system intended to facilitate and support the information and decision making needs of an organization. It provides easy access to both internal and external information relevant to meeting the strategic goals of the organization.

Management Information System: Commonly referred to as information technology management. A system that concentrates on the integration of computer systems with the aim of the organization and supports business processes and operations, decision-making, and competitive strategies.

Personal Digital Assistant: A handheld device that has evolved from a simple personal organizer to a miniature computer, capable of accessing the Internet, checking e-mail, interacting with other computers, and running numerous types of software. Commonly referred to as a PDA and sometimes referred to as a Pocket PC.
INTRODUCTION

The College of Information Sciences and Technology practices an applied approach to learning. This approach entails hands-on activities supported by a solid practitioner knowledge base. In addition, the curriculum presents a strong business orientation to the practice of information technology.

The need for IT consulting education at the undergraduate level became increasingly apparent after numerous discussions with many corporate partners. Approximately one-third are of the graduates from the College of IST are exclusively placed with consulting firms and more than 50% are working in a consulting capacity after graduation. All graduates, regardless of where they choose to work, will function in a consultative role as part of their jobs. The feedback received from corporate partners indicated that most IT curriculums do a good job with technology and business topics but rarely touch consulting-related issues, skills, and methodologies.

The ACM, IEEE, and AITP (previously known as the DPMA until 1996) have continuously addressed the educational needs of future IT professionals by curricula development and standardization. Each organization, in their latest curriculum guidelines, emphasize the importance of development and mastery of problem-solving skills in concert with real-world project and group activities. However, a recently published paper comprised of members from academia and industry reported that current graduates are often unprepared for entry positions in industry (Woratschek & Lenox, 2002). Among the specific deficiencies cited were problem-solving skills and the ability to work in groups. By failing to address these shortcomings, we ignore the needs of industry and neglect to prepare our students for employer expectations.

In response to this data, the College of Information Sciences and Technology IT Consulting track was created. The curricular track consists of three courses: IST 301 IT Project Management, IST 443 IT Consulting I, and IST 444 Advanced IT Consulting. At the heart of the track is a series of real-world consulting engagements with corporate clients from all areas of the country. The students work in teams of four or five on in-depth corporate projects, most of which span traditional semesters. In order to provide the students with an experience that is in-depth and as close to real-world as possible, we recognized that projects should not be forced into the 15-week constraint of the traditional semester. Rather, utilizing a flexible scheduling model allowed us to consider projects that are much more robust than typically undertaken in traditional courses.

Most projects are broken into implementation phases. The semester-long phase I typically consists of requirements gathering, solution design, and prototyping and is completed in IST 443. Phase II of the project can be accommodated in a variety of manners, depending on the interests of the client corporation. The second phase of the project can be conducted in a subsequent course, as members of the team working for the client as interns, or as part of a relationship where the client corporation provides funding for the development of the project at Penn State.

The success of the IT consulting track can be attributed, in part, to a unique, synergistic relationship between the faculty that teaches the courses in the track, the career services unit with the college, and the university development office. The track has proven to be a great mechanism for engaging corporations with the IST students and curriculum. Almost all of the participating corporations extend internship and/or full-time placement offers to one or more team members, thereby becoming an innovative placement tool for the career services unit within the college. The development office of the university views the track and associated projects as unique mechanisms for engaging corporations and alumni with the students. The positive experiences generated through the projects have generated substantial donations to the college and helped to foster stronger long-term relationships with a variety of organizations and individuals.
RATIONALE FOR THE IN-DEPTH PROJECT EXPERIENCE AND CONSULTING FOCUS

The typical course structure in the track utilizes traditional lecture and discussion and a real-world derivative of problem-based learning (PBL) known as problem-centered learning (PCL). The project experiences are modeled after PCL theory. Problem-based learning (PBL) stimulates engagement and learning by presenting students with complex problems. PBL can also share qualities with experiential, service, and cooperative learning. Designing open-ended, directed problems for small groups of students with the intent to produce solutions that benefit real-life people and institutions can be a powerful pedagogical construct.

Problem-centered learning (PCL) is more explicit and structured than PBL. These teaching strategies can encourage other learning outcomes beside developing problem-solving skills, including high student motivation, teaming skills, ability to organize, plan and execute, problem solving (technical, procedural and social), greater appreciation of course content utility, longer knowledge retention, knowledge of the real world, positive community awareness and civic responsibility, and the value of teamwork (Edens, 2000; Mierson & Parikh, 2000). Many PBL and PCL classroom experiences are case-like in nature. The variation in IST utilizes well-constructed real-world problems.

One learning objective that is persistent throughout the track is to develop in-depth problem-solving skills—to develop our students’ skill to solve open-ended, high-risk problems that may have multiple potential solutions. Another learning objective includes the ability to work well with all of the various stakeholders associated with the consulting engagement, including the members of the consulting team.

The projects selected for the consulting courses are carefully selected and scoped by faculty with substantial industry experience. Projects that provide opportunities for learning experiences for the students on multiple levels, as well as those that provide substantial value for the client organization, are sought. The selection and scoping of the project is one of the most crucial elements of the learning experience. Projects should be challenging and force students to step out of their comfort zones to learn (or re-learn) new skills and technologies in a real-world, on-demand mode. At the same time, projects must be scoped to determine achievability.

In-class lectures and discussions focus on a variety of consulting and project management issues, methodologies, and tools. A wide assortment of industry speakers are also utilized in the track. The use of structured methods require careful planning like the process to define requirements, evaluate design options, build-on schedule, and the set-up of testing and evaluation tools do not hold much relevance to today’s IT professional. Real-world projects change this perspective. Students gain a meaningful understanding of why and how structured methodologies affect success in a team-based environment. The implementation and relevance of textbook methodology comes to life in real-world examples of changing requirements, budget constraints, culture, and competing objectives. Students gain experience with the less tangible “people skills” qualities that get lost in the prescriptive textbook descriptions. Grades are determined by the use of individual, group, client, and instructor measures. In this manner, it is possible (and is usually the case) that members of the same team receive differing grades. This design helps to prevent the “free rider” from receiving the same or similar grade as the team member who contributed to the project.

Choosing a collaborative approach is a departure from the traditional model of the controlled, lecture-driven classroom familiar to most instructors and students. Bosworth (1994) contrasts the traditional approach to the collaborative approach in terms of the attributes of each. The traditional approach is characterized by: (1) competition; (2) focus on one’s own work; (3) destructive criticism of others; (4) manipulation of the system for one’s benefit; and (5) a general lack of trust. The collaborative approach is characterized by: (1) cooperation; (2) compromise; (3) flexibility or roles; (4) trust and respect of others; (5) questions as well as constructive criticism; and (6) group problem solving.

The use of groups and teams is not without perceived disadvantages. MacGregor (1992) identifies seven belief shifts that must take place to enter into such a collaborative learning environment:

1. From listener, observer, and note taker to active problem solver, contributor, and discussant.
2. From low or moderate expectations of class preparation to high ones.
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3. From a low-risk, private presence in the classroom to a public one with many risks.
4. From attendance dictated by personal choice to attendance dictated by community expectations.
5. From competition with peers to collaboration with them.
6. From responsibilities and self-definition associated with learning independently to learning interdependently.
7. From notions that teachers and texts are the sole sources of authority and knowledge to the notion that peers, oneself, and one’s community are additional and important sources of authority and knowledge.

The traps and obstacles to taking a project approach to traditional classroom instruction can be daunting. They include the ability to manage and direct open-ended assignments, managing student and customer expectations, engaging real-world customers, defining project scope, managing to a real-world deliverable, intellectual property issues, and customer commitment.

Students and instructors must be guided in making this transition to overcome the bias for the traditional approach. The use of corporate projects often results in greater time demands. These collaborative skills do not occur spontaneously. Research (Miller, Trimbur, & Wilkes, 1994) has shown that process-related issues of group activities consume as much faculty time as issues related to course content. Dysfunctional group behavior often occurs when members have not mastered a common problem-solving strategy or are not synchronized among the members. Another major concern is that of accountability. Slavin (1990) cautions that both group goals and individual accountability are essential in a collaborative environment.

The literature has shown that there is a benefit gained by collaborative problem solving and learning (MacGregor, 1988; Slavin, 1991; Wilson, Hoskin, & Nosek, 1993). Learning is more active and more effective when students work in peer groups to develop problem solutions and explain/understand the resulting algorithms. The instructor cannot leave the use of collaboration to chance. Research (Flannery, 1994; MacGregor, 1992) describes how the instructor must establish an environment conducive to collaboration and encourage the student’s transition from passive listener to active contributor. Olmstead (1974) states that the instructor should create a “culture” in which groups can succeed. The instructor’s responsibility is to train, guide, and manage the activities of the groups.

Curricula documents call for the use of groups; research demonstrates the benefits of collaborative learning environments. A common theme in the IT literature is that measures must be taken to foster a “reflective” problem-solving approach in IT professionals. Reflective behavior in IT problem situations translates into an adoption and consistent use of design methodologies and a mitigation of the observed student tendency for “impulsive” problem-solving behaviors (Merrienboer, 1988). Studies by Messer and Merrienboer suggest that impulsive problem-solving behaviors typically lead to incorrect, suboptimal, and incomplete IT problem solutions; a reflective approach, using established design methodologies, leads to improved performance.

A reflective approach is fundamentally important for clearly communicating a solution explanation (Solloway, 1986). Aiken (1991) describes this introspective awareness as the philosophical basis of problem solving at the center of the curriculum.

Unlike the experiences of a contracting consulting sector from 2001-2003, the consulting industry from the previous contraction continues to grow at a double-digit rate (Top Consultant’s Consultant-News.com, 2004). Growth projections of more than 360 billion dollars in revenue and annual expansion of all consulting facets nearing 10% year over year for the foreseeable future are forecasted (Plunkett Research, 2005). To consulting companies, this implies the need to continue to expand the consulting workforce through internal (organic) and external (inorganic) growth. The traditional recruiting models must be maintained—acquiring low-cost, highly skilled and motivated, recent graduates to fill out the lower rungs of the consulting pyramid. Penn State’s new IT consulting curricular track appears uniquely qualified to meet this need.

While consulting companies rely on highly leveraged teams, it is a challenging environment in which to “train” new hires. Clients are rightfully reluctant to pay high rates for inexperienced practitioners. And while consultancies typically invest large amounts in training, no training course can adequately simulate client project experience. The opportunity to gain first-hand client project experience as part of a university curriculum will prove invaluable to students and the companies that recruit them. Penn State is well positioned to provide this experience to its students. The
Penn State curriculum is a proving ground in both respects—classroom study and case studies that force students to improvise and react.

The consulting marketplace is dynamic, as is the consulting career. The career path is broad but shallow—there are many paths to the top, and many ways to demonstrate aptitude across a dizzying array of potential specialties. Consulting firms recruit new hires specifically for their demonstrated aptitude to learn new things quickly, and for a history of pro-active behavior that stretch beyond personal comfort zones. The past and current employment scenario shows a significant hiring of graduates who have proceeded through Penn State’s new IT consulting curricular track. More than 80% of those undergraduates who have been fully immersed into this curriculum and resulting practical experiences have been recruited and retained by leading consulting organizations throughout the world.

The reasoning behind the high rate of employment outcomes result from the commonality link between characteristics of the typical student who enrolls in this curriculum and the desired competencies required by hiring organizations in the consulting sector. The typical student that enters this curriculum has a propensity to be innovative and adaptive to change at varying levels. Furthermore, they tend to embrace the necessity of being pro-active in their course work. While some of these professional “traits” may be refined and improved through the curriculum and related experiences, the majority of the competencies contained within the undergraduate student in this track are already integrated into their solution-based approach. This has a very large appeal to consulting organizations since it provides organizations with experienced and highly flexible talent.

**RESEARCH STUDY**

When problem-centered learning (PCL) was introduced and gained popularity, it was touted as an approach that allowed the learner to experience the complexities of the problem immediately and gain practical experience. Problem-centered learning has taken many forms and varied in the problem types, scaffolds, instructor interventions, supporting materials, learning outcomes, and assessments (Albanese & Mitchell, 1993). The one element that has stayed constant is the idea that problem-centered learning is fundamentally an approach that presents the problem first followed by any necessary materials (differing from case-based learning where the whole context of the problem is presented to the learner with the problem).

**Purpose of Study**

The purpose of this study was to identify differences in two PCL approaches (written statement of real-life problem vs. working with a real-life problem) and compare the learning outcomes, assessments, and experiences of the learners.

**Theoretical Framework**

There are many theoretical underpinnings to PCL ranging from information processing (Schmidt, 1983), constructivism (Savery & Duffy, 1995), to knowing as doing (Bruner, 1996). The one consistency across all these theories is the influence of prior knowledge, linking new learning to the prior knowledge, applying the skills instead of memorizing the process, and encoding the experiences with the existing knowledge to facilitate transfer.

The theoretical framework for this study is constructivism. Savery and Duffy (1995) interpret the framework as requiring a realistic problem that engages the learners, allows the learner to experience the complexity of real life, engage the learner in an activity showing the long-term application of their knowledge, and support reflection and self-regulation of problem-solving skills. These are the skills that PCL fosters, and therefore we are using them as our theoretical framework.

**METHODS**

**Participants**

The participants in this study were 72 senior undergraduate students enrolled in two sections of a senior synthesis course in information sciences and technology. The two sections followed the same syllabus and utilized the same textbook but varied in the manner in which problem-based learning was employed.
Instruments

The materials for this study consisted of a pre-experimental questionnaire designed to collect background skill and experience data and problems that were presented to the students (Condition 1—written problem statement; Condition 2—students were presented the problem in a meeting with the client who needed the problem solved). Students created a portfolio that was assessed by two independent instructors and by the clients (in the second condition).

Each section was required to write a paper at the end of the semester. The students were asked to reflect upon the class experience and discuss the problem-solving process employed by their team, lessons they had learned, components they liked and disliked about the course, and approaches that they would do differently next time.

Condition 1

The problem was presented in a written statement to the students. Students worked in teams (5 to 7 members in each team). The problem used was the need for a large aircraft manufacturing company requiring the creation of a tracking system for intellectual property patents earned by the employees from multiple locations across the country.

Students worked in teams formulating questions, discussing alternatives, researching ideas, meeting with the instructor, and making presentations to the instructor and students. All student teams worked on the same problem and "competed" for the best solution. The course instructor initially gave information pertaining to the problem to the teams. Questions that arose as the project progressed were answered by the instructor or by e-mailing a representative from the company. Because of the time lag in response to the team’s questions from the company representative, the student teams were often permitted to make assumptions about the problem situation in order to proceed in their problem analysis. The students were allowed to self-select teams.

Condition 2

Students filled out a questionnaire to determine their prior experience, skill sets, and interests. Based on this information, the course instructor assigned students to one of 6 teams (5 to 7 members per team). Each team was then assigned a different client project. Each team “met” weekly with representatives of the assigned company via conference calls and e-mail to gain an initial understanding of the problem and to ask ongoing questions as the project progressed. No assumptions regarding the problem situation were allowed by the team members and the corporate clients or course instructor answered all project questions.

The corporate projects varied in the type of companies and technologies involved. Students worked in teams formulating questions, discussing alternatives, researching ideas, developing prototypes, meeting with the instructor and client representatives, and making presentations to the clients, instructors, and students. Every attempt was made to eliminate any possible bias from the study. The students were not aware of the two condition groups, and the instructors provided the same experiences to both groups. The two groups were in the same class and received the same instruction and team attention.

Qualitative comparisons were used in the analysis of the assessment as qualitative manipulation of this data would not be appropriate.

RESULTS

Qualitative Comparison

Qualitative comparisons were made using the written statement of experiences by the student. Overall, both conditions reported more experiences and knowledge, linking new learning to the prior knowledge, applying the skills instead of memorizing the process, and encoding the experiences with the existing knowledge to facilitate transfer. However, the degree to which the students processed and reported these experiences varied greatly between the two conditions.

Written Problem Group Outcomes and Experiences

Overall the 39 students in Condition 1 (written problem) discussed the team dynamics and progression of the problem-solving process extensively. Many students expressed dissatisfaction with the fact that the only contact they had with the company was via e-mail and that responses often took much time. This situation
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caused a perceived lack of interest by the company in the results of the project and negatively impacted team motivation.

The fact that each team worked on the same problem was also reported as a negative motivator by many of the students. Some students suggested that they might have learned more if each team worked on a different problem and shared their project experiences with the other teams in the class. In some cases, teams “collaborated” on problem solutions, thereby defeating the competitive atmosphere that the course instructor had hoped to create. In addition, if the same problem is utilized in subsequent semesters, a certain amount of information exchange between the students that have previously completed the problem and the students currently working on the problem is likely to occur. Sample quotes from students that participated in Condition 1 that illustrate these findings:

“I loathed the problem simulation. We were doing a project with no solid background. Yes, it was a problem based on a ‘real’ corporate scenario, but was any of this relevant? It was obvious to us that the company didn’t really care about the project.”

“I didn’t like that we were so removed from the company…it is much more rewarding when you get to present all your time, research, and solutions to someone who has a direct interest in it…”

“I did not like the fact that every group was working on the same project…I believe that you learn more when you learn from another group about what they did to solve a different type of problem.”

“The lack of student-customer interaction made the project frustrating and a little superficial; it might as well have been a problem made up by the professor.”

“I did not like that it seemed that we were just making up a bunch of stuff towards the end of the project, pretending instead of doing real stuff.”

Real Problem Group Outcomes and Experiences

On the opposite end of the spectrum, the 33 students in the real-life condition concentrated heavily on the problem, their experiences, and described the contextual constraints, solution alternatives, and the problem-solving process. Most of these students expressed that the weekly exposure to a real client, that had a sincere interest in the project, was a great motivator and a valuable learning experience. The students enjoyed the complex, real-world nature of the problems and often had to modify their understanding of the project goals based in new or modified information provided by the client.

Many students reported that this experience was the most important and meaningful in their academic study to-date. The deep of reflection on the experience, the complex and changing nature of the problems, and the real-world contact with a corporate sponsor evidenced in the Condition 2 writings demonstrated a level of motivation, reflection, and processing not found in the writings of the Condition 1 students.

Since each team worked on a different project, each group shared knowledge of their project, technologies involved, and lessons learned with the other groups at specified times during the course. Each project concluded with a set of deliverables presented to the client and the class. New projects are utilized every semester, thereby eliminating the possibility of information exchange between courses that is likely to occur when the same case studies or other written statements of problems are used from semester to semester.

Sample quotes from students that participated in Condition 2 that illustrate these findings:

“Throughout my studies most of the projects that were assigned were theoretical. There were not any real penalties for not making deadlines. In this course everything was real and what is being promised and produced had to be of the highest quality.”

“You can read all about consulting and project management in a textbook, but you will never truly learn how to do it until you do it. Having a real-world project with a real-world client was an extremely effective teaching tool.”

“What I gained from this project goes far beyond working in a group or understanding project management processes. I was able to gain an understanding of what my education is all about.”

“This learning experience did not even compare to any other since I have been at college…I firmly believe that
this project has helped me grow as a professional and gave me valuable skills that will benefit throughout my career.”

Statistical Comparisons

There were no significant differences in the scores of the portfolio score between the students that participated in the client condition and the students that worked in the written problem condition.

Educational or Scientific Importance of the Study

This research is an important advancement in clarifying that not all problem presentations are the same. The portfolio scores showing no significant difference is similar to the outcomes reported in earlier studies (Albanese & Mitchell, 1993). This finding suggests that both methods of problem-based learning examined in this study are equally effective in teaching students how to prepare project documents such as project plans and project reports. However, the qualitative data suggests that the two methods of problem-based learning are not equally effective in teaching and developing higher order learning skills associated with the problem-solving process such as understanding ill-structured problems, dealing with changing problem conditions, evaluating solution alternatives, and making and justifying recommendations.

The qualitative data also suggests motivational differences in the two methods of problem-based learning. One important factor of learner motivation is relevance of the learning situation (Keller, 1984). The data suggests that the environment of Condition 2 more closely reflected what the learners would encounter after graduation and served to highly motivate the learners.

As the use of constructivist learning environments increase and terms like problem-based learning are used frequently to describe the environment it becomes more critical to identify the specific approach used. This research begins to answer questions about two very specific implementations of problem-based learning and showcases how they differ in the experiences of the learner and assessments.

Little solid research exists on how to best plan and develop learning environments such as that created in Condition 2. Finding, selecting, and scooping projects that provide a robust learning experience can be challenging and time consuming for many educators. With the proper training, structure, and curricular support, the authors believe that the model outlined in Condition 2 could be successfully implemented and maintained. Suggested process and implementation models for developing problem-based learning environments in conjunction with real-world companies are the topics of a subsequent article.

REFERENCES


**KEY TERMS**

*Case-Based Learning*: A derivative of problem-based learning that engages students in discussion of specific situations, typically real-world examples. This method is learner-centered and involves intense interaction between the participants. Case-based learning focuses on the building of knowledge and the group works together to examine the case.

*Consulting*: An ongoing process of two-way communication between client and consultant(s). This process includes identifying and analyzing the client’s needs and problems.

*Experience-Based Learning*: A key element of experience-based learning is that learners analyze their experience by reflecting, evaluating, and reconstructing it (sometimes individually, sometimes collectively, sometimes both) in order to draw meaning from it in the light of prior experience.

*Problem-Based Learning*: A pedagogical strategy of active learning often used in higher education. The defining characteristics of PBL are:

- Learning is driven by challenging, open-ended problems.
- Students work in small collaborative groups.
- Teachers take on the role as “facilitators” of learning.

*Problem-Centered Learning*: A derivative of problem-based learning that is more explicit and structured.

*Project Management*: The application of knowledge, skills, tools, and techniques to a broad range of activities in order to meet the requirements of the particular project.
INTRODUCTION

While technology and human abilities have evolved over the years, individuals still have limitations in their abilities to accomplish certain tasks. This may be due to limits on financial or cerebral resources. Information needs have expanded and evolved as well. With the spurring of globalization and flatter hierarchies in organizations, it has become imperative that individuals are able to analyze, in shorter periods of time, information that is more complicated and wider in scope.

An increasing number of countries are expanding their companies across many borders, and as events and changes create more dynamic situations, these companies are turning more towards flexibility than rigid structures. The context of these situations, however, is a greater limitation of resources as organizations also try to emphasize efficiency in their processes. This creates a steady, and even increasing, demand for expert systems.

An expert system, also known as a knowledge-based system, is a computer-based system that uses captured human knowledge to solve problems that ordinarily require human experts (Foltin & Smith, 1994). This system is also considered as a branch of artificial intelligence that aims at making computers capable of emulating human reasoning behavior (Holsapple & Whinston, 1987). Like a human expert, an expert system is able to use stored expertise in making inferences about a situation, offer recommendations, and provide explanations to a user. The value of expert systems in providing decision support has long been recognized and is widely accepted today.

The goal of expert systems is to ensure that scarce expertise can be utilized when a human expert is not available (e.g., due to cost, other commitments, illness, and retirement) and when efficiency or consistency of an expert needs to be enhanced. Expert systems can be utilized to alleviate these needs from simple to complex situations. For example, when a decision maker needs some expert advice about a problem, a human expert may not be available. Instead of waiting or paying to consult another human expert, the decision maker could immediately consult an expert system to get comparable advice.

Unlike traditional data processing techniques that require complete modeling and precise data, an expert system uses information that is not always entirely consistent or complete but still can produce satisfactory answers and useful approximation (Bonczek, Holsapple, & Whinston, 1981). Expert systems can tackle problems that require judgmental decisions. For instance, MYCIN, an early expert system application, recommended treatments for suspected meningitis and other bacterial infections of the blood by analyzing a physician’s observations of a patient (Scown, 1985).

Expert systems are most often used as intelligent assistants or consultants to human users. They can be used to solve routine problems, thus, freeing the expert for more novel and interesting ones. Some corporations even see an expert system as a way to collect and preserve “corporate memory” because an expert system never retires, becomes sick, or leaves (Scown, 1985).

BACKGROUND

Generic Architecture of an Expert System

Expert systems have emerged as an economically rewarding branch of artificial intelligence (Jancura, 1990). They also form a subgroup of decision support systems. In order to emulate a human expert’s behavior, the reasoning knowledge for a particular problem domain must be acquired and stored in the computer. Furthermore, there must be software that is able to actively process such knowledge in order to derive advice for a user. A generic architecture of a decision support system, and thus an expert system, developed by Bonczek, Holsapple, and Whinston (1981) is shown in Figure 1.
As shown in Figure 1, the generic architecture of an expert system consists of four essential components as follows:

1. **A Language system:** A language system consists of all messages an expert system can accept (i.e., all requests that a user can make to the system).
2. **A Presentation system:** A presentation system consists of all messages an expert system can emit (i.e., all responses that the system can present to a user).
3. **A Problem processing system:** The problem processing system of an expert system is commonly called an inference engine. This engine is a program’s protocol for navigating through the rules and data in a knowledge system in order to solve the problem. The major task of the inference engine is to select and then apply the most appropriate rule at each step as the expert system runs, which is called rule-based reasoning.
4. **A Knowledge system:** A knowledge system consists of all knowledge an expert system has stored and retained. The effectiveness of the system comes from the quality and amount of knowledge provided for it. The major consideration is how to represent the knowledge in the system such that it can be used to recognize or solve problems. A knowledge representation can be defined as a formalized structure and set of operations that embodies the descriptions, relationships, and procedures provided in an expert system.

The Development of Expert Systems

Typically, the development of an expert system involves four major activities as follows:

1. **Knowledge acquisition:** These activities are conducted to extract, accumulate, transfer, and transform problem-solving expertise from human experts and/or documented knowledge sources to a computer program for constructing or expanding the knowledge base. The commonly used techniques are interview, protocol analysis, and observation.
2. **Knowledge representation:** These activities refer to the techniques used to represent problem-solving expertise from experts and/or documented knowledge sources into a computer knowledge base. Some of the more common methods by which expert systems internally represent their expertise are: (a) Rules, (b) Frames, (c) Semantic nets, and (d) Heuristics.
3. **Knowledge inference:** These activities refer to the techniques of programming a computer in such a way that it can make reference in an attempt to imitate the reasoning behaviors of human experts.
4. **Explanation and justification:** These activities refer to an attempt by an expert system to clarify reasoning, recommendations, and other actions (e.g., asking a question).
Exactly how expert systems perform their problem solving depends largely on how their expertise is internally represented. Most complete and successful expert system applications were developed using the rule-based approach. Rule management is a valuable technique for representing and processing reasoning knowledge (Holsapple & Whinston, 1987). With this approach, reasoning knowledge can be represented as rules that tell an inference engine what conclusions can be drawn under various circumstances. Each rule specifies that if certain conditions can be established as true, then certain conclusions can be regarded as being valid. The result of processing a rule set could be some advice or an explanation of the rationale behind that advice.

**Expert System Applications**

The number and variety of applications for expert system technology has increased considerably since the pioneering experimental systems. A study conducted to investigate the growth of expert systems uncovered approximately 2,500 developed systems in an extensive review of articles, conference proceedings, books, and information provided by software vendors (Durkin, 1996). As shown in Figure 2, the results indicate impressive growth in expert system development during the periods 1980 to 1992.

As demonstrated in Figure 3, in the early eighties, medical and scientific expert system applications dominated the scene due to the diagnostic nature of these applications and the relative ease of developing such systems. However, by the late eighties, business and manufacturing applications were becoming more common. Cumulatively, the primary use of expert system technology has been for business, manufacturing, and medical applications.

**Figure 2. The number of expert systems developed from 1980 to 1992 (Source: Adapted from Durkin, 1996, page 59)**

![Figure 2](image-url)

**THE VALUE AND LIMITATIONS OF EXPERT SYSTEMS**

Expert systems have evolved from their original conceptualization of the algorithmic processing of quantified data into real tools that individuals can use in their routine decision making. There are abilities in managing information and keeping decision makers aware of pertinent information that may be overlooked in the larger picture. The value and benefits of expert systems have been recognized for several years. Table 1 presents examples of potential benefits that can accrue from the development and use of expert systems (Holsapple & Whinston, 1996).

Although expert systems have many useful characteristics when applied, they have not evolved to the point where human influences can be completely excluded. There are inherent limitations.

The knowledge-based system is reliant on human programming in order to provide human-like analysis and answers. Thus, the value of the system depends
Expert Systems

Figure 3. The number of expert systems in various application areas (Source: Adapted from Durkin, 1996, page 57)

- The lack of human common sense needed in some decision makings
- Unlike a human being, an expert system does not automatically learn by experiences
- An expert system is not good at representing spatial knowledge
- An expert system cannot generate creative responses as human experts can generate
- Human experts are not always able to explain their logic and reasoning
- The challenges of automating complex processes
- The lack of flexibility and ability to adapt to new/changing environments and situations

In addition to the limitations mentioned, the decision to develop, implement, and maintain an expert system must factor in the cost such programs entail. Organizations must remember that although expert systems can be cost saving tools in their longer-term use, there are shorter-term investments that must be incurred first. While they can be effective and efficient tools for key decision makers, there are possibilities that the systems will not be supported by their accompanying costs, such as prolonged low productivity due to incorrect programming or use of an expert system.

Besides the direct costs of developing an expert system, an organization must consider other indirect costs such as losing members of an organization due to upgrades in the process of information management, training individuals on how to enter and interpret information, and setting up, as well as maintaining or upgrading current systems, can be arduous undertakings for unprepared organizations and individuals. It is also important that thorough consideration be given to the abilities and limitations of the systems and system users. Before making the decision to adopt a system, organizations should also recognize how utilizing the systems would impact their abilities and limitations, and how or if they are important or can be overcome.
FUTURE TRENDS

The times have changed regarding the use of expert systems. While companies are not replacing human beings in droves with mechanized beings, there have been improvements made in how individuals handle information. Expert systems have transformed from an academic possibility in the 1950s to a very real market product in the 21st century.

Expert systems can be seen implemented in diverse areas, from education to health care to business. The technology boom of information technology (IT) systems and all of their capabilities have made it possible for expert systems to still be very applicable to filter the information inundation that people can encounter as they strive to make decisions from a large assortment of choices. The systems continue to have the ability to expand an organization’s abilities, making them better able to realize decisions that are more appropriate and effective. For instance, an expert system can be applied to better foresee and handle possible breakdowns or irregularities in Web service systems (Tseng & Wu, 2007). The systems can also be used towards making more efficient decisions in managing productivity processes (Rao & Miller, 2004).

Other such advancements in expert systems are education and medicine. Several expert systems were developed to aid university students in their understanding of detailed and complex material (Changchit, 2003; Sheu & Wong, 2006). Other places have also reaped the benefits expert systems and their analytical capabilities provide. In the medical field, expert systems continue to be developed to help doctors and staffs diagnose and care for patients (Changchit & Spooner, 2004; Sigut, Pineiro, Gonzalez, & Torres, 2007). Expert systems have also evolved beyond programming and decision information in the business environment. The systems have enabled companies to better conduct their business and to better interact with their customers with more flexibility, accuracy, and efficiency (Green, 2001; Metaxiotis, 2005; Metaxiotis & Psarass, 2003).

Information is an important commodity in making decisions for many firms. There is a need in today’s competitive environment to keep up with efforts to capture, transfer, and preserve knowledge, and a key aspect of these processes is expert systems. The use of expert systems can help businesses stay competitive in the market (Abdullah, Kimble, Benest, & Paige, 2006). The systems help improve the likelihood of ready access to necessary information (Tiago, Couto, Tiago, & Vieira, 2007). Especially in cases where companies have global ties, the ready transfer and access of information by decision makers is a key to company success (Low, Johnston, & Wang, 2007). Expert systems can be vital in bolstering human capabilities to process and receive information (Meyer & Sugiyama, 2007).

Future research can explore how individuals could have ready access to such systems and how they are used. There is possible exploration into how expert systems could be used for answers by less experienced demographics, such as children and adolescents, and how knowledge-based systems impact their decision-making abilities. Also for further development, expert systems can continue to evolve and adapt to peoples’ needs outside of the workplace. Progress can look toward how individuals can implement expert systems in their home environments. Such as with deciding on restaurants, a readily available and accessible expert system by average individuals could enable a family to better select a venue for any kind of meal they would like to enjoy. This availability of information to masses of persons other than experts changes the dynamics of its application.

Another area of development could further explore how to make an expert system more efficient and economic in scope for less-defined problem areas. Expert systems need to encompass the vast amounts of complexity that humans can handle, but may be able to be tailored to securely provide needed information to those who are less able to process higher modes of thought.

CONCLUSION

Expert systems are great assistants in decision making, especially in an objective domain. They do not necessarily have opinions of their own, but help others reach their own conclusions based on an objective view of data. The development of such tools began in the mid-twentieth century, and continues to evolve today. Expert systems are used in a wide variety of industries and areas, although predominance can be seen in the business, manufacturing, and medical fields. Their applications continue to expand and evolve into other fields.

In addition, more societies are turning towards knowledge-based economic structures. At its core, this
requires the handling more of information than physical labor. As such, the demands on the quality, quantity, and application of information have changed. Expert systems are viable additions to the management and dispersion of information, especially in cases where resources are not available to make it possible to do extensive research and analysis by an expert individual or groups of individuals. Instead, those capabilities are encapsulated in a system that allows decision makers to have access to the key aspects that could be provided by a human expert.

Expert systems enable individuals to process extensive amounts of information in moments rather than hours and days. Science may never develop sentient technology capable of independent thought, analysis, and decision making that characterizes living beings. However, there are possibilities in the proper utilization of expert systems of today and in continuing to expand the expert system technology already available towards further and more complex applications.

REFERENCES


KEY TERMS

Artificial Intelligence: A field of study and development that attempts to imitate the functioning of the human mind, principally through the use of computer technology.

Expert System: A computer-based system that uses captured human knowledge to solve problems that ordinarily require human experts.

Inference Engine: A program’s protocol for navigating through the rules and data in a knowledge system in order to solve the problem. The major task of the inference engine is to select and then apply the most appropriate rule at each step as the expert system runs, which is called rule-based reasoning.

Knowledge: A collection of specialized facts, procedures, and judgment rules.

Knowledge Acquisition: The process of extraction, accumulating, transferring, and transforming of problem-solving expertise from human experts and/or documented knowledge sources to a computer program for constructing or expanding the knowledge base.

Knowledge Inference: The process of programming a computer in such a way that it can make reference in an attempt to imitate the reasoning behaviors of the experts.

Knowledge Representation: A formalized structure and sets of operations that embodies the descriptions, relationships, and procedures provided in an expert system. The process considers how to represent the knowledge in the system such that it can be used to solve problems.
INTRODUCTION

Agent-oriented design has become one of the most active areas in the field of software engineering. The agent concept provides a focal point for accountability and responsibility for coping with the complexity of software systems both during design and execution (Yu, 2001). It is deemed that software engineering challenges in developing large-scale distributed systems can be overcome by an agent-based approach (Paquette, 2001). In this approach, a distributed system can be modeled as a set of autonomous, cooperating agents that communicate intelligently with one another, automate or semi-automate functional operations, and interact with human users at the right time with the right information.

A distributed learning system typically involves many dynamically interacting educational components, each with its own goals and needs for resources while engaged in complex coordination. It is very difficult to develop a system that could meet all the requirements for every level of educational hierarchy since no single designer of such a complex system can have full knowledge and control of the system. In addition, these systems have to be scalable and accommodate networking, computing, and software facilities that support many thousands of simultaneous users concurrently working and communicating with one another (Vouk, Bitzer, & Klevans, 1999).

We have studied the implementation of collaborative agent system architecture (CASA) (Flores, Kremer, & Norrie, 2001) with a chemical reaction model (CRM) (Banatre & Le Metayer, 1990, 1993). CASA is a model that can catch the interactive and dynamic nature of e-learning systems. Our research results are published in Lin (2004) and Lin and Yang (2006). Following our existing work on the design methodology of multi-agent systems, we exploit this methodology in a project that aims at a grid system for laboratory use in undergraduate education. The new method will provide a solution to current problems in design of comprehensive environments to support lab activities in teaching courses on parallel/distributed systems and networks. The unified model in chemistry-inspired languages will enable formal specification of an evolving system and provide a framework for top-down design of the entire system.

BACKGROUND

With the fast innovation of computer and communication technologies, computer curriculum is being adapted to accommodate teaching modules that enhance teaching effectiveness by utilizing frontier technologies. For example, the Department of Computer Science, University of Houston-Downtown (UHD), is building an information technology (IT) option, which consists of courses in modern computer technologies defined by the current industrial desires, in its Computer Science degree program, to respond to the increasing need for effective convey of the knowledge of current technology to students to equip them for a career in the modern fast-changing computer industry. One of the most important parts of this project is designing labs that can be performed through the Internet. Our first step is implementing lab packages for our parallel computing and computer networking courses in a grid that encompass lab facilities centered at a Beowulf cluster. We will then extend our lab environment to include other CS and mathematical courses.

The challenge we are facing, however, is that we need to build an infrastructure that will accommodate multiple courses in different disciplines. The problems we are solving include: (1) an interface that is extensible to incorporate more lab modules and customizable to different course structures; and (2) a computational backbone that provides services for various lab activities, such as testing a parallel program, production of network phenomena, and performance analysis. Performing these activities requires coordination among multiple nodes. Also, the architecture of the system requires extensibility and scalability to accommodate multiple course modules. To address the first problem,
we follow the practice we had when we built the lab package for our CSI course. Outstanding features of this package include a lab explorer that allows students to browse through lab activities and the ability to invoke programs through the interface. We adopt the same structure in the lab package we designed for our parallel computing and networking courses. To address the second problem, we need to build an array of servers that run on a computational grid. A grid is a system of networked computing and storage sources (see Grid.org) that allows the sharing of information and computational powers. The grid is also a platform on which experiments of distributed data processing and computation can be exercised. Services are provided by different nodes of the grid system. The design of the grid must meet certain criteria so that the incorporation of any unit fits into our long term blueprint. For example, as aforementioned, the underlying infrastructure must support incremental and dynamic addition of lab exercises into the lab package. This is to support our ongoing construction of closed labs for our courses in parallel computing, computer networking, and other courses (Lin & Nguyen, 2005). On the other hand, however, the complexity of the system makes the design of its infrastructure difficult. Our existing research results suggest that the agent model is a powerful tool to solve problems in a distributed system. Therefore, we use agent technology to build the architecture of the grid system to manage the coordination and communication among the nodes and handle the load balancing issues. We envision that our practice will provide a solution to the problem of immersing current technologies into educational efforts which have been continuously made at UHD through the development of a comprehensive lab environment.

THE PROJECT

Goals and Objectives

The barrier in front of us is the integration of various networking technologies into one client/server model to provide a uniform lab environment for different lab activities. Given the targeted use of this solution, we need to define and implement the infrastructure that balances functionality and reliability. Based on our existing research experience, we desire a formal system to define the architecture of the grid system so that the development of the services and lab modules will no longer be pursued on case-by-case basis. The formal system must provide a language for the architecture specification, and a derivative method for system refinement. Architectural design should focus on system topology, interactions among system units, and dynamic features of the system, without involving proprietary platform information such as the operating systems on individual nodes, programming languages for program units, and vendor specific machine features. With the formal definition of the architecture on hand, interfaces among system units will be formally specified and design and deployment of each functional unit, such as a lab module, will not affect other units or cause any revision on the overall system.

Unfortunately, traditional formal methods in computer sciences are usually oriented to typical statically defined problems and not suitable for large-scale dynamic systems. Although there are attempts for developing formal methods in parallel and concurrent programming, no formal methods have ever been systematically used on evolving areas such as grid computing. We need a new model that can address the dynamic nature of a complex system without any presumption on the computation model.

As described earlier, an agent system provides an architectural model for a distributed networking system. As an active research area, the study in agent technology strives to apply intelligent information processing technologies to complex software systems. Features of an agent system have been summarized in the literatures, for example, according to Griss and Pour (2001), an agent shows a combination of a number of the following characteristics: autonomy, adaptability, knowledge, mobility, collaboration, and persistence. These features exist in different types of agent systems such as collaborative agents, interface agents, reactive agents, mobile agents, information agents, heterogeneous agents, and economic agents (Weiss, 2003). Because of the Gamma language’s higher-order operations and its closedness to specifications (no artificial sequentiality), these features can be described directly without being adapted to fit into proprietary frameworks. Since this paper focuses on the architectural design of the grid system, we omit some technical details about CRM. Interested readers can refer to our publications for explanations of our methods. In Lin (2004), a sequence of case studies shows that features of various agent systems can be grasped by the Gamma language succinctly. In Lin
and Yang (2006), we give a comprehensive example of specifying a course material maintenance system using the Gamma language. In addition, part of our work in constructing the cluster is presented at the 16th IASTED International Conference on Modeling and Simulation (MS 2005) (Lin & Nguyen, 2005).

The Design

The project includes a sequence of major steps: grid construction, lab design, client/server model definition, definition of the interface of functional units, agent-based architecture construction, a module language for program refinement, and architecture specification in the chemical reaction model. Our plan can be described as a pyramid-shaped model illustrated in Figure 1.

The system will be designed using a bottom-up strategy (the design theme). We construct the grid and design lab modules using existing toolkits, such as Globus Toolkit 3, Java, and Apache Server. The services provided by the system are implemented in client/server architecture. A Java-based user interface delivers the services on the Web. Servers run on the clusters. Multiple servers interact with one another in the agent-based infrastructure. A formal definition of the interfaces of functional units of the system forms the basis for multi-agent system design. Each agent is then designed in the module language we have proposed for specifying multi-agent systems (Lin & Yang, 2006). The overall system is specified in the chemical reaction model. In Figure 1, we can see the multi-agent system is the conceptual model for implementing grid services, and the interfaces of functional units define the interaction among functional units and are the central part of the agent system. The interface also separates the architectural design from the design of individual functional units.

Adding/deleting services or features in the grid can be done in a top-down strategy (the application theme). If a service of a new type is to be added into the system, for example, it is added into the architectural specification. Through an automatic transformation procedure (see Lin & Yang, 2006), the specification is re-written into a multi-agent system in the module language. The actual program that codes the services is then incorporated into the system through the standard interface. Therefore, updating services or lab exercises in the system will not cause any change in other parts of the system and correctness and reliability of the system can be ensured to the maximum extent.

A Show Case

The following is a list of labs we are using in our parallel computing and networking courses. These labs are carefully designed based on the goals of the course set

Figure 1. The pyramid model of the project
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forth in its syllabus and pursuit in our teaching experience. Lab topics are either typical topics of the area or problems we tackle within the course projects. Our lab design emphasizes the operability and vividness as well as the manifestation of the basic concepts and typical technologies. We also address the role played by the cluster when we design the labs.

- **Topology**: Circuiting messages in a ring.
- **Collective Communications**: Matrix transpose.
- **Group Management**: Matrix multiplication with Fox’s algorithm.
- **Scientific Computation**: Solving linear systems with Jacobi’s algorithm.
- **Combinatorial Search**: Traveling salesman problem.
- **Parallel I/O**: Vector processing—Summation.
- **Performance Analysis**: Visualization with Upshot—Trapezoidal rule problem.
- **Parallel Library**: Solving linear system with ScaLapack.
- **Scalability Analysis**: Bitonic sorting.
- **LAN Configuration**: The use of NICs and hubs.
- **Network Analysis**: Monitoring a chat room.

Here we show one example lab we have designed. This lab allows students to use standard metrics to analyze the performance of a parallel program. The students predict the performance of the parallel program they choose, load the program onto the cluster, compile and run the program, and then compare the predicted results to the experimental results. As illustrated in Figure 2, one lab session is organized in a series of tasks and each task a series of activities. In this lab, students study some standard measurement criteria, viz. speed-up and efficiency, for performance analysis of parallel algorithms in Task Activity 1 and 2, and predict the speed-up and efficiency of the chosen program given the size of the problem input and the number of nodes in Activity 3. Task 2 requires the students to load the chosen program onto the cluster and then compile the code. The students can click on the C++ Compiler button in the bottom of the page to compile the code.
Exploiting Agent Technology

once the loading is finished. Task 2 Activity 1 walks the students through the program loading process. Activity 2 asks the students to compile the code. The code is then checked in Activity 3 by a program to ensure its correctness. Erroneous code causes the students to be asked to correct the code until it is errorless. In Task 3, the students can analyze the experimental performance of the program by using MPICH JumpShot profiling software and compare the experimental results to the theoretical predicts, which have been done in Task 1. In Activity 1, the students are required to insert profiling commands into the program and obtain a profile of the program by running it. In Activity 2, the students start up the JumpShot program from the program menu to obtain a Gantt chart of the program. The students then calculate the actual performance data by using the logged timing data and compare the experimental results to the predicted. This is done in Activity 3. Figure 3 shows some snapshots of the lab activities. Figure 3(a) shows the window that takes the student’s response to performance prediction questions. Figure 3(b) shows the moment when the student opens a program through a dialog window and monitor the execution of the program through a pop-up window.

Figure 3(c) shows a text window in which the student adds profiling statements into the program.

THE INITIAL USE AND THE FUTURE PLAN

Although the depicted system is still in the development phase, the foundations have been established. We have tested the ontology of the design by building the transformation methods that implement the design starting from specifications in the chemical reaction model. This approach allows us to design the architecture that supports the development of modular components and allows the modules to be added in an incremental fashion. The system is being developed in different levels of the pyramid model concurrently. We have designed several lab modules and used them in our parallel computing classes. Although the lab packages are not as stable and full-functioning as commercial software, they present the complex concepts in an integrated programming environment and give the students a start point to acquire more sophisticated design techniques. We continue to involve students...
Exploiting Agent Technology

Figure 3b. Snapshots of lab—compilation and execution

Figure 3c. Snapshots of lab—profiling
in the design and improvement of the lab modules in forms of senior projects and student research programs. The grid has been fully established and is being tuned for the best performance. The peak HPL (High Performance Linpack) benchmark performance of 16 nodes is 9Gflops at this point.

We will add more lab modules into the system to support experiments on parallel/grid computing, computer networking, security, databases, programming languages, and other courses in an incremental fashion. With the grid as the computing base, we set our long-term goals at information sharing among multiple institutions and cross-campus collaborations in developing and evaluating course modules as well as research collaborations.

On the fundamental side, we will exploit \( \gamma \)-Calculus, the newly developed chemical reaction model, as the modeling language of the agent-based architecture. In addition, we will study the design from logic specifications of the architecture and develop a rewriting system that supports the transformational design.

**CONCLUSIONS**

We present a method for designing a computational grid that supports online lab exercises, as part of our information technology track of curriculum design. A lab package is designed to support the learning process in courses of parallel computing and networking. The grid is centered at a Beowulf cluster, which provides a computational backbone of the grid, and services are deployed in distributed nodes of the computing networks and organized by a multi-agent system. To address high-level architectural design issues, such as scalability, extensibility, and modularity, we use the chemical reaction model to formally specify the architecture and we facilitate a transformational method for implementing the system to the module interface level. We have developed the lab with an interface that accommodates different lab activities in different courses and demonstrated the design by show cases.

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**KEY TERMS**

**Chemical Reaction Models:** An abstract computing model which describes computation using the chemical reaction metaphor. In these models, data are represented as multi-sets and computation is performed by a series of element combination, that is, one or more elements are selected by the operator, if the selected elements satisfy the reaction condition, the selected elements are consumed and new elements that are produced by the reaction rule are injected back into the multi-sets. Computation terminates when no more reaction can take place. The chemical reactions models are suitable to specify high-level architectural properties of complex systems and are used as a specification tool for software architecture and coordination programming.

**Client/Server Model:** A model used to implement services via interaction between a server and clients. The server is a program designed to perform the computation requested by clients and the clients are programs that run on end-users’ platforms and serve as an intermediary between the end users and the server. Client programs usually are featured by user-friendly interfaces and preliminary processing of users’ requests. The server receives requests from the clients, performs the requested computation, and sends the results back to the clients. Client/server model is the dominant method for implementing Internet services.

**Cluster Computing:** A method of parallel computing using a cluster of computers inter-connected by high-speed networks. The computers of a cluster are usually personal computers or workstations and the networks are usually commonly used local area networks (LANs). The advantage of cluster computing is cost-effectiveness. It allows for high-performance computing without using expensive specially designed super-computers.

**Collaborative Agent System Architecture:** A model for multi-agent systems that features the collaboration among multiple agents to achieve the works. This model focuses on the conversation among the agents. Conversation is a process in which the agents exchange information to reach a solution to any emerged problem during the transaction. This model classifies agents into five categories, viz., interface agents, task agents, collaboration agents, knowledge management agents, and resource agents.

**Distributed Laboratory:** A laboratory that utilizes resources on a set of computers inter-connected through the network. To allow the students to access these resources and perform the lab exercises, a distributed laboratory usually has an online interface that is implemented by a client/server model. A distributed laboratory is often used to design lab exercises for parallel computing and grid computing courses.

**Gamma Languages:** Languages developed to describe computation in the chemical reaction models. In late 1980’s, Banâtre and Le Metayer proposed the original Gamma language. In 1994, Le Metayer proposed a higher-order Gamma language. In 1998, Fradet proposed a structured Gamma language. The newest Gamma formalism is Gamma Calculi, which were proposed by Banatre, Fradet, and Radenac in 2004 and 2005.

**Grid Computing:** A new distributed system that consists of distributed computing resources over the Internet. A grid allows the sharing of computing power, data, and information in a unified model. The studies of grid computing include how to use the distributed computing resources effectively to provide high-performance computing power, deliver e-services, and allow for information sharing while ensuring security and reliability.

**Multi-Agent Systems:** Multi-agent systems (MAS) is a new methodology to address the issues in organizing large-scale software systems. This methodology
Exploiting Agent Technology

provides a conceptual model that helps maintaining constraints, a task conventional software engineering is unable to achieve. An agent is a software entity that actively seeks ways to complete its tasks. Intelligent agents have the ability to gain knowledge through their problem-solving processes. Multi-agent systems are often used to model loosely coupled distributed systems with decentralized control and data allocation. In these systems, communicating agents represent distributed expertise for problem solving. The agents have the ability to process local data efficiently and to communicate with other agents when necessary if the tasks that they are facing are beyond their domain knowledge.
INTRODUCTION

The use of instructional technology is not new. During WWII, films were used as instructional media to train new recruits. The use of film as an instructional technology for training military personnel in WWII prompted the investigation of technology applications in formal educational settings. In the years following WWII, researchers began to study the applications of instructional technology in the classroom, as well as conduct studies on its effectiveness (Reiser 2002). Although technology has changed in the ensuing years and educators have access to many technologies, the integration of technology into the classroom has been slow (Cuban, Kirkpatrick, & Peck; 2001; Culp, Honey, & Mandinach; 2005; Hernández-Ramos, 2005) and its reported effectiveness on student learning and achievement has been mixed (Honey, Macmillan, & Carrigg, 1999; Keller & Bichelmeyer, 2004). The slow rate of integration is often explained from a technology evolutionary perspective, (Cuban et. al., 2001) that purports that with increased availability and access to technology, integration will occur naturally with time, or from technology determinist perspective (Surry & Land, 2000) that proposes that technology integration occurs when a technology is developed to meet a specific need, (i.e., if you build a better mousetrap it will be used). Although these two perspectives might explain some technology integration in society, they fail to provide a reasonable explanation for the lack of technology integration in classrooms. In order to understand why integration has been slow and often times fails to meet intended outcomes, we must adopt an instrumentalist’s perspective to technology integration. This perspective considers the human factors related to technology integration, and proposes that integration is more a human endeavor than a natural process. (Surry & Land, 2000). I extend this perspective to include organizational and environmental factors that impact technology integration. This paper will examine the variables that impact technology implementation, and present two approaches that school systems could employ to facilitate the integration of technology.

SUPPORT FOR THE INSTRUMENTALIST PERSPECTIVE

The instrumentalist perspective advocates that human, organizational, and environmental factors impact technology integration. Research into technology integration supports this perspective. A brief presentation of literature on technology integration examines some of the variables related to these three factors, and will help build a foundation for discussing the two approaches for facilitating technology integration.

A review of educational technology polices from the last 20 years resulted in the seven recommendations to facilitate technology use in schools. These recommendations included technology infrastructure, access to technology, professional development, support of teachers, increased financial resources, increased and varied stakeholder involvement, increased research and evaluation of technology integration, assessment of technology-integrated learning, and policies and practices related to technology use (Culp, et al., 2005). Becker (1994) compared exemplary computer using teachers to typical computer using teachers and found the school environments of exemplary teachers were more likely to provide social support for computer use among peers, use computers for project-based activities rather than instructional delivery activities, provide support for teachers through professional development and on-site technology personnel, and provide resources to facilitate the integration of technology into the classroom. Cuban, Kirkpartik, and Peck (2001) indicated that for integration to be maximized, we must move beyond simple access to the technology and address the operational and organizational factors in schools, preparing teachers both technically and pedagogically to integrate technology, develop quality a technology infrastructures, and increase the availability of technology support personnel.
Facilitating Technology Integration

Ertmer (1999) describes the variables related to technology integration as being two distinct sets of barriers. First order variables or extrinsic variables are independent from the teacher. These variables include training, time, equipment, and support. The teacher has limited effect over these variables and can do little to alter them. Ertmer suggests that these variables are addressed by the organization and often lead to the emergence of second order or intrinsic variables. These variables represent the teacher’s pedagogical philosophies and practices, view of learning, the classroom environment, and view of technology in learning. The resolution of these variables often requires a shift in pedagogical values, practices, and perceptions of technologies role in instruction. This shift occurs through professional development, support from peers, and support from leaders.

A survey of teachers in California reported that teachers also identified the need for more “release time” and access to educational technologists to develop technology integrated lessons. Additionally, the survey results supported previous research (Becker, 1994) that reported professional development and on-site technical support as critical factors related to technology integration (Hernández-Ramos, 2005). The same study indicated that teaching experience was positively related with amount of technology integration. This finding seems counter to the commonly held idea that younger teachers will be more “tech savvy” and willing to integrate technology. Furthermore, data analysis discovered a positive relationship between constructivist teaching philosophies and amount of technology integration (Hernández-Ramos, 2005).

An evaluation of technology integration projects in K-12 settings in Michigan (Zhao, Pugh, Sheldon, & Byers, 2002) discovered 11 factors that influenced technology integration. These factors were grouped on three dimensions. The first dimension was labeled the “innovator” and represented the teacher variables such as the technical knowledge and abilities of the teacher, the match between the teacher’s pedagogical beliefs/practices and technology being integrated, and the teacher’s ability to navigate the schools social and cultural dynamics. The second dimension labeled the “context” and represented the school variables such as quality of the “technological infrastructure” specifically equipment, software, networks, quality of the “human infrastructure” specifically the policies, procedures, technology and pedagogical support personnel, and “organizational culture” (pg. 490), specifically the level of the social support from peers and school leaders related to technology integration efforts. The third dimension labeled as “innovation” represented the project. This dimension was discussed in terms of distance of the project from three factors. The further the project was from the factor the more difficult the integration. These factors were school culture or how far the project differs from accepted pedagogical values (i.e., beliefs and practices) of the schools constituency; existing practice, or how far the project differed from current or previous technology integration efforts by the teacher; existing technological resources or distance between the needed technological resources for the project and the existing resources (Zhao, et al., 2002).

The research on technology integration consistently indicates that organizational, environmental, and human factors can either be obstacles that prevent technology integration or facilitate integration. For schools to foster technology integration they must adopt an instrumentalist perspective and work to create environments that meet these issues.

FACILITATING TECHNOLOGY INTEGRATION

The integration of technology is not a simple task. The mentioned studies indicate that multiple variables influence the integration of technology. In order to assist stakeholders with technology integration we need to provide some structure for facilitating the process. However, we first need to understand the process that leads up to technology integration. Technology integration results from the diffusion of the technology within the organization. The process of technology diffusion consists of three related and sequential stages: adoption, implementation, and integration.

Adoption. Adoption refers to the decision to use a specific technology for some intended outcome or purpose. This decision results from the resolution of feelings and thoughts about how the innovation will assist the organization or meet some organizational need (Rogers, 1995). According to Rogers, the resolution of thoughts and feelings comes about through the innovation decision process. In terms of technology in K-12 settings, adoption refers to the decision to purchase a particular type of technology (e.g., computers, video conferencing equipment, educational software,
or handheld devices) for the purpose of facilitating or increasing student learning.

**Implementation.** Implementation refers to the specific actions taken by organizational members to meet human organizational and environmental factors that will lead to the diffusion of the technology throughout the organization. Successful implementation should result in the use of the technology by the intended user(s) to meet the need for which the technology was adopted. In terms of technology in K-12 schools, this refers to actions such as providing training, increasing the access and availability of the technology, and creating organizational cultures that will encourage technology integration in the classroom in order to facilitate the learning of students.

**Integration.** Integration refers to the specific practices and amount of use that occurs once a technology has been implemented. The practices may differ between users, but the integration in all its forms should work to meet the organizational need. In terms of K-12 schools, this refers to the lessons and activities that occur in the classroom (e.g., digital storytelling activities, using spreadsheet software to organize and analyze data, using the Internet to research topics) that assist students in learning content and developing cognitive processing skills.

Because of the related nature and the sequential order of these stages, it is assumed that “success” at a previous stage influences success at the subsequent stage. Given this assumption, we can conclude that adopted technology that is not successfully integrated into the classroom fails to be integrated due to problems at the implementation stage. Burkman (1987) notes that even quality products fail because the implementation process was not addressed, while Berman (1981) states, “The best research and evaluation, whether qualitative or quantitative, suggests that how an innovation is implemented may be as important to outcomes as its technology.” (p. 262). Because the implementation stage is critical in the diffusion process, schools must take specific actions to ensure that the human, organizational, and environmental factors are addressed in order to support integration efforts. Two approaches provide us with a means for addressing these factors.

**CONDITIONS THAT FACILITATE IMPLEMENTATION AND THE RIPPLES MODEL**

The research on school change is vast. Major contributors include the likes of Fullan (2001), who advocates for a shared meaning and understanding between all constituents in the school, Havelock and Zlotolow (1995), who provide a step-by-step guide for change agents, Reigeluth and Garfinkle (1994), who describe the systemic nature of school change and the interactive affects of variables, and Stockdill and Morehouse (1992), who describe specific variables related to a schools organizational capacity to change. Two lesser-known approaches provide a framework for addressing implementation issues. These are the eight conditions that facilitate the implementation of innovations and the RIPPLES model. Both of these approaches take an instrumentalist view of technology implementation by addressing critical areas related to the implementation stage.

**Ely’s Conditions.** Don Ely, (1990, 1999) describes eight human and environmental conditions that facilitate the implementation of innovations. These conditions traverse cultural and organizational boundaries as well as innovation type (Ely, 1999). The following provides a general summary of the condition and then presents a technology integration interpretation:

Dissatisfaction with the status quo refers to an emotional discomfort resulting from the use of current methods that are perceived as inefficient or ineffective (Ely 1990, 1999). This condition reflects a teacher’s perception that current methods of instruction without technology are not effective or efficient. Those dissatisfied with the status quo will seek new methods, while those satisfied with status quo will avoid and resist technology integration. In order to facilitate integration schools must create catalyst events such as showcasing technology integration efforts, visiting schools where technology has been successfully implemented and integrated into the curriculum, and creating a social support network that encourages the sharing of technology integration ideas. Maintaining the status quo often results from feelings that one cannot personally integrate the technology given their current abilities, knowledge, and time. By addressing other conditions, this condition can be minimized and an organizational culture that embraces technology integration can be fostered.
Facilitating Technology Integration

Knowledge and Skills refers to whether or not those charged with using an innovation possess the needed skills and knowledge to implement the innovation (Ely, 1990, 1999). This condition represents the teacher’s knowledge and skills related to technology itself, as well as the pedagogical knowledge needed to facilitate learning through technology integration. Schools must address these areas and provide on going professional development to extend teachers technology literacy, technology application skills, pedagogical literacy and knowledge, as well as instructional practices related to technology.

Adequate Resources is the availability and access to resources needed to successfully implement the innovation (Ely, 1990, 1999). This conditions represents the technological infrastructure related to technology integration; that the organization has working technology in place and the means to sustain the technology. Also, the technology infrastructure should be easily accessible, schedules devised that facilitate the use of the technology, and support personnel on-site to solve problems and collaborate with teachers on integration efforts.

Adequate time refers to the organizational leaders’ willingness to provide adequate and compensated time for users to increase personal level of comfort and develop the skills and knowledge to successfully use the innovation (Ely, 1990, 1999). This condition also refers to the users’ willingness to devote time to learn new skills for implementation. For technology integration, this condition represents administrators’ willingness to provide paid time for teachers to develop both their technical and pedagogical skills, as well as provide release time to develop classroom activities and lessons that integrate technology. It also reflects the teachers own willingness to devote time to developing instruction that integrates technology.

Rewards or Incentives refers to the incentives that motivate users to employ the innovation, or rewards provided by the organization for those who do use the innovation (Ely, 1990, 1999). For technology integration, the incentives need to be directly related to the teacher’s success in his or her position, or linked directly to student learning and achievement. Current methods of teacher evaluation, both internal and external, must include technology integration as a value activity in order to legitimize technology integration efforts.

Participation refers to active involvement of key stakeholders in decisions that involve the planning and design of the innovation (Ely, 1990, 1999). The condition refers to all stakeholders, but emphasizes the frontline users. For technology integration efforts to succeed, all stakeholder perspectives and support must be acquired. This includes not only teachers, but students, technology coordinators, technology support staff, administrators, and other faculty involved in the integration. The action of soliciting participation from the various stakeholder groups allows for multiple perspectives on technology integration. Additionally, participation increases a stakeholders’ sense of ownership in the diffusion process and therefore, their support.

Commitment refers to the user’s perception that the powerbrokers of the organization (i.e., School Board, District Administrators) actively support the implementation of the innovation (Ely, 1990, 1999). For technology integration, teachers must perceive the school district as providing and supporting a technology vision and plan. The visible signs of commitment include technology and financial resources being allocated to meet the vision; hiring of technology support personnel; institutionalization of polices to facilitate integration of technology; addressing systemic change issues related to curriculum, pedagogical values, and philosophies; and assessment to support technology efforts of teachers. The visible actions of those in power positions provide not only tangible resources, but also creditability to the integration efforts.

Leadership refers to the assistance of immediate supervisors that helps users overcome obstacles to implementation (Ely, 1990, 1999). For technology integration efforts, school administrators, department chairs, and even technology coordinators must create a technology integration climate. These individuals must model behaviors, provide encouragement, promote social support, and work to reduce obstacles that prevent integration.

Research has supported the role of these conditions in the implementation of innovations in schools. Bauder (1993) examined the conditions’ ability to predict the use of computer software in schools, and found a predictive relationship between the presence of six of the eight conditions and the school use of the software. Ravitz (1999) investigated the presence of the conditions in schools whose teachers actively used the Internet in the classroom, and found a significant presence of seven of the eight conditions in these schools with high Internet use. Recent research has focused on developing a means for assessing the...
importance of these conditions prior to implementation (Surry & Ensminger, 2003, 2004), and indicates that the perceived importance of these conditions can be assessed (Ensminger 2005; Ensminger, Surry, Potter, & Wright, 2004). The information gained from assessments can focus implementation plans and direct initial changes efforts on those conditions to build momentum for integration.

RIPPLES model. The RIPPLES model presents a strategy for facilitating technology integration. Although this model was developed to address the implementation of technology in higher education, the seven components of model are relevant in all academic settings. The components of the model were identified through review of the literature and a survey of university administrators (Surry, 2002; Surry, Ensminger, & Haab, 2005). Each component reflects specific areas that schools must address in order to facilitate the implementation of a technology. The first letter of each component is used to construct the name of the model: Resources, Infrastructure, People, Policies, Learning, Evaluation, and Support.

Resources are the financial resources that are available to meet both direct costs (e.g., software, hardware, professional development) and indirect cost (e.g., maintenance of the technology, extra salary, and personnel) related to the implementation of the technology (Surry, 2002; Surry, Ensminger, and Haab, 2005). Stakeholders (i.e., students, parents, administrators, and the teachers) may have specific needs that will require funding in order to successfully integrate the technology. School systems have to plan at both the district and school level to fully fund technology efforts and accept that technology implementation is an on-going process and a not one-time expenditure.

Infrastructure includes the technological resources needed for the integration effort (Surry, 2002; Surry, et al., 2005). Technology resources are often easily identified and assembled; however, technology integration requires resources beyond the needs of the teacher and may include peripheral technologies beyond the established technologies within the organization. It is important to note that each stakeholder group may require different technology resources at different times. The school’s responsiveness to these resources needs will influence the success of integration efforts.

People refers to the role of humans in the implementation process. Technology implementations must take into account the human aspect associated with change (Surry, 2002; Surry, et al., 2005). Schools must consider the views on technology, anxieties, and current level of knowledge and skills of their teachers when implementing technology. It is critical that districts and schools provide opportunities for members to communicate their thoughts and feelings about the technology, as well as, involve all stakeholders in decisions. Teachers are key stakeholders since they are the gatekeepers to the integration of technology into their own classrooms. Schools would be well advised to actively seek their involvement in decision making.

Policies is the fact that the implementation of technologies requires changes in the policies, procedures, and practices of an organization (Surry, 2002; Surry, et al., 2005). School systems must examine their current polices and make changes accordingly to encourage technology integration. This might include policies related to accessibility to networks and servers, professional development, curriculum development, teacher evaluation, and student assessment. Additionally, individual schools must look at their policies and procedures to ensure that they do not hinder the integration of technology in the classroom. This might include the scheduling of labs, or mobile technologies, the extension of class times, assessment strategies, and student access to technologies. Along with formal practices, school personnel must be aware of the informal practices in the culture such as pedagogical beliefs and views of technology that can influence the implementation of technology.

Learning includes the learning outcomes or pedagogical benefits that result from technology integration (Surry, 2002; Surry, et al., 2005). Technology integration efforts often focus on activities that encourage higher-order cognitive processing. Schools often need to shift their organizational culture to accommodate these new outcomes and change their assessment strategies in order to evaluate the learning outcomes. Keller and Bichelmeyer (2004) present a discussion of the disconnect between the standards-based instruction policy of the No Child Left Behind Act and expected learning outcomes associated with technology integration.

Evaluation: Schools must develop strategies to evaluate student learning outcomes, the technology itself, social and cultural changes that result from technology implementation, and the return on investment (Surry, 2002; Surry, et al., 2005). It is not simply enough to implement a technology, schools must take a proactive stance in gathering the evidence and in-
Facilitating Technology Integration

formation needed to make changes that will facilitate the diffusion process. The evaluation of outcomes and social and cultural changes are critical to facilitating technology integration efforts.

Support refers to both the technological and pedagogical support that stakeholders will need to integrate technology. Teachers pursuing an integration effort may not have the technical expertise and/or pedagogical expertise to integrate technology into their classroom. Schools must be ready to hire individuals such as educational technologist who often have both the technical and the pedagogical expertise to support teachers with integration efforts. School should support professional development of teachers in the areas of technology literacy and instructional practices related to technology. Additionally, schools will need to consider the support needs of students as they work on technology projects.

CONCLUSION

Since the use of instructional technologies in schools results from the diffusion process of adoption, implementation, and integration, and obstacles or resistance can occur at any and all stages of this process; stakeholders in schools can not adopt an evolutionist or determinist perspective towards technology. Instead, stakeholders must have an instrumentalist perspective and actively work to ensure that the technology is successfully implemented and, therefore, successfully integrated. This requires that those responsible for diffusioning a technology need to familiarize themselves with the strategies and models that can aid in developing implementation plans. While two approaches were presented to assist schools in their implementation of a technology, I advise a tandem use. The RIPPLES model provides a comprehensive approach and guiding strategy that outlines the major areas that schools must address in order to successfully implement a technology. Ely’s conditions provide critical areas to evaluate when conducting a needs assessment about a specific technology. Results from the needs assessment can direct administrators to conditions that may need more attention than others or provide a starting point for the implementation process. No matter the strategy or model employed, human, environmental and organizational considerations must be made when developing an implementation plan that can be used to facilitate the integration of technology into classroom practices.

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KEY TERMS

Adoption: The resolution of cognitive and emotional concerns that leads to the decision to use a specific technology to facilitate student learning.

Determinists Perspective: Perspective that technology is an autonomous force, that advances in technology will naturally lead to the integration of the technology into the classroom, and that the diffusion process does not require human intervention.

Ely’s Conditions: Eight conditions supported through research that, when present, facilitate the implementation of innovations within organizations. These conditions are Dissatisfaction with the Status Quo, Skills and Knowledge, Resources, Rewards, Time, Participation, Leadership, and Commitment.

Implementation: Specific actions taken by stakeholders that reduce barriers and increase the likelihood
Facilitating Technology Integration

that technology will be integrated into the classroom to facilitate student learning.

Instrumentalist Perspective: Perspective that technology is not autonomous nor does availability of the technology naturally lead to integration in the classroom. This perspective emphasizes that humans play a vital role in the diffusion process.

Integration: Actual lesson plans, instructional practices, and activities in the classroom that involve technology to facilitate student learning.

RIPPLES: A model of implementing technology that advocates the meeting of specific needs within seven components of the model. These components are Resources, Infrastructure, People, Policies, Learning, Evaluation and Support. Each has specific needs that must be addressed in order to maximize the integration of technology.

Technology Evolution Perspective: Perspective that given enough time, a technology will be diffused and integrated into classroom activities and no special strategies are required to facilitate this process.
Fair Use and the Digital Age

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“The primary objective of copyright is not to reward the labor of authors, but ‘to promote the progress of science and useful arts.’ To this end, copyright assures authors the right to their original expression, but encourages others to build freely upon the ideas and information conveyed by a work...This result is neither unfair nor unfortunate. It is the means by which copyright advances the progress of science and art.”

Justice Sandra Day O’Connor

INTRODUCTION

Copyright

Copyright is a form of protection provided by the laws of the United States (title 17, U.S. Code) to the authors of “original works of authorship” including literary, dramatic, musical, artistic, and certain other intellectual works. This protection is available to both published and unpublished works. For example, a copyright protects original works of authorship giving the holder exclusive rights to reproduce or copy, produce derivative works based on the copyrighted work, distribute copies of the work, perform the work freely, and display the work publicly.

Some works are copyrightable, others are not. Literary works are in the first category and include novels, nonfiction prose, poetry, newspaper articles and newspapers, magazine articles and magazines, software manuals, training manuals, manuals, catalogs, brochures, text ads, and compilations such as directories and indices. Musical works are also copyrightable; songs, advertising jingles, and instrumentals are covered by this code—as are dramatic works; pictorial, graphic and sculptural works; motion pictures; and, other audiovisual compositions including, but not limited to sound recordings, computer software, and even electronic mail.

Works that are not copyrightable are often less tangible. They include ideas or concepts; lists with little, if any, originality; factual information readily available in public records, court transcripts, or statistical reports, for example; and titles or short phrases (not to be confused with trademarks which are protected).

Fair Use

As more and more material fell subject to the pitfalls of copyright infringement, particular categories of users sought relief from the burdensome demands of seeking release to use. Enter the “fair use” laws and an additional set of complications associated with the reproduction of privileged materials. Fair use is defined as the “manipulation of copyrighted works, including such use by reproduction in copies or recordings, for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research” (Wikipedia, 2006). Invoking the stipulations of fair use opens the door for the incorporation of materials under specific circumstances, without infringement of copyright restrictions and without formal requests for copyright release. In determining whether the use made of a work in any particular case is a fair use involves the following factors:

• Purpose and character of the use, including whether such use is of a commercial nature or is for non-profit educational purposes;
• Nature of the copyrighted work;
• Amount and substantiality of the portion used in relation to the copyrighted work as a whole; and
• Effect of the use upon the potential market for or value of the copyrighted work.

For educators, a few additional factors have been advanced by the community of scholars and must be considered when determining fair use of text, audio, and visual materials. In the 1970s, a committee of publishers and librarians worked out guidelines to expand copyright laws pertaining to educational and library situations. These guidelines encompass four specific areas: (a) classroom use of copied materials,
**Fair Use and the Digital Age**

**Table 1. Applications of fair use laws in education**

<table>
<thead>
<tr>
<th>Content</th>
<th>Examples</th>
<th>Limitations</th>
</tr>
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<tbody>
<tr>
<td>Text</td>
<td>Self-explanatory</td>
<td>Up to 10% or 1,000 words of a work</td>
</tr>
<tr>
<td>Visuals</td>
<td>Illustrations and Photographs</td>
<td>No more than five images from one artist or photographer. No more than 10% or 15 images, whichever is less, from a collection</td>
</tr>
<tr>
<td>Multimedia</td>
<td>Moving Images and Music</td>
<td>No more than 10% or 3 minutes from any video or animation. No more than 10% or 30 seconds from any musical work.</td>
</tr>
<tr>
<td>Multimedia Projects</td>
<td>Portfolios</td>
<td>No more than two copies may be made of a project.</td>
</tr>
<tr>
<td>Numerical Data Sets</td>
<td>Spreadsheets and databases</td>
<td>Up to 10% or 2,500 fields or cell entries, whichever is less, from a copyrighted database or data table.</td>
</tr>
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</table>

(b) replication of music for educational purposes, (c) interlibrary loan, and (d) videotaping of broadcasted programming for educational purposes. From these initial beginnings came a plethora of generalities and specifics that would swell to redirect the attention of faculty, students, and administrators as they attempt to walk the fine line between academic freedom and aversion of plagiarism. Table 1 illustrates the common limitations for educational and library applications under fair use laws.

**Use: Getting a Handle on Fair or Unfair**

Educators have historically been among the first to embrace innovations in the form of sound, video, slides, photographs and art, and text. By combining different media, new technologies have expanded even further the possibilities of instructional media for enhancing the quality of their teaching. But with the truly cross-platform tools provided by 21st century technology, educators are now free to compose, consolidate, integrate, and infuse sounds, images, and text as heretofore nonexistent entities. Doing so often impedes on the boundaries of copyright as teachers trample fair use parameters without obtaining permissions from the component copyright holders. Further confounding the issue are the gigabyte iPods, thumb-sized jump drives, writable CDROMs, inexpensive DVDs, transferable e-books, and who-knows-what-will-be-available-next-month media readily applied to the digital classroom. A generation of students (and soon teachers) will have grown up in the gray abyss of disk-copying software, downloading music, taping movies, and sharing ringtones.

**We Better Get a Handle on What’s Fair Game and What’s Not Before It’s Too Late**

Under Section 106 of the Copyright Act, the owner of a copyright has exclusive rights to his/her works along with all privileges to by-products from the works. At the same time, the fair use provision of Section 107 may or may not protect would-be (intentional or unintentional) plagiarists from lawsuits asserting infringement. Fair use allows for the educational use of resources without obtaining permission from the copyright holder, governed by four criteria:

1. **Limited Access to the Resources**: Given the susceptible nature of digital media, limiting access to the resources downloaded from the Internet or
reproduced from a CDROM may indeed be the most tricky delimiting criteria. Copied materials linked prominently (i.e., without security or access restrictions) on a home page or placed within a file transfer index is ripe for a potential violation.

2. **Limited Time of Use:** Use of copyrighted materials for extended periods of time (more than one semester or for an entire academic year, for example) suggests the need for a release request from the owner.

3. **Limited Quantity or Portion Used:** Table 1 demonstrated the quantity limitations in effect with the law. Cases are already on the books in which words have been counted and seconds have been timed.

4. **Limited Commercial Effect to the Author:** Regardless of the access, time, or quantity of the materials gathered, fair use does not permit the fabricator to benefit monetarily from the unprotected materials. Journals are particularly cognizant of copyright violations and often require their contributors to attest to the originality of their submitted manuscripts (see example copyright agreement, courtesy of Idea Group Incorporated, 2006).

Again, fair use all depends on circumstances and no law (and certainly no article such as this) can describe all the possible transgressions that might be encountered in either an educational or library setting. Permission from the copyright holder is encouraged whenever resources will be employed not clearly protected by fair use. These might include selections of materials larger than fair use allows; permanent, extended, or recurring uses of the copyrighted materials; materials that will be widely distributed (to students, other faculty, in journal citations, or the like); and any creation of materials with potential commercial implications.

In previous decades, fair use was often limited by circumstance; instances ripe with copyright infringements were necessarily restricted by the ability to copy originals: text, sound, video, and so forth. However, in the decade of the 2000’s, the tools available to reproduce books and periodicals, capture voice and video, and duplicate and transmit electronic content are limited only by the imagination. It is incumbent on today’s educators to consider the implications of technology on fair use.

### Digital Age Guidelines

As educators explore the complexities and potential of digital content, from multimedia to networking, debates over what is or is not “fair use” has been replaced with significantly more complex deliberations regarding what (technically) is or is not feasible. While in the past, the question was one of “how do we capture this article of text, video, or sound file for use in the classroom?” Now, the question has evolved (because technology has presented so many solutions), to one of “what are the boundaries for the use of this material?” Or, to remain consistent with Justice O’Connor’s statement (at the introduction to this paper), “how is science and art advanced through the fair use of digital content?”

### Regulation by the Discipline of Information Technology

In 1998, the Digital Millennium Copyright Act (DMCA) was enacted. In spring 1999, the U.S. Copyright Office conducted public hearings to recommend changes to the DMCA in support of distance education through digital technologies. In testimony before the United States Senate on May 25, 1999, the Register of Copyrights, Marybeth Peters, addressed eight key areas of copyright-specific issues that play on the fair use of digital content. As each of these key areas was introduced and recommendations offered to address noted imperfections in the law, for all intents and purposes, Peters put forward suitable guidelines for dealing with fair use in a digital learning environment. Note: the italicized phrases are direct citations from the text of the Peters’ address; the commentaries that follow are attributable solely to the author.

- **Broadening the meaning of “transmission” to include transmissions by digital means as well as analog.** In prior legislation, it was unclear whether copyrightable materials included electronic content; there was never any doubt about analog (e.g., video tapes, sound recordings, etc.).

- **Expanding the law’s “coverage of rights to extend” to new technologies as they become known and available.** Previous exemptions did not address digital transmissions over computer networks (high-speed transmission for the popu-
lace was not as prevalent during initial drafts of the legislation. The Copyright Office recommended expanding the scope of the act to add network transmissions and to include, in a more sweeping broad brush statement, new technologies as they became identified and integrated into the fabric of everyday life.

- **Emphasizing the concept of mediated instruction.** If an entire work can be: (1) repeatedly downloaded, (2) whenever a student wishes, (3) for an indefinite period of time, subsequent purchase of the original text, video, or sound is highly questionable. Section 110(2) of the original act sought fair use exemptions specifically for students to access individual works asynchronously. Music-related downloads opened an entirely new vista of unintended copyright infringement in the late 1990’s and early in the new millennium. Even the most visionary technologist could not have predicted the impact of high speed cable access piped directly into offices and homes and the effect it would have on pirated music. To restrict the intent of copyright protection laws, the Copyright Office sought to ensure that the performance or display of content material remained analogous to conditions as they would be found in a traditional classroom setting. Additional language was recommended to address that downloadable content, to be protected under the fair use laws, must be at the direction of an instructor to illustrate a point in, or as an integral part of, the equivalent of a class session in a particular course.

- **Eliminating the requirements of the physical classroom.** In its original form, sections of the DMCA restricted transmission of fair use content directly to the classroom or similar instructional environments (labs, libraries, etc.) or, in a rare departure, to persons who are unable to attend class (e.g., special needs students). The evolution of online distance learning made this restriction unenforceable if not undesirable. Instruction, it was posited, must be free to occur anywhere at any time in many different forms to an expanding definition of eligible class of target recipients. Eliminating the physical classroom limitation reflects today’s realities.

- **Adding new safeguards to counteract new risks.** Transmission of digital content material to students was found to pose a greater risk of unrestrained copying and distribution (citation here). The harm to markets (particularly in the music industry) beyond the primary educational market are well documented. As a result, the DMCA was expanded to cover digital transmissions and incorporate safeguards to minimize these risks. The Copyright Office suggested three specific precautions: any transient copies permitted under the exemption should be retained for no longer than reasonably necessary to complete the transmission; those seeking to invoke the exemption should be required to institute policies regarding copyright; and when works are transmitted in digital form, technological measures should be in place to control unauthorized uses (Testimony on Copyright Office Report on Copyright and Digital Distance Education, 1999).

- **Maintaining existing standards of eligibility.** An educational institution must be “nonprofit” to be eligible for exemptions provided by fair use laws. In 1999, the debate over the definition of for-profit and non-profit was just beginning to obscure qualified institutions entitled to digitized educational material. Unresolved only a few years ago, the debate over this evolving issue continues.

- **Expanding categories of works covered.** On a similar note to eligibility issues is the issue related to categories of works. Distinctions once finely delineated and embedded in law for decades is now blurred as sound and video are readily captured, transmitted, and even disentangled digitally to form new content with the help of very sophisticated (yet less and less expensive) software and hardware. The main categories of works that were once readily recognizable as audiovisual, sound recordings, and dramatic literary and musical works are now categorized as sound bytes, mp3’s, video clips, e-books, and the like. Distinctions for fair use purposes have certainly become less clear with the proliferation of multimedia-rich content materials. Licensing issues have surfaced in the courts as the definitions of protected works are expanded in response to the rapid discovery of new technologies.

- **Establishing accountability for the use of lawful copies.** Fair use applications require no visible
Fair Use and the Digital Age

acknowledgment of borrowed material as does copyrighted content. The © is more than a symbol; it has become a recognized warning sign that the material contained therein is protected and overt actions are necessary (e.g., citations, permissions, releases, etc.) and are in order before incorporating content. The Copyright Office suggested a non-compulsory addition to course syllabi and course instructions encouraging instructors to require their charges to infuse a recognizable symbol of their own for content retrieved for fair use purposes and then hold them accountable for its use in papers, recordings, and presentations.

The Digital Millennium Copyright Act of 1998 was the industry’s noble attempt to address issues inherent in the harried advancement of technology into the formerly well-defined arena of copyright protection. Who would have ever thought in 1950, 1960, or even into the early 1990’s that technology would become such an irresistible vehicle for transmitting and sharing information? Tribulations now associated with safeguarding copyrighted content opened new vistas into what were relatively uncomplicated decisions. So much so that the discipline of education itself has found it necessary to tender its own regulations concerning the fair use of copyrighted materials for educational purposes.

Self-Regulation by the Discipline of Education: The Challenges for Educators

The rapid emergence of new technologies has resulted in a plethora of new challenges for today’s classroom teachers. Consider the following:

“Google has doubled the number of Web pages it indexes from 4 billion to about 8 billion, according to a posting on the company’s Web site.” (Hansen, 2004)

This citation from Evan Hansen in a November 2004 article of CNET News articulates (albeit in already aged data) the geometric contributions of the Internet and availability of computers and digitizing equipment toward the advancement of information and knowledge. Newer technologies allow educators to download, copy, and digitize learning materials faster than ever, often leaving no trail as to the original source of the text and images saved as computer files (Carter, 1996, p. 4). And, with the added pressures to integrate technology into the classroom curriculum, it is no wonder that teachers often overlook the guidelines for using other people’s work without proper citations and acknowledgments. The law can be confusing, sometimes ambiguous, and always cumbersome. While educational institutions have begun to protect themselves from liability via better accounting, faculty and student workshops, and documented institutional policies, teachers and students, either through carelessness or indifference, continue to engage in illegal fair use of materials.

In light of these issues, and considering the caveats offered by the discipline of information technology (see the previous section), it is wise to consider admonitions particular to faculty, trainers, and students. The review will begin with a look at some of the accepted rules of fair use for educators.

Brevity and Recurrence

Fair use reproductions of content-rich materials by teachers must meet the tests of brevity (how much of the content will be copied) as well as recurrences (how many times the content will be copied). The “how much” question has been adequately addressed; the reader is referred to Table 1 for numerical limitations. Recurrences, unfortunately, is not so cut and dry. Common sense is often tapped as the measure of how many times is too many and, as we all know, common sense is not all that common. Teacher who use borrowed content repeatedly are expected to seek permission as soon as feasibly possible. Using content repeatedly over an extended period of time (semesters, academic years, etc.) is most definitely not within the spirit of the fair use laws.

Pitfalls of Improper Fair Use

Some of the most common violations of the fair use laws occur when: making multiple copies of individual works instead of purchasing books, publisher’s reprints, or periodicals; reproducing the same materials from semester to semester; using the same material for several different courses either at the same or different institution; or copying the same material more than 10 times in a single semester.
Circumstances of Copyright Permission

Fair use is not an excuse to avoid seeking a copyright release, especially: when the content is intended for commercial purposes (e.g., content will be incorporated into a book); when the content will be used repeatedly; or when the content exceeds the limitations noted in Table 1. If any of these circumstances are encountered, seek copyright permission and remove all doubt surrounding the misapplication of fair use laws. One easy remedy is to always capture the citation information for all materials, whether you intend to seek a copyright release or invoke fair use. Then, if you see a copyright release is a better avenue, you have that information in hand to request permission for specific materials.

Here’s more advice. Always credit the source of your information, whether copyright permission has been received or not. Look for authors who explicitly invite educators to use their work for classroom applications and offer specific guidelines for acknowledging the source of the original content. Whenever feasible, ask the owner of the copyright for permission. Keep a copy of your request and acknowledgment received.

Similarities and Differences Between Student and Faculty Guidelines

Students may incorporate portions of copyrighted materials when producing a project for a specific course; faculty may include portions of copyrighted works when producing multimedia projects for their own teaching in support of curriculum-based instructional activities. Students may perform and display their own projects and use them in portfolios, for job-related interviews, or as supporting materials for application to graduate school; faculty may use their project for assignments for student self-study, remote instruction provided the network is secure and is designed to prevent unlawful copying, conferences, presentations, or workshops, and their own professional development portfolios.

Violating Copyright Laws

Educators are in a fortunate position to foster compliance with fair use laws within their discipline by example as well as directive. They are able to encourage development of unique content and materials while considering time, resources, and skill-levels constraints. They promote educational fair use guidelines and share royalty-free, public domain materials, whenever possible. They offer technical tips that encourage educators to seek the permission of the copyright holder by maintaining a Webliography of resources gathered online to facilitate copyright permissions either immediately upon downloading the information or later when a realization sets in that fair use limitations are being exceeded. Journals, members-only Web sites, professional associations, and accreditation organizations are key players in guiding the conduct of associate institutions and their faculty and students.

FAIR IS ONLY RIGHT

So far, the discussion of fair use laws and copyright permissions has centered on legal aspects. On the other end of the spectrum, and certainly just as important, is the issue of ethics. Educators, sometimes without knowledge of privileged restrictions, other times ignoring these boundaries for expediency purposes, illegally reproduce academic content materials or download unlicensed software. On the surface, such actions appear to be victimless when, in fact, the perpetrator is stealing intellectual property and depriving the originator of earnings (monetary or personal reputation) to which the author is entitled.

CONCLUSION

Advocates of information technology have an obligation to demonstrate integrity and trustworthiness. Just as they expect their colleagues to refrain from cheating and stealing, they should, in turn, uphold the parameters of fair use and copyright laws when it comes to acquiring intellectual content. Together, supporters of the industry should protect themselves from legal liability while modeling behavior that places them above reproach. Instructional technologists are a sophisticated professional group who incorporate many technologies into their work on a daily basis whether they are trainers, curriculum designers, or managers. They infuse interactive video, computer-based instruction, digitized images, and online services to accomplish their goals. With this empowerment comes responsibility, and the majority of educators are uninformed when it comes
to understanding the copyright laws applicable to the technologies. Too often they fall back on the myth of “educational use” as an excuse to justify their actions. This article has provided a close-up look at key elements of the laws, critical factors in assessing your own adherence to fair use, and many recommendations and tests for operating in a technology environment.

REFERENCES


KEY TERMS

Copyright: Copyright is a form of protection provided by the laws of the United States (title 17, U.S. Code) to the authors of “original works of authorship” including literary, dramatic, musical, artistic, and certain other intellectual works.

Digital Millennium Copyright Act (DMCA): Enacted in 1998. In spring 1999, the U. S. Copyright Office conducted public hearings to recommend changes to the DMCA in support of distance education through digital technologies.

Fair Use: The manipulation of copyrighted works, including such use by reproduction in copies or recordings, for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research (Wikipedia, 2006).

Fair Use Criteria: Include limited access to the resources; limited time of use; limited quantity or portion used; and limited commercial effect to the author.
INTRODUCTION

Humans have different interpretations of learning theories and different beliefs about how people learn. All these beliefs may come from personal experience, self-reflection, observation of others, and through the experience of trying to teach or persuade someone else to your way of thinking. In a nutshell, everyone keeps learning every waking minute, using different learning theories. In democratic cultures, people may prefer critical thinking as an effective learning theory whereas in authoritarian cultures, people may like rote learning or memorization as an effective learning theory. It is extremely difficult to determine which learning theories are better than others because people are engaged in informal or formal learning to change the way they see themselves, change the way they see other people, and change the way they see situations (Cramer & Wasiak, 2006). All these learning theories are valuable in guiding one’s action in a particular culture, subculture, or even a particular setting. Although scholars have different interpretations of learning theories, the goal of any learning theory is the same. For example, Merriam (2004) explains a learning theory as leading to learners’ growth and development. Mezirow explains the theory of transformative learning as helping learners achieve perspective transformation. Maslow considers the goal of learning to be self-actualization: “the full use of talents, capacities, potentialities, etc.” (p. 150). Some learning theories such as the theory of andragogy encourage learners to be self-directed in learning whereas other theories emphasize the roles of teachers as information transmitters instead of learning facilitators, thus placing learners at the feet of master professors.

Over the years, scholars have never stopped debating over which learning theories are superior to other learning theories for a certain group of learners. Very often, these scholars are divided into two blocs: some who emphasize releasing the energy of learners as a good learning theory from the Western hemisphere and others who emphasize the passive role of following their teachers as learners from the Eastern hemisphere. Often times, this line of division may be blurred as globalization brings different cultures together. The next section addresses how different learning theories came into being and what may be the essential elements in these theories that both scholars and learners need to pay attention to.

BACKGROUND

Experiments on how animals and humans learn went back as early as the late nineteenth century when John B. Watson (1878-1958) conducted a study of learning in animals. The Russian physiologist Ivan Pavlov (1849-1936) conducted experiments that resulted in the concept of conditioned reflexes (as cited in Knowles, Holton, & Swanson, 1998, 2005, p. 25). Upon the basis of these experiments and others, scholars have tried to make comparisons between human and animal learning. The conclusion drawn is animals learn via reflexes and behavior modification whereas humans learn through reflection (Wang & King, 2006, 2007). As the first American educational philosopher, John Dewey (1933) addressed the issue of why people learn by stating that learners are faced with learning problems and these learning problems perplex and challenge the mind so that it makes belief uncertain. Dewey continued to say that it is this perplexity that leads to reflective thinking, hence learning of the learners. This line of thought was widely accepted in the academic world. Later, in the early 1980s, Jack Mezirow advanced the theory of transformative learning which explains that it is the disorienting dilemma that forces learners to learn. The premise of Mezirow’s theory does not deviate too far from Dewey’s reflective thinking theory.

The early study of how animals and humans learn has sparked widespread study in generating more useful learning theories. The 1960s saw a proliferation of learning theories in the Western hemisphere. Rogers (1969, p. 5) explains how a learning theory can lead to effective learning by claiming:
Personal involvement: The whole person, including the person’s feelings and cognitive aspects, are involved in the learning event.

Self-initiation: Even when the impetus or stimulus comes from the outside, the sense of discovery, of reaching out, and of grasping and comprehending, comes from within.

Pervasiveness: Learning makes a difference in the behavior, attitudes, and perhaps even the personality of the learner.

Evaluation by the learner: The learner knows whether the learning meets personal need, whether it leads toward what the individual wants to know, and whether it illuminates the dark area of ignorance the individual is experiencing. The locus of evaluation, we might say, resides definitely in the learner.

Its essence is meaning: When such learning takes place, the element of meaning to the learner is built into the whole experience.

To Gagne (1972, pp. 3-41), an effective learning theory must lead to change in five domains of the learning process:

1. Motor skills: Which are developed through practice.
2. Verbal information: The major requirement for learning being its presentation within an organized, meaningful context.
3. Intellectual skills: The learning of which appears to require prior learning of prerequisite skills.
4. Cognitive strategies: The learning of which requires repeated occasions in which challenges to thinking are presented.
5. Attitudes: Which are learned most effectively through the use of human models and “vicarious reinforcement.”

Later, Gardner (1983) developed the theory of multiple intelligences that is widely applied in the field of teaching and learning. Easterners did not seem to have conducted as many experiments as Westerners regarding how humans learn. Their learning theories seem to have been derived from either Buddhism or Confucianism or from a combination of both. Today, open any textbook in the field of teaching or learning written by either Westerners or Easterners and there will be at least one or two prevalent learning theories expounded on with the intention to guide both educators and learners. With so many learning theories out there in the field, can educators and learners make a smart choice as to which ones to pick up and apply in practice? This remains a question to be addressed in the next section.

**ESSENTIAL COMPONENTS OF LEARNING THEORIES**

Researchers have made great efforts in their attempts to categorize learning theories. To date, educators and learners are not unfamiliar with the 11 categories identified by Hilgard and Bower (1966):

1. Thorndike’s Connectionism
2. Pavlov’s Classical Conditioning
3. Guthrie’s Contiguous Conditioning
4. Skinner’s Operant Conditioning
5. Hull’s Systematic Behavior Theory
6. Tolman’s Purposive Behaviorism
7. Gestalt Theory
8. Freud’s Psychodynamics
9. Functionalism
10. Mathematical Learning Theory
11. Information Processing Models

Prior to categorizing learning theories, Dewey’s pragmatism stood out as an effective learning theory that was widely accepted by both educators and learners. It must be pointed out that not all learning theories fall into certain categories. The beauty of categorizing learning theories will help educators and learners discern these theories. Otherwise, both educators and learners will get overwhelmed by the vast number of learning theories, wondering which ones to use to guide their action.

An important feature about learning theories is that any theory presupposes a more general model according to which theoretical concepts are formulated (Reese & Overton, 1970). Unless a general model is successfully derived from a learning theory, educators and learners may find it hard to apply in practice. Such is the case with the theory of transformative learning. Many people have heard of the theory, but do not have a clue as to how to apply it in practice. Wang and King (2006, 2007) developed a model out of an in-depth comparison between transformative learning and Confucianism. As
Fundamentals of Learning Theories

It is true that few people, other than theorists, ever get excited about theories (Torraco, 1997). This is because most people do not pay enough attention to learning theory fundamentals. If they do pay attention to the categories, the general models theories can generate and the roles and relationships learning theories can specify, people will find value in almost every existing learning theory. Besides, most theories, except those that are truly revolutionary, such as the contributions of Newton, Einstein, and Darwin, just do their jobs quietly behind the scenes (Torraco, 1997, p. 114). Once the learning theory fundamentals are applied, both educators and learners and even the general public can make the theories do their jobs out there in the open instead of behind the scenes. After all, theory is meant to be united with practice to guide one’s action (Elias & Merriam, 1995, 2005).

CONCLUSION

In the course of pursuing knowledge about learning theories, many learning theories have been generated and discarded. The ones that have endured are the ones that truly guide one’s action in learning. The theory of andragogy has endured because it has successfully explained how adults learn differently from children. The theory of transformative learning has endured because it can address how learners are engaged in perspective transformation via a disorienting dilemma. Gardner’s multiple intelligences theory has endured because one’s IQ score does not account for other

educators and learners ponder the model, they probably can relate to the theory, hence be able to apply it step by step. The model listed below (Figure 1) is a perfect example to show that a general model can be derived from any learning theories.

Yet, more importantly, good learning theories always specify the role of the educators, the role of the learners, and above all, the relationship between the educator and the learner. This line of thought has become important simply because more and more people buy into the concept that it is in relationship with others that humans learn. Human beings are often referred to as “social animals.” The theory of andragogy, for example, has clearly defined the role for teachers and learners and the relationship between teachers and learners. In order for adult learners to maximize learning, teachers are required to serve as learning facilitators, resource persons, and process managers instead of being information transmitters. This very role of the teacher specifies that teachers must release the energy of learners by encouraging learners to be self-directed. This very role of the learner specifies that learners cannot be submissive followers of their teachers. Learners must take the initiative to become self-directed learners and the relationship between teachers and learners is specified as a “helping relationship” instead of a “directing relationship” (Wang, 2005). Upon the basis of this analysis, it is natural to conclude that the theory of pedagogy (the art and science of teaching children) specifies completely different roles for teachers and learners and that their relationship must be a directing relationship given the nature of children.

Figure 1. Model of learning through critical reflection by Wang and King (2006, 2007)
intelligences that learners may have. The list can go on and on. However, the central point is no one can afford not to pay attention to learning theory fundamentals. Without these learning theory fundamentals, it is hard to learn to apply theories in practice. Theories are meant to be united with practice. But the learning theories fortified by learning fundamentals provide guiding principles from which people can successfully discern theories and hopefully apply them to practice. If learning is defined as a process that leads to a change in a learner’s disposition and capabilities that can be reflected in behavior (Gagne, 1985), then learning theories are meant to guide one’s learning. To understand how learning theories work, efforts must be exerted upon learning theory fundamentals. This article does not try to be exclusive. In fact, there may be other learning theory fundamentals that the author has unintentionally overlooked.

REFERENCES


**Fundamentals of Learning Theories**

**KEY TERMS**

**Buddhism:** Buddhism is a dharmic, nontheistic religion, a philosophy, and a system of psychology. Buddhism is also known in Sanskrit or Pali, the main ancient languages of Buddhists, as Buddha Dharma or Dhamma, which means the teachings of “the Awakened One.” Thus was called Siddhartha Gautama, hereinafter referred to as “the Buddha.” Early sources say that the Buddha was born in Lumbini (now in Nepal), and that he died aged around 80 in Kushinagar (India). He lived in or around the fifth century BCE, according to recent scholarship. Buddhism spread throughout the Indian subcontinent in the five centuries following the Buddha’s passing, and thence into Central, Southeast, and East Asia and Eastern Europe over the next two millennia.

**Connectionism:** Stanford Encyclopedia of Philosophy defines connectionism as a movement in cognitive science which hopes to explain human intellectual abilities using artificial neural networks (also known as “neural networks” or “neural nets”). Neural networks are simplified models of the brain composed of large numbers of units (the analogs of neurons) together with weights that measure the strength of connections between the units. These weights model the effects of the synapses that link one neuron to another. Experiments on models of this kind have demonstrated an ability to learn such skills as face recognition, reading, and the detection of simple grammatical structure.

**Functionalism:** Stanford Encyclopedia of Philosophy defines functionalism as the doctrine that what makes something a mental state of a particular type does not depend on its internal constitution, but rather on the way it functions, or the role it plays, in the system of which it is a part. This doctrine is rooted in Aristotle’s conception of the soul, and has antecedents in Hobbes’s conception of the mind as a “calculating machine,” but it has become fully articulated (and popularly endorsed) only in the last third of the 20th century. Though the term “functionalism” is used to designate a variety of positions in a variety of other disciplines, including psychology, sociology, economics, and architecture, this entry focuses exclusively on functionalism as a philosophical thesis about the nature of mental states.

**Gestalt Theory:** This refers to a school of researchers who maintained that phenomena could only be understood if they were viewed as structural wholes; they had a great influence on early learning theory.

**Learning Theories:** Learning theories deal with the ways people learn. There are a number of different learning theories in our society. For example, there are behaviorist, cognitivist, social, and experiential learning theories. All learning theories strive to lead to change in basically three domains: cognitive, affective, and psychomotor. Some theorists list more domains and others divide learning theories into different categories. According to this article, all learning theories may contain a general model that can be derived from learning theories if special attention is paid to observing these theories. Good learning theories determine the roles for the learners and the teachers and the relationships between learners and educators. Learning theory fundamentals help users of theories discern learning theories.

**Maslow:** Abraham Maslow (1908-1970), his primary contribution to psychology is his Hierarchy of Human Needs. Maslow contended that humans have a number of needs that are instinctive, that is, innate. These needs are classified as “cognitive needs,” “cognitive needs,” and “aesthetic needs.” “Neurotic needs” are included in Maslow’s theory but do not exist within the hierarchy. Maslow assumed needs are arranged in a hierarchy in terms of their potency. Although all needs are instinctive, some are more powerful than others. The lower the need is in the pyramid, the more powerful it is. The higher the need is in the pyramid, the weaker and more distinctly human it is. The lower, or basic, needs on the pyramid are similar to those possessed by nonhuman animals, but only humans possess the higher needs.

**Purposive behaviorism:** According to Tolman’s theory of sign learning, an organism learns by pursuing signs to a goal, that is, learning is acquired through meaningful behavior. Tolman (1948, p. 192) emphasized the organized aspect of learning:

*The stimuli which are allowed in are not connected by just simple one-to-one switches to the outgoing responses. Rather the incoming impulses are usually worked over and elaborated in the central control room*
into a tentative cognitive-like map of the environment. And it is this tentative map, indicating routes and paths and environmental relationships, which finally determines what responses, if any, the animal will finally make.

**Self-actualization:** The highest level of personality development and the realization of one’s own potentialities. See Maslow’s hierarchy of human needs.
INTRODUCTION

Robert Mills Gagne (1916-2002) was an American educator, experimental psychologist, and theorist, whose research led to the development of learning theories on instructional design and effective teaching practice. While serving as the Director of the U.S. Air Force’s Perceptual and Motor Skills Laboratory (1949-58), Gagne conducted a series of studies that culminated into his learning theory: *Conditions of Learning*. Out of this theory, Gagne formulated a model of direct instruction entitled the “Nine Events of Instruction.”

BACKGROUND

Educated at Yale (A.B. 1937) and Brown (PhD 1940), Gagne taught at Connecticut College for Women (1940-49), Penn State University (1945-46), and then at Florida State University. Initially a behaviorist, Gagne reinforced learning theories that involved conditioned responses and stimuli induction. Although he favored the theories of sequenced learning, Gagne’s views somewhat shifted after his work as the Director of the Perceptual and Motor Skills Laboratory of the U.S. Air Force (1949-58). In his early research for pilot training, Gagne observed the outcomes of sequenced learning events and evaluated the cognitive processes resulting from these events. Following a series of published articles examining isolated tasks within learning sequences, Gagne began to examine how external events contributed to the learning process. In 1962, Gagne published an article entitled, *Military Training and Principles of Learning*, in which he raised questions regarding how instructional design could better facilitate the process of learning.

In response to his own inquiry, Gagne published *The Conditions of Learning* (1965) which identifies the cognitive processes that occur in learning. Gagne’s work was primarily derived from his observations on information processing and cognitive mapping, and placed great emphasis on the acquisition of intellectual skills. To organize the discussion of his results, Gagne identified five taxonomies of learning: verbal information, intellectual skills, cognitive strategies, attitudes, and motor skills. Gagne argued that connections between internal and external conditions (found within each of the taxonomies) must be established to generate the desired response of learning. Gagne refers to internal conditions as the innate capabilities possessed by the learner whereas external conditions are independent in their action. In his view, Gagne argued that differences in the conditions for learning can lead to differences in the *types* of learning.

To identify the sequence of tasks needed to facilitate learning, Gagne suggests that activities for acquiring the intellectual skills needed should be organized in a hierarchy according to complexity. This hierarchy included the following: stimulus recognition, response generation, procedure following, use of terminology, discriminations, concept formation, rule application, and problem solving. In turn, the hierarchy could outline the conditions (external and internal) that need to occur to ensure learning takes place at each level. To illustrate his theory, Gagne (1970) and further updated by Gagne and Briggs (1974) outlined nine instructional events and corresponding cognitive processes that must occur for learning to take place:

1. Gaining attention (reception);
2. Informing learners of the objective (expectancy);
3. Stimulating recall of prior learning (information retrieval);
4. Presenting the stimulus (perception);
5. Providing learning guidance (encoding);
6. Eliciting performance (responding);
7. Providing feedback (reinforcement);
8. Assessing performance (assessment retrieval); and
9. Enhancing retention and transfer (generalization).
In turn, these “nine events” serve as the basis for designing instruction and selecting appropriate media (Gagne, Briggs, & Wager, 1992).

Gagne’s theory served as a building block for instructional design because it prompted learning theorists to re-examine existing models of practice. Applications of Gagne’s theory of learning included a large scale project entitled Science: A Process Approach (SAPA) as part of the American Association for the Advancement of Science (AAAS). Fields (2005) cites Gagne’s research as the foundation for problem solving and scientific inquiry in science texts well into the 1980s. According to Fields, Gagne (1965) argued that the process approach was the bridge between content understanding and creative ability. In turn, Gagne’s influence on science curriculum also contributed to the development of instructional programs for mathematics, computer programming, and instructional technology. Gagne’s research has also been applied to developing a design model for successful training in business and industry as well. More recent use of Gagne’s model has been applied to instructional design and information processing.

FOCUS

To understand the application of Gagne’s nine instructional events, it is necessary to explain how each of the events functions in the process of learning. The first instructional event that must occur involves getting the attention of the learners. Students are motivated to learn when they are curious. As the students express interest in the material, it is necessary to inform them of the learning objectives involved in the instruction. Objectives organize the instruction and serve as the basis for assessment. If students understand the objectives, they can be alert to the key elements of the instruction.

Once students are aware of the objectives, they also need to understand that participating in the learning activity will foster an outcome. The goal is to create a sense of expectancy for the learner. In Gagne’s view “expectancy may be established by telling a subject what will happen when he/she has completed a learning act” (p. 147). As students begin to learn new information, instruction should involve the recall of prior learning to establish a common foundation of understanding. It is easier for students to grasp information when there are connections made to their prior learning experiences. Simply doing a pre-test or pre-lesson assessment of the material will help the educator adjust instruction to accommodate students that need additional information to understand the new concepts. By assessing the knowledge base of students, the instructor can accommodate the lesson to meet the needs of the students.

The next learning event involves the actual presentation of content. To respond to different learning styles, educators should be prepared to present content in different modes or learning environments. Gagne’s early discussions regarding the significance of adaptable environments for learning are significant because they anticipate the modes of distance learning. These ideas also promote the importance of instructional design. As students work to learn the new information, guidance is necessary. Learning guidance serves as the next event of instruction. Guidance includes providing supplemental instruction, analogies, examples, and other devices to assist with the comprehension of information.

The next three events of instruction relate to assessment. Initially, to ensure the students are learning the material, they may be asked to practice this skill. Homework, quizzes, or discussion may occur to determine the level of understanding. Once an educator has determined if the students have understood the instruction, feedback is necessary to help students understand whether or not they have understood the material. Feedback should be immediate and formative. Educators should not wait until the end of a semester to determine whether learning has occurred. Multiple levels of assessment are encouraged, and summative assessment should occur when the educator believes the students have been given opportunity to respond to the formative assessment. The outcomes derived from the assessment of performance should also be used to modify instructional events (objectives, guidance, etc.). Finally, the last event of instruction is to reinforce the retention of information through application and transfer. An instructor may review the material that was learned in a lesson prior to the lesson being taught to ensure that the previous material has been recalled.

Although Gagne’s nine instructional events are presented in a sequence, it is important to note that the nine events need not occur in a single lesson, nor does the sequence of events have to occur in the exact order as listed. Denton, Armstrong, and Savage (1980) argue that Gagne’s intent was that these events should all be considered in terms of establish a framework for instructional planning. Kearsley (1994) emphasizes...
Gagne’s Nine Events of Instruction

that different learning activities will require varying sequencing of the nine instructional events. For example, if the students are studying for a test, the student may engage in the assessment events first, followed by a review of the material that was not understood and going back to practice the material to relearn it again.

FUTURE TRENDS

Although Gagne’s learning theory has been challenged by constructivist theorists, the “nine events of instruction” continues to serve as a primary model for some educators associated with instructional design and technology. Kruse (2006) notes that “applying Gagne’s nine step model to any training program is the single best way to ensure an effective learning program.” Gagne’s sequence of learning has been used in many teaching scenarios because it corresponds to cognitive levels of learning: knowledge, comprehension, application, analysis, synthesis, and evaluation. More recent applications of Gagne’s research have been found in distance education. Gagne’s early discussions of the modes or environments of learning have served as a foundation for understanding how different environments of learning require modifications of instruction.

CONCLUSION

Gagne’s work brought forth the understanding that different types of learning exist and that different instructional methods are necessary to ensure that learning takes place. Gagne’s nine events of instruction serve as a basic framework for instructional planning and has helped pioneer the emphasis on instructional design as it relates to improving the quality of teaching and learning. His views of the cumulative nature of learning and the internal nature of learning have no doubt fostered the research in cognitive psychology and problem-based learning. His work has been applied in models in instructional technology, concept mapping, computer-based training, and multimedia development. His study, Principles of Instructional Design (1988), is often listed as a primary reading source for program developers and database engineers.

Although Gagne’s designs have established foundations for training in terms of computer and instructional technology (design, programming), it does not allot for the interactivity of learning or learner-centered models that we know of today. In addition, specific research on the transitions between learning events is needed to determine if other cognitive processes occur during the sequence of learning. Gagne’s view that “the discussion class is not primarily concerned with learning at all, but with the transfer (generalizing) of what has already been learned,” does not necessarily support the tenets of reflective teaching. However, Gagne’s program of learning can be considered instrumental in terms of defining the process of instructional practice.

REFERENCES


Gagne’s Nine Events of Instruction

KEY TERMS

Conditions of Learning: Learning theory first developed by Robert Gagne that proposes a program for instructional design.

Curriculum: (Gagne’s definition) A sequence of content units arranged in such a way that the learning of each unit may be accomplished as a single act, provided the capabilities described by specified prior units (in the sequence) have already been mastered by the learner.

Instructional Design: The organization of material that identifies instructional goals, practice, and evaluation.

Learning Hierarchy: A structure of learning which organizes instructional tasks such that one can identify the final outcome.

Learning Process: The sequence of conditions (internal and external) that need to occur for learning to take place.

Nine Events of Instruction: Robert Gagne’s model for direct instruction which partners cognitive processes to external conditions in a sequenced hierarchy.

Robert Gagne: American educator, experimental psychologist, and theorist, whose research Conditions of Learning led to the development of learning theories on instructional design and effective teaching practice.
INTRODUCTION

Adults learning about digital imagery or digital imaging software to create and manipulate images for personal and professional purposes is increasingly popular. Since 2001, the Duquesne University course, Digital Imagery for Teachers, has been taught to adults who teach or present to other adults or children. The course focuses on helping participants create and edit digital images, create and animate illustrations in movies, and implement design concepts for creating Web sites for their own students. The software packages used are Adobe Photoshop, Macromedia Flash, and Macromedia Dreamweaver.

When teaching these software packages it is important to consider the needs of the adult learners learning technology. To meet both the needs of adult learners and address the demands of learning new technology, the Generative Learning Model has been implemented in this course.

BACKGROUND

The Generative Learning Model

The Generative Learning Model, developed by Merlin C. Wittrock in 1974, is a “cognitive model of human learning with understanding” (Wittrock, 1974a, p. 87). The model “implies that learning can be predicted and understood in terms of what the learners bring to the learning situation, how they relate the stimuli to memories, and what they generate from previous experiences” (Wittrock, 1974a, p. 93). The Generative Learning Model requires the learner to reflect metacognitively about what he or she has learned. The objectives of the Generative Learning Model are for the learner to actively participate in the learning process by generating meaningful relationships and transferring learning to new situations.

Human learning with understanding is a generative process involving the construction of (a) organizing systems for storing and retrieving information, and (b) the processes for relating new information to the stored information (Wittrock, 1974b, p. 182).

The Generative Learning Model focuses on how information can be first stored and retrieved, or recalled from memory, and related or transferred to new situations. This model also addresses the needs of adult learners learning new technologies by requiring them to:

- Be active in the learning process (Brookfield, 1986; Grabowski 2004; Johnson & Bragar, 1997, p. 366; Knowles, 1995);
- Realize that they are in control and are responsible for their own learning (Knowles, 1995; Williams, 1996);
- Link prior experiences to new learning (Knowles, 1995; Stilborne & Williams, 1996)
- Apply or transfer learning to his or her own set of situations (Johnson & Bragar, 1997, p. 366; Stilborne & Williams, 1996; Wlodkowski, 1999);
- Reflect upon what and how he or she has learned (Brookfield, 1986; Vella, 1994);
- Use higher order thinking skills (Pepicello & Tice, 2000; Wojnar, 2000);
- Develop the information processing capabilities of the learner (Higginbotham-Wheat, 1991, p. 54).

The model includes five major components based on neural and cognitive processes essential in learning: attention, motivation, knowledge, generation, and metacognition (Wittrock, 2000). In this model, the instructor constructs learning activities and opportunities so that students are directed or guided to what is important (attention component) and encouraged to pursue new learning by having the learner realize that he or she is capable and in control (motivation compo-
The learner’s prior experience is considered so that relationships can be made between this experience and new learning (knowledge component). The student is engaged in activities that “require the generation of learning between prior experience and new learning” (Wittrock, 1991, p. 176).

Finally, the students reflect on their own learning and realize what they have accomplished, and “when to use different learning strategies” (metacognition component) (Wittrock, 1990, p. 372).

The Generative Learning Model is a “teaching and learning model” (Maeder, 1995, p.2); that is, both the teacher and the learner play active roles in the learning process. Table 1 outlines the actions that both the instructor and the students take during the teaching and learning process according to the Generative Learning Model:

The generative learning activities that promote understanding among concepts presented in instruction include the following (Grabowski, 2004; Wittrock, 1991):

- Titles
- Headings
- Questions
- Objectives
- Summaries
- Graphs
- Tables
- Main ideas
Digital Imagery for Teachers

Digital Imagery is an elective course developed and taught by Maria Kish, Ed. D. for the Instructional Technology Program in the Education Department at Duquesne University, Pittsburgh, Pennsylvania. The program focuses on providing technology instruction to teachers in the K-12 environment, as well as those interested in teaching and presenting technology to adult learners.

In this course, participants are encouraged to be creative and responsible for developing materials for their courses. Participants are to develop an approach for learning software packages so that they are able to transfer their learning to future versions or similar software. This is significant due to the rapid changes in technology and the need to keep up with these changes so that they can get the most out of this technology when creating their own presentations. The digital imaging course competencies and objectives are as follows:

- Open, retouch, select, and edit areas of different digital images after learning fundamental editing skills.
- Obtain images by using a scanner or by downloading images from a digital camera.
- Create digital illustrations after learning basic drawing skills such as importing and editing clip art, selecting and altering lines and areas of an image, coloring and reshaping an image.
- Create a Web site using a list of fundamental design considerations, content requirements, and an understanding of hypertext markup language (HTML).
- Research and present information regarding a command or advanced procedure from one of the software packages covered in the course.
- Demonstrate their understanding of a software package by developing a guide to procedures and commands most often used.

CONSIDERATIONS FOR TEACHING DIGITAL IMAGERY WITH THE GENERATIVE LEARNING MODEL

Introduction to Digital Imagery for Teachers

The components of the model are addressed in the following ways when the course is introduced to the class.

The learner’s attention is first addressed when the instructor emphasizes the main purpose of the course is to help them gain the necessary skills to create their own images and Web presentations for either their personal or professional use. The course helps them learn different types of software packages, and not just the software packages covered directly in class. To make sure their professional and/or personal goals are addressed, a background questionnaire is provided and reviewed in class. This questionnaire asks students why they are taking the course, the type of computer used, previous experiences with the different software packages offered in this course (or similar packages), and what they would like to learn specifically about each software package. A syllabus is presented that includes course competencies, objectives, and the five learning assignments with due dates. While this syllabus is presented, the interests and goals of the students are also addressed.

The instructor focuses on motivating the students by explaining the different strategies and approaches to learn the software including tutorials offered online and in the actual programs, instructor’s notes, and texts. Then, the instructor presents a review of books that students would find helpful for the class; this is to meet the different learning styles/preferences when learning new technologies. The students are required to purchase one book per software package.

The instructor addresses student’s prior knowledge and needs with the background questionnaires. She explains that they already know about certain aspects of the interface of the software programs because of previous work with other types of software programs, such as Microsoft Word.
The students do not generate new learning until they begin working on the projects. Metacognition, or reflection on how one learns or thinks, is addressed when the instructor provides different examples of texts that the students can choose to work from during the course, based on their learning styles.

**Working with Photoshop**

The instructor explains that Photoshop is a software package that allows users to edit and combine digital images and to create image files ready for print or for publishing on the World Wide Web. It is explained that Photoshop is similar to other digital imaging programs such as Corel® Paint Shop Pro® Photo XI, ArcSoft PhotoStudio®, Microsoft Digital Image Suite, and Avisa® Photo.

After the students’ attention is addressed, the instructor motivates students by making sure they are able to follow along with her demonstrations of the software package and that they understand essential digital imaging concepts (such as pixels, the makeup of a digital image, and resolution). The instructor makes sure that any students’ questions are answered as soon as possible, and that they understand that at times, he/she has to approach the material at a slower pace so that everyone can follow along. To address other ways of learning the material, students are directed to other references such as tutorials available online, in the software, and in the book and course notes. The class notes are printed out and distributed before every class meeting so that the students can focus on working with the software package.

To build upon the knowledge of the students, they first learn and work through the user interface. As the interface is explained, the instructor emphasizes how aspects of this interface are similar to what students have seen previously in other software packages. The instructor focuses upon what students may have already done or seen at photo kiosks, such as rotating, flipping, and resizing an image. Other major topics covered in Photoshop include file management; creating, editing, saving, and loading selections; working with layers; working with text; managing the history palette; color management; resizing images; working with photo editing tools; compositing images; and optimizing images.

Students have different opportunities to generate their knowledge. The students receive several demonstrations of Photoshop, during which time they are required to replicate what the instructor does in Photoshop. Students are required to create to Photoshop posters that they can use to either teach or present information. Additional help notes, scoring guide and rubric are provided and explained for this assignment (and others) so that students understand the expectations of the assignment and how to go about completing the assignment.

To address the metacognition component, students are required to reflect upon their learning in two different ways. Participants reflect upon the main actions that they need to know to use Photoshop, and what they need to know when learning about later versions of Photoshop as well as other digital imaging programs. The major topics for Photoshop previously mentioned are highlighted again.

**Working with Flash**

The instructor explains that Flash is a software package that allows users to create, import, and animate vector graphics to create movies and graphics that can be easily published to the World Wide Web. It is explained that Flash is similar to other vector image editing programs such as Adobe Illustrator and CorelDRAW and animation programs such as Adobe LiveMotion.

After the students’ attention is addressed, the instructor motivates students by making sure they are able to follow along with her demonstrations of the software package, and that they understand underlying concepts such as the difference between vector and raster graphics. The instructor makes sure that any questions students have are answered as soon as possible, and that they understand that at times she has to approach the material at a slower pace. To address other ways of learning the material, students are directed to other references such as tutorials available online, in the software, and in the book and course notes. Again, students are provided a printed version of the course notes before class so that they can focus on working with the software during class. Students are shown several examples of Flash movies and animations that they may either find useful in incorporating into their own movies or viewing for different ideas regarding the subject matter they would find helpful to create for their own students.

To build upon the knowledge of the students, they first learn and work through the user interface. As the
Generative Learning Model to Teach Adult Learners Digital Imagery

interface is explained, the instructor emphasizes how aspects of this interface are similar to the interface in Photoshop, such as the menu bar, tool box, and panels. The instructor explains that certain concepts, such as layers, are present in both Photoshop and Flash, and that they can be renamed, moved, viewed differently, and so forth. Both Photoshop and Flash provide working files, in file formats PSD and FLA, respectively, that let the user make edits, and other file formats such as JPEG, GIF, and SWF, that show the final image or movie. The instructor focuses upon what students may have already done or seen on other Web sites. Major topics covered in Flash include the following: drawing graphics; working with text; selecting colors and creating and editing gradients; bringing in graphics from other applications and editing them; breaking apart graphics and text; working with the timeline and layers; creating and editing symbols; working with the library; creating animations such as frame-by-frame, motion tween, shape tween, and motion guide tween; and exporting GIF and SWF files (for graphics and movies, respectively).

To assist in the generation of their knowledge, the students receive several demonstrations of Flash, during which time they are required to replicate what the instructor does in Flash. Students are required to create an educational movie in Flash that they can use to either teach or present information.

Students reflect upon the main actions that they need to know to use Flash and what they need to know when learning about later versions of Flash, as well as other animation programs. The major topics for Flash previously mentioned are highlighted again.

Working with Dreamweaver

The instructor explains that Dreamweaver is a software package that assists in the development and management of Web pages and Web sites. Benefits to learning Dreamweaver include the following: file management for the Web site is efficient and easy; the HTML code generated is not cluttered with excess code, making it easier to debug a Web page when there is a problem; and the final published Web sites do not require a Web server that supports additional extensions to have some of the features work. It is explained that Dreamweaver is similar to other Web site creation programs, such as Microsoft FrontPage® and Adobe® GoLive®. Because many of the participants are required to work with Microsoft FrontPage, or at times, another Web page or Web site editing program in their profession, it is important for the instructor to emphasize the benefits of this program over other similar editing programs.

The instructor motivates students by making sure they are able to follow along with his/her demonstrations of the software package and that they understand underlying concepts, such as major parts of Web pages and sites and the difference between a Web page and a Web site. To address other ways of learning the material, the same techniques are used as described in the previous modules. Students are shown examples of Web sites so that they understand and/or receive a review of the different parts of Web pages and Web sites, and get ideas to consider for designing their Web sites.

As with the other software packages demonstrated in this course, students must first work through and become comfortable with Dreamweaver’s interface. As the interface is explained, the instructor emphasizes how aspects of this interface are similar to the interface in Flash. The instructor explains that if the participants are familiar with other Web site editors then certain functions, such as inserting and formatting text headings, inserting graphics and buttons, managing colors and page properties, and providing appropriate file names are the same. The instructor focuses upon what students may have already done or seen on other Web sites. Major topics covered in Dreamweaver include the following: defining and editing a site; creating and editing HTML files within a site; managing page properties; inserting and editing text; inserting graphics; inserting links; inserting, editing, and managing the layout of a page with tables; managing object properties; inserting Flash text, buttons, and movies; previewing a site and publishing a site.

To assist in the generation of their knowledge, the students receive several demonstrations of Dreamweaver, during which time they are required to replicate what the instructor does in Dreamweaver. Students are required to create a Web site that may either be an educational portfolio that presents all of their work, or a site that teaches different aspects of a subject, such as math or English. This site is to include the posters they create in Photoshop and the movie they create in Flash; in this way, they generate information among the concepts within the course.

Students reflect upon the main actions that they need to know to use different versions of Dreamweaver and other Web site editing programs. The major topics for
Dreamweaver previously mentioned are highlighted again.

**Other Major Assignments**

Aside from the three assignments required for the different software packages, there are two other assignments that focus upon transfer of learning: the quick start guide (sheet), and research of an advanced command.

A quick start sheet is a table that includes all of the major actions, commands, and procedures for a specific program. For this assignment, students are broken into three groups, Photoshop, Flash, and Dreamweaver, so that a quick start sheet is developed for each of the software programs. The goals of this assignment are to have students reflect upon and generate another form of their understanding of the software package, and to have a quick reference they can refer to after the course. At the end of the course, after all of the quick start sheets are submitted, the instructor reviews them for accuracy and sends everyone a copy for reference. To assist them in this assignment, the instructor has everyone in the class reflect upon the most important actions, commands, and procedures for each of the software packages. The instructor assists the groups in determining how to set up the guide so that the students within each group can decide upon documenting at least three actions for the quick start sheet. The instructor provides an example of a quick start sheet he/she developed for PowerPoint in another class.

The assignment focusing on the research of an advanced command requires students to find a command, not covered during the course, that he or she finds interesting. Students are required to provide the purpose, benefits, and the procedure for this command in a handout they distribute when they present the command to the class.

**CONCLUSION**

The Generative Learning Model has been used successfully in meeting adult learner’s needs in a digital imagery course. This includes addressing their previous knowledge, motivating and encouraging learners to understand how they learn and to take charge of their learning, helping students connect their prior knowledge to digital imagery concepts, connecting concepts among the digital imagery software packages covered, and transferring their knowledge to creating projects for their own students and to learning other versions of the software packages presented as well as software packages similar to the ones demonstrated in the course. Over the years, participants who have taken this class have found the information to be useful in one or more of these ways. The author believes that the Generative Learning Model can be implemented successfully into any computer software course to benefit adult learners.

**REFERENCES**


**KEY TERMS**

**Bloom’s Taxonomy:** Education classification system that focuses on the cognitive domain. This system includes the following levels, given in order from lowest to highest, of descriptions of desired student behavior: knowledge, comprehension, application, analysis, synthesis, and evaluation.

**Digital Imagery:** Working with digital images, including manipulating photographs, creating and editing line art, and presenting images in different formats (e.g., in movies and Web sites).

**Generative Learning Model:** A cognitive model of “human learning with understanding” (Wittrock 1974a, p. 87) that was developed by Merlin C. Wittrock in 1974, which focuses on considering the learner’s previous learning experiences and understanding so that the learner can actively generate meaningful relationships between this prior knowledge and new information.
Higher Order Thinking: Refers to the upper levels of Bloom’s Taxonomy, including application, analysis, synthesis, and evaluation.

Quick Start Sheet/Guide: A table that includes all of the major actions, commands, and procedures for a specific program.

Transfer: “occurs when a person’s prior experience and knowledge affect learning or problem solving in a new situation. Thus, transfer refers to the effect of knowledge that was learned in a previous situation (task A) on a learning or performance in a new situation (task B)” (Mayer & Wittrock, 1996, p. 48).
INTRODUCTION

When we collaborate, there is an interaction between two or more individuals who are working together to achieve a particular goal. “Teachers who use collaborative approaches tend to think of themselves less as expert transmitters of knowledge to students, and more as expert designers of intellectual experiences for students, as coaches or midwives of a more emergent learning process” (Smith & McGregor, n.d., ¶ 1). In certain environments, collaboration may be more difficult to achieve; it does not occur by simply putting individuals together and asking them to work collectively (Galagher, Kraut, & Egido, 1990). Friend and Cook’s (1992) definition of collaboration emphasizes goal orientation: “Interpersonal collaboration is a style of direct interaction between at least two co-equal parties voluntarily engaged in shared decision making as they work toward a common goal” (p. 5). Collaboration is further defined as “a process through which parties who see different aspects of a problem [or issue] can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible” (Gray, 1989, p. 5).

Collaboration simultaneously accentuates the group while paying homage to the individual as a member of the group. This involves valuing group function while continually seeking ways to support individuals in their collaborative process. Productive collaborations occur when individuals understand group processes and are able to function well in a value-laden but diversely rich community. Individual processing skills vary, but people often reason by putting small pieces together to make wholes. Meaning is derived from this process; however, group perception varies with the individual, and many different meanings are possible within a group. Varied perceptions and interpretations are rich attributes of a collaborative process that carefully examines information and ultimately provides a broader perspective.

In an educational environment, collaborators seek to actively involve individuals in a learning process. These individuals interact with each other, share ideas, seek information, verify information, make decisions, deliberate, and ultimately share their conclusions. Little (1987) observes, “The accomplishments of a proficient and well-organized group are widely considered to be greater than the accomplishments of isolated individuals” (p. 496). Group collaboration epitomizes the social nature of learning, emphasizing the importance of students working collaboratively in order to resolve problems, interact appropriately, and actively engage all group members. These joint intellectual efforts by students and teachers have experienced significant growth in recent years.

BACKGROUND

Educators are developing collaborative strategies with the advent of new technologies that are providing significantly enhanced platforms. The pursuit of improved methods of collaboration enhances learning as an interactive process based in communities of learning, where groups of individuals collaborate on matters of common interest (Moll, 1990). Technology will continue to refine group collaborations by offering a vast array of options that probe new depths of human interaction and understanding. In a setting of group collaboration, students can criticize their own and other students’ contributions, they can ask for explanations, they can give counter arguments and, in this way, they will stimulate themselves and the other students. Although each collaborative arrangement is distinct, they generally follow a common pattern where the group helps to illuminate the dynamics of collaboration. When a learning community increases its diversity of expertise and interests, individuals can advance their understanding by the increasingly significant knowledge base available to them. Group collaboration provides opportunities to share ideas, compare best practices, get questions answered, and collaborate.
While business selects collaborative tools that reduce costs and bring their products to market faster than the competition, education has a different purpose. Educational institutions must develop tools of collaboration that are pedagogically sound within an instructional delivery system that maximizes course underpinnings. New social norms are being defined by technology, as well as a new global interdependence, which educational institutions are just now beginning to realize (Cohl, 1996). Teachers utilizing collaborative methodology understand the evolutionary nature of the pedagogy, which requires practice, interaction, analyses, and modification (Rolheiser-Bennett & Stehahn, 1992). Linden (2002) mentions four challenges to collaboration as individual, organizational, societal, and systemic. Educational institutions of higher learning must be prepared to meet each of these challenges as they compete for students in an increasingly competitive and networked society. Group collaborations within this new context are a result of, and a response to, the complex needs of students whose technological knowledge and skills are quite advanced. Students can help structure the class experience through suggestions regarding class format and procedures. This is a level of student empowerment, which is unattainable with a lecture format or even with a teacher-led whole class discussion. Both businesses and institutions of higher education can utilize collaboration as they acculturate individuals into learning communities that work for improvement.

The Philosophical Bent of Group Collaboration

Group collaboration is a philosophy, not just a classroom technique. Philosophy in its purest form is an attempt to understand the world. It is the foundation by which people view the nature of things, learning to incorporate their intellectual, epistemological, and ethical considerations. As a comprehensive system of ideas about human nature and the nature of the reality, philosophy determines perspective and how people interact. Researchers have an interest in the philosophical bent of group collaboration, which examines how individuals view themselves, how they see others, and the processes they adapt. Philosophy is, moreover, essential in assessing the various standards of practice implemented by members of a learning community individually and collectively. Audi (2001) observes, "Wisdom, leadership, and the capacity to resolve human conflicts cannot be guaranteed by any course of study; but philosophy has traditionally pursued these ideals systematically, and its methods, its literature, and its ideas are of constant use in the quest to realize them" (p. 5).

When individuals get together in groups, it is important to respect and recognize individual group members’ abilities and contributions. Collaborative efforts require sensitivity to the diverse nature of its membership (Chang, 1993). There is an underlying premise of group collaboration, which requires consensus building through cooperation by group members. Teachers/facilitators learn to apply a philosophical approach in collaborative communities as a way of understanding, appreciating, and learning from other people. Learning is a process of participating in cultural practices, a process that structures and shapes cognitive activity (Lave & Wenger, 1991). It begins with an introspective examination of self to fully understand the lens through which we view the world. Our perception of other people is a deeply intrapersonal process. Nin (1961) states, “We don’t see things as they are, we see them as we are” (p. 124). In our own lives we are impacted by our human nature, demeanor, personal experiences, self-perceptions, and various interpretations, all of which help form our perceptions of people. To a remarkable extent, our perceptions define us (how we think, how we understand, and how we interact with people). Learning how to respect all voices in the group, as well as understanding one’s self, is an essential part of living in a collaborative community. Dewey (1929) notes that “true education comes through the stimulation of the student’s powers by the demands of the social situations in which he finds himself” (p. 3).

Constructivism is a philosophy of learning that has been associated with sociology, anthropology, cognitive psychology, and education. The tenets of constructivism fit nicely within the pedagogy of group collaboration. The construction of knowledge takes place in a social context, such as might be found in the activities of group collaboration. Students acquire knowledge, connect it to previously assimilated learning, and, in this process, construct their own interpretation. Students learn to process information and create new ideas. This intellectual processing creates and nurtures information that is consensual, meaningful, and effective. By processing information cooperatively, students learn to become
adaptive learners. They make quick application of what they learn in real-world, and often real-time, scenarios. Collaborative pedagogy does not dictate one specific approach to group work; rather the group members are responsible for creating what is needed for them to collaborate. Group members must evolve the structure and processes to remain relevant and functioning.

**Group Collaboration as a Phenomenon**

It is the dynamic of group interaction that creates phenomenon. Adams and Hamm (1996) state

> Using collaborative learning activities means structuring student interaction in small, mixed-ability groups, encouraging interdependence, and providing for individual accountability. By taking part in cooperative experiences, students are encouraged to learn by assimilating their ideas and creating new knowledge through interaction with others. (¶ 1)

The extent to which collaboration takes place in an educational environment ranges from minimal, where schools attempt to be collegial in their practices, to higher levels, where groups replace traditional methodology in place of a unique dynamic that maximizes both technology and group interaction.

Collaboration is a unique group phenomenon, unique in the sense that it blends the contribution of individuals within a group dynamic. It is a fusion of intellectual and social processes that creates a mosaic of shared ideas. Most definitions include commonalities such as shared goals, division of labor, collective ownership, empathic understanding, trust, exploratory processes, and the prospect of individual and institutional learning. When students begin to plan together, they create interdependence with the group. Students learn by combining what they know with what others know. This is the basis for the evolution of ideas and collaborative learning. Strengthening these initial efforts, the teacher/facilitator nurtures the group phenomenon by reinforcing one another’s teaching.

To study the phenomena of group collaboration, one has to realize that people, like networks, come in all shapes, sizes, and configurations. This diversity requires participants to be careful about how they teach or share concepts with each other. Steinfield (n.d.) addresses collaborative groups by noting, “It is important to provide a robust communication and collaboration infrastructure with features that address critical dispersed group needs” (¶ 11). In *Built to Last*, Collins and Porras (1994) note the importance of “shared meaning” in a survey of highly successful companies. Adherence to a mutual understanding of processes was essential to keep companies focused on purpose and mission. (Gray, 1989) sees collaboration as a process of negotiation among stakeholders. This theory emphasizes the temporary and emergent nature of collaboration as participants work out details for moving forward with a shared project or activity. Knowing that other individuals are relying on you is a powerful motivator for group work (Kohn, 1986). Goodlad (1994) and Frieri (1971) have long advocated dialogue among stakeholders’ groups. Through communication, a common understanding can be built which will empower groups to be more conciliatory and facilitative in their actions. The development of this common understanding allows change to occur. Common understandings that guide individual actions will produce new knowledge and behaviors resulting in changed culture. The experience of group collaboration should be characterized by what Oldfather (1994) identifies as “sharing the ownership of knowing” (p. 12).

**The Impact of New Technologies on Group Collaboration**

Advances in technology make a paradigm shift in group collaboration not only possible, but also necessary. However, Young (2002) notes that the convergence of classroom and online education is the single greatest unrecognized trend in higher education today. While collaborative, face-to-face planning, learning, and work are features of a school culture that assumes collective responsibility for learning, technology will increasingly be the means for new and varied forms of collaboration. Garmston and Wellman (1999) note that an adaptive school is one that not only meets today’s challenges but can also effectively handle problems that emerge in the future.

The process of using technology to improve learning is never solely a technical matter, concerned only with properties of hardware and software. Like a textbook or any other cultural object, technology resources for education function in a social environment, mediated by learning conversations with peers and teachers. (Bransford, Brown, & Cocking, 1999, p. 218)
An institution’s self-interest may be mutual with the students it serves, and if so, strategies can be implemented to advance both. This advancement requires faculty and institutional transformation through participation in collaborative evolutions. Gilroy (2001) notes, “E-learning should be first and foremost about creating a social space that must be managed for the teaching and learning needs of the particular group of people inhabiting that space.” Institutions of higher learning are becoming increasingly dependent upon group collaborations, where students interact in a culturally disparate but tech-savvy environment. Lipnack and Stamps (2000) define online collaboration as “a group of people who interact through interdependent tasks guided by a common purpose” and function “across space, time, and organizational boundaries with links strengthened by webs of communication technologies” (p. 18).

Glotzbach (2006) addresses the changing nature of collaboration by identifying characteristics of the “self-directed innovator,” whom he states is more progressive than the mere “knowledge worker” of the 1990s. Collaboration stirs innovation. The self-directed innovator has an incessant need for information but is not process driven. These individuals collaborate with a broad network of friends, and there tends to be an intermingling of personal and professional life as they process information for both home and the workplace. Career and personal life are managed and advanced through social relationships because what is done with others is always social in today’s world. Terminology varies, but some refer to the combination of traditional and online collaborative learning as a blended methodology. “Blended learning, the integration of classroom learning with online or technology-supported learning activities, is on the rise…faculty members from a range of disciplines are viewing blended models as part of a teaching continuum to improve learning outcomes” (Owston, 2006, ¶ 5).

The emerging paradigm laments even the most recent strategies, which advocate a standardization of groupware. Boyd (2006) states

The individual is the new group…while I am instant messaging a buddy about work related issues, I may veer off into personal issues. I am constantly switching context while in communication with individuals, and real-time communication supports that directly and it is natural to do so. (¶ 6)

The old system of standardization, which required specific groupware platform and applications, is outdated. Boyd (2006) continues by saying, “I envision a time where even in the largest organization, our lives as individuals will define the norm for computer-assisted work” (¶ 9). The individual as the new group is an oxymoron with great significance for both the teacher and researcher. Research efforts in the future will be directed toward the development of a prototype electronic environment that captures individuality within a framework of group interaction.

Teachers/facilitators will increasingly evaluate pedagogy in relation to emerging technologies and a more sophisticated, tech-savvy student. Students will increasingly expect institutions of higher learning to take the lead, to know and be responsive to expectations for group participation and performance. Employers will seek students who are comfortable building a framework of collaboration and who are knowledgeable of collaborative values and emerging technologies.

CONCLUSIONS

Professionally designed collaborative efforts will continue to enrich academic life.

Philosophically, group collaboration is rooted in the social construction of knowledge, which advocates student ideas, experiences, and perspectives, as an essential and ongoing process of the learning community. When teachers and students are able to create such a community they achieve their goals through knowledge, communication skills, and an understanding of others as well as self.

Successful group collaborations are a unique phenomenon in which members adapt a philosophical approach to self, others, and the processes of their learning community. Group members became quite adept at the negotiation of ideas, decisions, and the division of tasks. To be successful, collaborators must know the dynamics of the collaboration process and be prepared to cope with collaboration’s challenges as well as reap its rewards. A strong collaborative ethic in higher education among teachers and students provides an increasingly productive support network.

Group collaboration is an evolutionary process as teachers and students utilize technologies that continue to refine pedagogy. The teachers’ expertise in designing intellectual experiences that enhance learning is
Group Collaboration in Education

critical. Group collaboration will continue to experience dramatic growth through Web-based systems as dispersed teachers and students create cultures dedicated to the collaborative learning processes that are both socially and intellectually stimulating.

There are three imperatives for a learning community to collaborate in the fullest sense. First, understand the philosophical nature of collaboration which requires an introspective examination of self and appreciation for the processes of human nature that shape a specific culture. Second, just like the individuality of mankind, collaborations are a unique phenomenon shaped by human nature, circumstances, and the needs of a group. In this respect, collaborations will vary in meaning, quality, and usefulness just as the ever-changing dynamics of a group bring newness. Third, technology is redefining pedagogy as individuals learn innovative ways to communicate and interact. This breeds a new type of tech-savvy student.

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**KEY WORDS**

**Collaboration:** Collaboration enables key stakeholders to share information by working together cooperatively. It is both a process and end result.

**Communities of Learning:** Communities of learning gravitate to knowledge or practices they consider important. A sense of community occurs because learners are socially engaged in a valued process of learning.

**Constructivism:** A learning theory that suggests individuals create their own knowledge when encountering something new. Knowledge is therefore temporary, individually constructed, and socially reconciled.

**E-learning:** A general term used to refer to technology-enhanced learning. It includes the delivery of learning content via Internet and emerging technologies.

**Epistemology:** A branch of philosophy that relates to the nature of knowledge. Basically, it is how we know what we know; an examination of our intellectual framework.

**Platform:** Platform refers to the specific combination of hardware and/or support software for a particular activity.

**Social Environment:** The physical surroundings, social relationships, and cultural setting within which certain groups of people function.
**INTRODUCTION**

*Group decision support systems* (GDSSs) which aim at increasing some of the benefits of collaboration and reducing the inherent losses are interactive information technology-based environments that support concerted and coordinated group efforts toward completion of joint tasks (Dennis, George, Jessup, Nunamaker, & Vogel, 1998). The term *group support systems* (GSSs) was coined at the start of the 1990’s to replace the term GDSS. The reason for this is that the role of collaborative computing was expanded to more than just supporting decision making (Patrick & Garrick, 2006). For the avoidance of any ambiguities, the latter term shall be used in the discussion throughout this paper.

If we trace back, GDSSs are specialized model-oriented *decision support systems* (DSSs) or management decision systems that were born in the late 1960s. By the late 1970s, a number of researchers and companies had developed interactive information systems that used data and models to help managers analyze semi-structured problems. From those early days, it was recognized that DSSs could be designed to support decision makers at any level in an organization. DSSs could support operations, financial management, and strategic decision making.

**BACKGROUND**

In the early 1980s, academic researchers developed a new category of software to support group decision making. Execucom Systems developed *Mindsight*, the University of Arizona developed *GroupSystems*, and researchers at the University of Minnesota developed the *SAMM system* (Power, 2003). These are all examples of early GDSSs. The increased need for GDSSs arises from the fact that decision making is often a group phenomenon, and therefore computer support for communication and the integration of multiple inputs in DSSs is required. The desire to use GDSSs therefore comes from the need of technological support for groups.

GDSSs are designed to remedy the dysfunctional properties of *decision-making groups*. These systems are becoming popular in aiding *decision* making in many organizational settings by combining the computer, communication, and *decision* technologies to improve the *decision*-making process. These systems use a key tool to improve the quality of *decisions made by a group*. This key tool is the anonymity of members of a *decision-making group*. The purpose of GDSSs is to maximize the benefits of group work, while minimizing the dysfunctions of group work. This maximization and minimization can be made possible by GDSSs mainly by two factors: anonymity and parallelism.

**MAIN FOCUS**

*Strengths and Weaknesses of GDSSs*

GDSSs provide a lot of support for communication, deliberation, and information flow especially for group activities that may be distributed geographically and temporarily. Group work has numerous benefits and advantages. First, groups are better at understanding problems and catching errors than individuals. Second, a group has more information than any one member which when combined can create new knowledge. Third, working in a group stimulates creativity and synergy. Finally, groups balance out the risk-tolerant and risk-averse. GDSSs offer many benefits. First, GDSSs support parallel information processing, parallel computer discussion, and generation of ideas. Second, they promote anonymity, which allows shy people to contribute and helps prevent aggressive individuals from driving the meeting. Finally, these systems help
keep the group on track and show the big picture. The two keywords here are parallelism and anonymity (Turban, Aronson, & Liang, 2005).

Some of the potential dysfunctions of group work are not automatically eliminated by GDSSs. First, as mentioned earlier, groupthink is where people begin to think alike and not tolerate new ideas. We can also include inappropriate influences, and free-riding. Second are the lack of coordination, excess time consumption, poor quality solutions, and nonproductive time. Third are the duplication of efforts, and high cost of meetings, including travel. Finally, information overload, concentration blocking, and group misrepresentation add to the potential dysfunctions of group work. Process dysfunctions are caused by structural characteristics of the group setting that could hinder a group from reaching its full potential. Process dysfunctions hinder productivity because of unequal participation or unequal air time; this happens in a setting where only one person can take control of the floor. This sort of dysfunction can be countered by the use of computerized exchanges because people may enter their comments and thoughts simultaneously. Power (2003) states that simultaneous expression of ideas may be beneficial for the quantity of ideas generated because of the computer’s capacity for concurrency. Finally, process dysfunctions are usually caused by limitations in the structure and form of meetings.

Social dysfunctions, as Power (2003) describes, can hinder group productivity through undesirable social processes that occur in the group. For example, a group may limit the quality and quantity of input from any of its members by social processes such as evaluation apprehension, conformity pressures, free riding, social loafing, cognitive inertia, socializing, and domination due to status imbalance, groupthink, and incomplete analysis. These problems arise from processes present in all groups and are rooted in the ways in which group members change their behavior to adapt to the group. Finally, the prevalent analysis of group decision making is that social influences within the group lead the rational individual astray.

The view of GDSSs portrayed by Power (2003) is that they are text-based tools made with the purpose ofremedying some problems of decision making in co-present groups. These systems claim to remove the social obstacles that prevent individuals from attaining their full potential in the group. Anonymity is central to achieving this full potential of individuals in a group.

Recent GDSSs Research Findings

Decision-making in an organization today has become more the work of some form of group. Whether this group is a board, team, or a unit, important issues can be at stake. It is fair to ask, given the possible problems that occur in a group setting: Would the group setting have a negative effect on the quality of decisions that have to be made by the group? Current research in this area suggests that GDSSs, if implemented and used correctly, can improve the quality of group decision making significantly by minimizing the negative effects of group decision making and by maximizing the benefits of group collaboration and decision making.

Having come a long way since their inception, current and previous research efforts have made significant findings on the effects of the numerous criteria that affect the decision-making process in a group setting while using GDSSs. The results show that while the Internet has made it easier and less costly to use GDSSs than ever before, the social effects of group decision making can have a significant effect on the quality of decisions made in a group setting using GDSSs.

By manipulating things such as visual cues, group versus individual-based incentives, anonymity, group size, feedback, leadership role, communication mode, type of tool used, social presence, face-to-face versus distant, shift work or non-shift work, the fit between facilitation style and agenda structure, and finally, a relationship versus a task focus, it is possible to significantly impact the quality of decisions made by a group using GDSSs.

According to Barkhi, Jacob, and Pirkul (2004), GDSSs are divided into two groups: distributed GDSS (DGDSS) and face-to-face GDSS (FGDSS). DGDSS groups consist of members who use a GDSS at the same time but at different places. On the other hand, FGDSS groups consist of members who use a GDSS at the same time and same place. The authors studied and compared the decision process and outcomes of groups that use FGDSS to those that use DGDSS. The results indicate communication mode, and incentive structure can influence the effects of each other. Therefore, the appropriate design of incentive structures may be important to the success of virtual organizations.
The Web-based multi-criteria group support system (MCGSS) according to Zahir and Dobing (2002) is designed so that users can enter their preferences in an easily understood and user-friendly interface through a Web browser. They state that easy-to-learn and user-friendly interfaces are essential if GDSSs are to become more commonly used in organizational decision making and that MCGSS uses a new visual mode of preference entry. The relative importance of any two objects is expressed through a pair of side-by-side bars drawn in a graphical window. The ratio of the heights of two bars represents the user’s relative preference for the two objects. Bar heights can be adjusted dynamically by dragging the mouse or utilizing some other device. Their article presents the design of a Web-based MCGSS that can be used by a group of geographically dispersed decision makers. This system takes advantage of Internet technology and enables a novel procedure to aggregate intensities of preferences.

In line with Kim (2006), the role of leadership facilitates group processes by adding structure to group interaction. The effects of leadership on group performance in GDSSs settings still remains one of the least studied areas of GDSSs research. An analysis of comments by group leaders show that they are more efficient when making comments on group objectives and interaction structure, but this is only true in the early stages of group interaction. In the later stages, it is of increasing importance that group leaders make comments that encourage interaction and maintain cohesion between members of the group. Dennis and Wixom (2001/2002) presented a meta-analysis investigating five moderators. These moderators are as follows: tool, the type of group, task, the size of the group, and facilitation. The authors studied their effects on GDSSs. Results of the study draw multiple conclusions. First, process satisfaction is less for decision-making tasks than it is for the idea-generation tasks. Second, the GDSS tool itself influences decision quality. Finally, the authors conclude that group size is an important moderator when it comes to measuring satisfaction with the process and decision time.

Rutkowski, Fairchild, and Rijsman (2004) demonstrated experimentally that in the context of dyadic conflict, patterns of interpersonal communication, supported by a particular GDSS technology, affect the quality of decision making. The authors find that GDSSs are efficient tools that support inter-group communication and relations. The authors also delve further into this topic and discuss the implications of their research on the study of intercultural negotiation and conflict resolution. Groups are becoming increasingly important in organizations, and that they use electronic groupware to facilitate communication and workflow. Barkhi (2005) compared the performance and information exchange truthfulness of groups under these various experimental conditions. The author utilizes a game theory perspective to study the behavior of members in these groups. The results indicate that communication channel and incentive structure mitigate strategies that lead to decision choices and information exchange truthfulness among members in a group.

GDSSs can improve communication and learning as demonstrated by Bandy and Young (2002). Their study examined the impact of two collaborative technologies and a priming agent upon communication complexity and learning style in a group decision-making context. Findings revealed that communication complexity was significantly greater in groups using a GDSS compared to groups using a simple chat system, suggesting that characteristics of the GDSS served to structure discourse among group members. Burke (2001) examined how GDSS learning environments (face-to-face vs. distant) and task difficulty level (simple vs. difficult) influenced participation levels and social presence among accounting students working collaboratively on an accounting task.

Hostager, Lester, Ready, and Bergmann (2003) examined the effects of agenda structure and facilitator style on participant satisfaction and output quality in meetings employing GDSSs. This study indicates that GDSS facilitators should try to find a fit between their facilitation style and the agenda structure, while not forgetting to adopt either a relationship or a task focus and ensuring that they are consistent with their choice. A GDSS is designed as an analysis tool to support the decision processes of a group. Inherent in the design is the developer’s desire to make the basic meeting process better either by increasing process gains or reducing process losses. Further, it is suggested by Martz and Sheperd (2003) that one way that GDSSs attack these losses is by providing immediate feedback.

**GDSSs in the Real World**

There are options for setting up GDSSs technologies. One of them is in a special-purpose decision room, another is at a multiple-use facility, and the third is a
Facilitating Meetings

One example of the use of GDSSs is the system developed by a group of researchers from the University of Arizona to facilitate the organization of meetings. A typical meeting room consisted of a microcomputer for each participant, as well as a large projector for the display of either individuals’ work or the combined results off the group efforts. A typical meeting consisted of a three-tier process consisting of electronic brainstorming, idea generation, as well as voting. Under the electronic brainstorming phase, all group members typed at separate terminals using electronic brainstorming software, and recorded their ideas regarding questions posed for the day. Even though these sessions were anonymous, everyone could see the abundance of ideas. Additionally, an issue analyzer assisted the group in identifying and consolidating key ideas generated from the idea generation. Finally, a voting tool provided various methods for prioritizing key terms. Here, even though voting is anonymous, the results are readily displayed for all to view. This GDSS by Nunamaker, Briggs, Mittleman, Vogel, and Balthazard (1996/1997) was used at an IBM site. It was found that process structure helps focus the group on key issues and discourages irrelevant digressions and unproductive behaviors.

Web-Based GDSSs

A Web-based GDSS is a GDSS built with Web technologies so that the users access with Web browsers through Internet connections (Chen et al., 2005). In addition, Web-based GDSS applications that are developed by companies may be deployed on company intranets to support internal business processes or can be integrated into public corporate Web sites to enhance services to trading partners (Power & Kaparti, 2002).

Most Web-based GDSSs are currently individual DSS systems (Bharati & Chaudhury, 2004). On the contrary, Web-based GDSSs provide a broader approach to solving complex problems that are less structured. As noted earlier, there are a few Web-based GDSSs and one of them, GroupSystems, is a local area network-based client-server that exists for online collaboration (Chen et al., 2005). Several commercially available Web-based GDSS products also contain decision-making tools. One such product is FacilitatePro 9.0, which provides support to the group decision-making process with tools that facilitate brainstorming, idea generation, organization, prioritization, and consensus development (Facilitate.com, 2006).

Distance Learning

Several courseware packages facilitate distance learning. They range from such tools like Blackboard, through Microsoft NetMeeting, to PlaceWare Virtual Classroom. Distance learning can be an effective learning tool, and many corporations have taken advantage of it mostly through Web-based streaming and other private company intranets. Distance learning therefore acts as a strong collaborative and knowledge management tool and is accessible every hour of the day.

GSS for Political Events

The multi-faceted use of GDSS is reflected in the dynamism inherent in organizational structures. For instance, political risk associated with corporations’ decisions to expand internationally could be alleviated using GDSS. This is because the key to analyzing political events is obtaining good information about these events. GDSS thus provides higher reliability in accessing this needed information, through anonymity, simultaneity, and documentation features that are lacking in face-to-face interactions. Among other advantages, anonymity offers participants a greater degree of freedom in expressing their thoughts, and presents them with a greater sense of confidence to be more critical. Blanning & Reinig (2005) suggest a two-characteristic framework depending on whether analysis of the event under consideration is static or dynamic, as well as whether the analysis is one-dimensional or multi-dimensional.

FUTURE TRENDS

GDSSs are transforming into GSSs and the same ideology used for enhancing group meetings is being used in other areas as well. The idea is not just to increase the effectiveness of decision making, but to incorporate the current improvements in communication technology to redefine collaboration. Anonymity is also becoming more and more widespread in this new Internet
culture; its effects on collaboration are very interesting as shown. The findings presented in this paper uncover the social effects that might affect group work. These findings can also be applied to other fields in which collaboration is experiencing growth as in education and social networking. By combing the Internet, emerging technologies, and the findings in social behavior as they relate to group work, with the exploding growth currently being experienced in communication, the results and the rate of introduction of new ways of collaborating will be absolutely amazing.

CONCLUSION

GDSSs, if implemented and used correctly, can improve the quality of group decision making significantly by minimizing the negative effects of group decision making and by maximizing the benefits of group collaboration and decision making. GDSSs have come a long way since their inception. Current and previous research efforts have made significant findings on the effects of the numerous criteria that affect the decision-making process in a group setting while using GDSSs. The results show that while the Internet has made it easier and less costly to use GDSSs than ever before, the social effects of group decision making can have a significant effect on the quality of decisions made in a group setting using GDSSs. By manipulating things such as visual cues, group versus individual-based incentives, anonymity, group size, feedback, leadership role, communication mode, type of tool used, social presence, face-to-face versus distant, shift work or non-shift work, the fit between facilitation style and agenda structure, and finally, a relationship versus a task focus, it is possible to significantly improve the quality of decisions made by a group using GDSSs.

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KEY TERMS

Distributed Group Decision Support Systems (DGDSS): Groups consisting of members who use a GDSS at the same time but at different places.

Face-to-Face Group Decision Support Systems (FGDSS): Groups consisting of members who use a GDSS at the same time and same place.

Group Decision Support System (GDSS): Can also be referred to as a GSS or an electronic meeting system. A GDSS is characterized by being used by a group of people at the same time to support decision making.

Group Polarization: The tendency of people to become more alike or extreme in their thinking following group discussion. It is also the phenomenon that is generally considered decision bias.

Group Support Systems (GSS): Any combination of hardware and software that enhances group work. GSS is a generic term that includes all forms of collaborative computing.

Multi-Criteria Group Support Systems (MC-GSS): GSS designed so that users can enter their preferences in an easily understood and user-friendly interface through a Web browser.

Social Presence: The degree to which people establish warm and personal connection with each other in a communication setting. Changes in the level of social presence can affect group communication.

Time/Place Framework: A framework for classifying IT communication support technologies. The matrix consists of four possibilities: same time/same place systems, same time/different place systems, different time/different place systems, and different time/same place systems.
Humanistic Theories that Guide Online Course Design

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INTRODUCTION

Humanism comes from one of three schools of psychology in which theories are categorized. The other two schools are the schools of behaviorism and cognitivism. It is believed that one school of theory is not better than the other, and individuals are encouraged to apply the theory that is the most appropriate for the student. Theories from the school of humanism focus on students’ affective needs which means that the theorists center their attention on feelings, emotions, values, and attitudes (Tomei, 2007). Colonel Parker, once deemed the Father of Progressivism of the nineteenth century by John Dewey, promoted creating curriculum with the child at its center. He wanted the school to be a replica of home, an inclusive community, and a budding democracy for the students. Parker’s work and thought on curriculum would eventually be an apparent part of John Dewey’s progressive work (Pinar, Reynolds, Slattery, & Taubman, 1996).

Years later, G. Stanley Hall fervently criticized a report created by the Committee of Ten that promoted fitting children in a learning mold that consisted of canned subjects that were meant to be taught to all students in the same way without individualization of any kind. Hall rejected these ideas, because he believed that changes in society evolved slowly and that genetics not surroundings impacted students. Unlike Parker’s push for individualization so that every child’s needs could be met, Hall believed in individualization so that the gifted child would stand out. Eventually, Hall’s critics who saw no need for social reform labeled his laissez-faire ideas as disastrous (Pinar et al., 1996).

Then, during the 1950s, theorists such as Elliot W. Eisner, Ross Mooney, and Paul Klohr expressed their views concerning curriculum and the need of the educator to design curriculum that focused on self-value. Finally, during the 1960s, humanism began to be thought of as the third psychological orientation that followed theories of behaviorism and cognitivism. At this time, Carl Rogers and Abraham Maslow, respected humanistic psychologists, began to contribute papers on humanism which provided the field with an alternative educational view. The change that began to occur was considered to be a paradigm shift in which theorists moved from an interest in curriculum development to an interest in understanding curriculum. It was antiwar efforts and political unrest that helped drive the interest in a curriculum that focused on the self (Pinar et al., 1996).

Researchers noted that in 1975, McNeil presented four conceptions of curriculum: the humanistic, the social reconstructionist, the technological, and the academic curriculum conception (Pinar et al., 1996). The humanistic view brought back the facet of progressivism that looked to child-centered and individual-focused learning experiences. This came as the social reconstructionists tried to bring about societal reform through school reform.

HUMANISTIC THEORIES AND ONLINE DESIGN

When we look at the past, we see that theorists such as Elliot Eisner and Elizabeth Vallance thought of schooling as a way for individuals to gain personal fulfillment. They thought of it as a means to provide a way for people to discover and create their own identities. Curriculum, at that time, had the responsibility of fostering personal development in many different ways. Theorists began to present their theories through models of teaching and learning (Pinar, et al., 1996). For example, the phenomenal field theory, self-actualization theory, theory on nondirective teaching, theory of moral development, theory of immediacy and social presence, and cooperative learning theory came about.

Phenomenal Field Theory

A humanistic theorist named Arthur Combs presented his phenomenal field theory with psychologist Donald
Snygg. According to this theory, they postulated that to understand human behavior, the time must be taken to consider the point of view of another. They believed that if one wanted to change another person’s behavior that he or she must first modify his or her beliefs or perception. One had to “walk in their shoes” if one wanted to understand and guide change. By taking this line of thinking, educators had to recognize that the learner needed to find meaning and understand the learning as opposed to learning and understanding the strategies (Boeree, 2007; Tomei, 2007).

Combs and Snygg felt that if they were to understand and foresee the behavior of another that they had to reach into the person’s phenomenal field. Since it was impossible for them to physically look into another person’s mind, they had to make inferences from what was observed. When educators utilize this theory, they cannot choose a topic of instruction and a strategy, implement the learning experience, and expect every child to be motivated by what has been placed before them, because the information does not connect to their own lives. Instead, the educators have to get to know the learner’s phenomenal self and create learning experiences that have meaning to the learner. Once instructors take this path, the student that was not motivated to learn at one time will become connected to the learning experience (Boeree, 2007; Tomei, 2007).

**Self-Actualization Theory**

Nearly forty years ago, Abraham Maslow and Carl Rogers presented their ideas about personal growth and performance in connection with individual differences in how individuals respond to their physical and social environment. Other theorists who based their theory in the other schools of psychology focused on ability and development. Other theorists who based their theory in the other schools of psychology focused on ability and development. Maslow and Rogers focused on an individual’s view of his or her self. Maslow believed that strong beliefs about ones self was connected to the thought of self-actualization. According to his thinking, individuals with strong self-actualization interacted well with others, and they found ways to develop and contribute to the world around them fairly easily. Those who did not have strong self-actualization choose to live within their environment and accept what comes their way, instead of reaching into their environment and making new opportunities happen for themselves. People of this nature are less secure with themselves in their environment and their ability to succeed. Maslow believed that every individual had a force within that either sought or shunned growth (Joyce, Weil, & Calhoun, 2000; Pinar et al., 1996; Tomei, 2007).

For people to reach the level of self-actualization, they had to be fulfilled at each level of what Maslow referred to as the hierarchy of needs. The first level was the biological level. At this level, an individual’s need for food and shelter had to be met before the individual could move to another level. At the next level, the individual would have to feel secure. Level three of the hierarchy of needs demanded that the individual felt as though the individual belonged and was loved. Needs for self-respect, achievement, attention, and recognition needed to be fulfilled if an individual was to move past the esteem level of the hierarchy. When an individual had past each of those levels, the individual had reached the final level, the level of self-actualization. At this point, the individual’s ability to reach potential could take place. While each level had to be fulfilled, they did not have to stand alone and one behavior could satisfy more than one level on the hierarchy. Instructors who utilize this theory when designing and conducting a course look to see if their students needs have been met to help them understand student behavior (Joyce et al., 2000; Pinar et al., 1996; Tomei, 2007).

**Nondirective Teaching Theory**

Carl Rogers believed that in order for people to grow, they needed positive relationships with other people. Instructors who have utilized this theory nurtured their students instead of controlling the learning experience. The nondirective procedure required the teacher to guide students to explore new information and experience new occurrences in the world around them. According to this theory, students and their teachers are partners in learning (Joyce, et al., 2000). Rogers believed that all humans had an innate drive to learn. He felt that when a student viewed the learning as valuable that the experience would be valuable to the student. Educators were expected to create a threat free learning environment where students could initiate learning, and they could think metacognitively about their own learning needs. Teachers were seen as facilitators in the nondirective teaching approach (Joyce et al., 2000; Tomei, 2007).

**Theory of Moral Development**

Lawrence Kohlberg developed the theory of moral development. According to Kohlberg, individuals moved through different stages that defined their own
perception of justice. He presented three levels from which he believed morals developed. The first level, the preconventional level, was divided into two stages. At this level, individuals responded to the cultural rules and labels of good and bad or right and wrong. During the first stage of this level, the individual’s moral judgment was motivated by a need not to be punished. An individual’s moral judgment was impacted during the second stage by the need to satisfy personal desires. The second level of the moral development theory was the conventional level. At this level, honoring the expectations of ones family, friends, or others in society determined the individual’s development. This phase also contained two separate stages. The first stage from the second level held that individual and moral judgment was impacted by the need to avoid rejection, disaffection, and disapproval. The second stage at this level showed moral judgment to be impacted by ones need to not be criticized by others. The third phase of this theory was the postconventional stage. During this stage, individuals tried to describe the morals and values that they felt were valuable. Individuals from this level of moral judgment tend to be influenced by community respect and a need for social order. Those at the second stage from the third level found that their moral judgment was motivated by their own conscience. Instructors who integrated this theory in the curriculum guided the learners to look at their own moral situation, and they lead them to recognize how they justified their moral position. Critics of this theory have indicated that it is difficult for a teacher to apply this theory during instruction because the students were all at different levels of moral development (Joyce et al., 2000; Pinar et al., 1996; Tomei, 2007).

Theory of Immediacy and Social Presence

A model of online learning which presented the significance of social presence during asynchronous computer mediated discussion was presented by Rourke, Anderson, Garison, and Archer (2001). They held that learning took place through the interaction of three core components: cognitive presence, teaching presence, and social presence. A more in-depth look was made by the researchers of the social presence response and was presented as affective responses, interactive responses, and cohesive responses (Martyn, 2004). These responses were used as indicators by Rourke et al. (2001) when analyzing content during their exploration of computer mediated discussions and affective behaviors among participants. Learners’ perceptions were an important factor that instructors kept in mind when designing online courses, because learners’ perceptions influenced their behavior. Two behaviors that have had an impact on interaction are immediacy or quick response to an act or question and social presence referred to a learner’s skill of visually and affectively interacting in the learning environment whether it be done synchronously or asynchronously.

After administering a questionnaire, researchers found that perceptions of interaction had an influential effect. In the case of this study, the teacher’s perceptions of the interaction influenced how the students perceived the actual interaction which in turn influenced the teacher’s perceptions of interaction. Based on the results of the study, self-assessment and self-reflection on the part of the teacher for the purpose of modifying the actual interaction was necessary if the teacher wanted to change the perceptions of interaction in the classroom. If perceptions were adjusted for the better then circular communication processes developed so that behaviors were influenced to be more interactive (Fisher, Richards, & Newby, 2001).

Predictors of learner satisfaction were explored by Gunawardena and Dupaorne (2000) in a study that focused on the academic computer conference environment. Of the influential factors that they investigated in the study, comfort with participating in discussions, easiness with communicating with text, and assurance with presenting ones self into a computer mediated discussion were some of the variables that significantly impacted learners’ perceptions. Results pointed to the understanding that learners’ social presence was effected by students’ perceptions of preparedness and that course design and immediacy on the part of the instructors attended to familiarize the learners with online features, computer mediated discussion learning approaches, as well as the tools and abilities that they needed to feel ready to participate in a discussion.

Murphy (2004) presents sharing personal information, recognizing group presence, communication appreciation towards other participants, expressing feelings and emotions, and expressing motivation about a project or participation as indicators of social presence in a computer mediated discussion that promoted collaboration. Social presence existed as a lower level thinking ability on the online asynchronous discussion.
model that was designed and presented by the researcher. Social presence was a significant engagement that the researcher found to exist during a computer mediated discussion. It was a skill or behavior that learners needed to accomplish before they could move to the higher levels of Murphy’s design model.

Cooperative Learning Theory

Five facets of the basic elements of cooperative learning were presented to help others understand how to design learning experiences that utilized cooperative learning theory. Positive interdependence took place when students worked together, and they perceived that they were moving toward the same goal. Direct interaction occurred when students discussed what they planned to do and how to go about it. Individual accountability brought individuals to master learning while sharing and working with others. Attaining collaborative skills involved individuals working together before they could cooperate and learn. Finally, group processing took place when the individuals in the group discussed and evaluated their work. Upon evaluation, the group members found that they worked well together. Instructors who have applied this theory would guide their students through each facet of the model. The more students developed, the better that worked in a cooperative learning situation (Joyce et al., 2000).

Teaching Tips

Instructors who utilized humanistic theory were advised to use developmental psychology as a guide for adjusting instruction so that the students were asked to perform at their own developmental level. Some instructors found that once they had identified their students’ developmental level of ability that they should not expose the students to the higher levels of instruction. Other instructors believed in instructing just above the students developmental level because the students were not ready. Joyce et al. (2000) indicate that instructors should not underestimate an individual’s mind. They felt instructors should remember that students need hands-on experience to help them understand the concepts.

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Humanistic Theories that Guide Online Course Design

**KEY WORDS**

**Behavioral Theory:** Behavioral theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of behaviorism hold that the environment has an impact on learning and that all behavior is learned.

**Cognitive Theory:** Cognitive theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of cognitivism guide students to process information in ways that are meaningful to the student. These theories are based on declarative and procedural learning tasks that are authentic.

**Humanistic Theory:** Humanistic theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of humanism focus on learner’s affective needs that include their feelings, emotions, values, and attitudes.

**Instructional Design Theory:** Use of theory by professionals when designing, developing, managing, and evaluating a learning experience.

**Online Instructors:** Qualified individuals who have had the schooling or training to teach or guide learners to gain new knowledge and abilities in an online learning environment.

**Online Learning:** A form of learning in which learners interact with each other and the instructor through either asynchronous or synchronous modes of learning.
Immersive Learning Theory: As a Design Tool in Creating Purpose-Built Learning Environments

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**INTRODUCTION**

This article explores an application of immersive learning theory in an Australian secondary school. The emphasis in this study is on the development and implementation of a learning environment that encompasses four essential learning elements: immersion, engagement, agency, and risk (Blashki, Nichol, Jia, & Prompramotes, 2007; Nichol & Blashki, in press). The following documents the impact of a “purpose-specific environment” (Blashki, 2000) created at Karingal Park Secondary College (KPSC) and referred to as the max learning space. The max learning space (“The Max”) was constructed, both physically and pedagogically, upon the precepts of immersive learning for year 7 students to enhance and support their initiation into secondary school learning.

The max learning space was established at KPSC to create engaging, immersive, and interactive learning experiences for students, assist them in the transition from primary to secondary school, and enhance and support the development of a range of skills such as independent inquiry, higher order thinking and “interpersonal reasoning and social interaction” (Kirkely, 2004, p. 321). Such an environment is expected to more appropriately prepare students for their future tertiary study, social and work experience, and lifelong learning rather than the traditional classroom setting.

Immersive learning aims to employ a learner-centred approach that supports learners to participate directly and implement engaging and interactive learning activities. The underlying philosophy of immersive learning emerges from, and is inspired by, a number of seminal theoretical approaches, including: Piaget’s constructivist theories that view learners as active participants in the construction of knowledge (Newby et al., 2000; Savin-Baden, 2000); Papert’s constructionist approach which focuses on social engagement among learners in sense making activities (Harel & Papert, 1991); Vygotsky’s emphasis on building social cultural activities to achieve effective learning (Newby et al., 2000; Vygotsky, 1978); and Maslow’s assertion that humans naturally need to learn and strive to increase their intelligence. In addition, the immersive learning model builds upon Boekaert’s (1997) self-regulated learning that places the learner in control, the American Psychological Association’s (APA) (1993) learner-centered principles which acknowledge the learner’s active role, and Bandura’s (1977) social cognitive theory which perceives learning as a three-way interaction among the environment, personal factors, and behaviour (Ainley & Patrick, 2006; Bandura, 2001; Bonk & Cunningham, 1998).

In application, immersive learning has been implemented with great success in higher education (Blashki, 2000; Blashki & Nichol, 2006). Blashki has established various studio environments incorporating immersive learning principles at both Deakin and Monash Universities in Melbourne, Australia, and results indicate increased motivation, retention rates, and performance.

However, researchers are still in the nascent stages of exploring this innovative theory, and there are many complex and interesting issues still to explore. To research these issues will not only enrich the field of understanding of teaching and learning practice, but also benefit implementations which connect theory, research, and practice. Moreover, there has been little work in the
ways in which secondary students might benefit from this innovative learning theory. This article aims to focus on exploring a purpose-built interactive learning environment at KPSC. More specifically, this article will examine the use of immersive learning as a design tool in creating the physical learning environment, and the ways in which such a learning environment might impact on teaching and learning.

BACKGROUND

Learning environments are instructional strategies. Teachers’ choices about the types and organization of learning environments are choices about what and how students will learn. (Norton & Wiburg, 2003, p. 271)

The Max immersive learning environment was funded by a grant from the State Government and the design was developed by a collaborative team comprising of the teaching staff that would use The Max, and the research team. Completed in early 2007 for the incoming year 7 students at KPSC, the environment was named “The Max” because of the maximum benefits it was believed it would have for the students. The physical architecture of this space reflects design principles governed by the four immersive learning principles discussed in detail later. The physical space is open and, more importantly, without imposing structures or boundaries as impediments to the free flow of space, an important and active part of the teaching/learning process. It was important that the physical environment supports and reflects the values of the research and teaching team; an opportunity for active, interactive, and social learning practice.

The arrangement of furniture and other resource materials in The Max is nonlinear, often appearing to more traditionally oriented teachers as “random” and “chaotic.” Students and staff co-operatively determine the placement of furniture and so forth “on the fly” or according to the demands of the current activity. At any one time approximately 100 students will be participating in a variety of different subjects: math, integrated studies, science, literature, and so forth, with each group comprising of approximately 20 students dependant on the student’s willingness to participate and staff selection. In the initial session students are introduced to the pedagogic concepts in plain language and are encouraged to take “ownership of the learning space.” While the space accommodates at least 100 students at any time there are only 25 computers set up in the space. This is to emphasize that the technology is merely a tool in the same way as books, pencils and paper, and not to be relied upon to do the “thinking” for them. Each student has been allocated a user name and password in order to conduct research, or work collaboratively with one or more students to explore a topic. They do not need to sign in to access these computers, and they can use the technology at any school time (including after class) to access these facilities. All computers are connected to the World Wide Web, thus students have free access to the Internet. In one corner of The Max is a television and VCR set, which serves the dual purpose of teaching resource and recreational pastime. During work time students need to request to use it if it is not related to work currently being undertaken.

Throughout the space there are many areas students can post their work: notice boards, whiteboards, and walls around the space are available for students to use for display. These displays comprise of not only print, but also pictures, booklets, newspapers, maps, students drawings, and charts. Student work is everywhere. In addition, there are two specific corners which display the results of competitions: one based on student’s self-evaluated reading score (a poster indicates the appropriate levels) and one based on a staff record of students who exhibit appropriate behaviours such as providing help to others or by contributing to the community (The “star of the week” and a picture will be posted on the wall).

As Norton and Wiburg (2003, p. 258) suggest, a quick survey of a learning space “gives one a good indication of the kind and quality of literacy being produced.” The setting of The Max ensures that students have easy access to all learning materials and tools but also encourages sharing, collaboration, and group activities. Moreover, similar to Blashki’s “studio environment,” The Max also aims to bring students into a community and establish stronger connections between “experience, knowledge and practice” (Blashki, 2000).

WHAT IS AN IMMERSIVE LEARNING ENVIRONMENT?

An immersive learning environment is a space for explorative play; a learning space rather than a teaching
An immersive learning environment is a student-centred environment, with an emphasis on active and interactive learning. It epitomizes the central tenet of a constructivist approach, where the student comes to know and understand the world, not by the transmission from one (the teacher) to another (the student), but rather by interacting with it.

As Norton and Wiburg (2003, p.32) suggest, the constructivist notion of learning rests on four central tenets. First, knowledge depends on past constructions, where learners must interact with their learning environment and construct their own learning and make sense of their experiences. Second, through active construction of their own meaning of the world, learners develop a higher-level theory or logic to encompass the information. Third, learning is an organic process of invention, where learners must actively engage in “sense making” activities in order to formulate their own understanding of the world (construct knowledge). Lastly, meaningful learning occurs through constant reflection and resolution of cognitive conflict, where learners either rely on self-evaluation strategies to do so, or rely on assistance from teachers.

In such constructivist, learner-centred environment, students not only develop co-operative and collaborative work skills but also learn to work independently, that which Vygotsky (1978) terms the learner’s “zone of proximal development.” Students learn not only from their own (first-person) experiences but also learn from the stories of others’ (third-person) experiences (Herrington & Herrington, 2006).

Immersive learning as educational practice thus encourages students to engage in critical reflection on their individual learning experiences (Mezirow, 2000), which in turn may lead to transformation of their beliefs, attitudes, and emotional reactions to any future learning.

Figure 2 illustrates the immersive learning model used in this study. Within

The Max, a specifically designed learning space, students play a central role in their own knowledge acquisition. The conceptual and physical design of such a space is premised on the four immersive learning elements: immersion, engagement, agency, and risk/creativity.

- **Immersion**: The active involvement of physical, emotional, and cognitive processes and concentration
- **Engagement**: The ability to attract and sustain the user’s prolonged interest
- **Agency**: The user’s active control over the learning and playing process
- **Risk/creativity**: The ability to move beyond the expected and experiential boundaries of stasis and safety required in order to overcome habits

(Blashki et al., in press; Nichol & Blashki, in press)
than in subjects driven by the specifics of syllabus requirements. That the intellectual structures are built by the learner rather than taught or imposed by a teacher should not imply that they are built from “nothing.” Such an environment aims to support the student as they contemplate, articulate, design, and construct their own intellectual structures, drawing upon their surrounding environment and their experientially gained knowledge. The environment thus places the learner in a qualitatively new kind of relationship to knowledge.

During their journey the learner is encouraged to nurture and develop the skill of recognizing and selecting a variety of alternatives for optimum learning. Students are encouraged to think about and articulate their habitual routines for acquiring knowledge and contemplate new ways of learning that best suit their individual needs for both content and structure of knowledge. Therefore, the acquisition of knowledge is transformed and the student engages in a more active and self-directed learning process.

**IMMERSIVE LEARNING: HOW DOES IL WORK?**

**Students in ILE**

Students are encouraged to explore and further determine the methods they use when confronted with the “unknown,” such as a new word, idea, or skill. Importantly they are not provided with, nor do they require, traditional judgements of progress such as “correct” and “incorrect,” as they have the responsibility to continually assess and justify their choice of action and response. Such self analysis empowers students to arrive at their own conclusions regarding the appropriate, rather than “right” or “wrong” response/answer.

Experiential “training” within the environment quickly familiarizes the student with the most reliable and functional response/action to a given situation. The student thus constructs knowledge in the course of actively engaging with it in a constructivist and fully immersive learning process. This natural, spontaneous learning that the students encounter in interaction with the environment, contrasts radically with the more traditional, curriculum-driven classroom.

Inevitably, such educational expectations can (and do) engender fear and anxiety in both students and staff. Learning is supported and enhanced by risk-taking and further by creativity. Not surprisingly many students retreated from the “freedom” of setting their own learning boundaries, preferring the safety of stable knowledge, “answers” that they need for the “exam” at the end of the term. Many demand to be taught the software, the specific programs/tools, and the “facts” which they perceive are essential in order to complete the required tasks that they set for themselves. Undeniably, first term is a difficult transition for students as they grapple with an entirely unconventional (to them) mode of learning and the difficulties of transition to secondary schooling and the accompanying emotional and biological changes they are undergoing. Conversely, many students revel in their first taste of what they perceive to be educational “freedom,” unearthing new abilities and talents previously constrained by traditional classroom practice. This self-validation is enabled by both the immersive learning environment and also the acknowledgement of the value of peer support and community building. Once students understand that ownership and the responsibilities of the space really do rest with them (after an incredulous few minutes), their continuous interaction with the environment, teachers, and other students creates an atmosphere in which they feel safe and secure within this carefully supervised “comfort zone.” Moreover, within this familiar environment, and with teaching staff and other students they know, students can test ideas and practices without fear in the immersive learning environment.

**Teachers in ILE**

An integral component of The Max is that students feel both ownership and responsibility for the physical learning space in which they work. Clearly this directly challenges the teacher’s traditional claims of authority and power. Within such a student-centric environment teachers inevitably face the intimidating responsibility of forging their own philosophy of education and necessitate a metacognitive awareness of one’s own pedagogic practice. Moreover, for many (if not most!) staff new work skills are required. Of the seven staff involved in The Max, six of them were initially very hesitant claiming that they had neither the skills nor the time to devote to what they perceived as “difficult,” “intensive,” and “hard” teaching. New methods and new content may need to be acquired and written which inevitably directly impinge on both precious preparation time and personal teaching preference. However
it also enables teachers to be more expansive in their teaching, to allow for multiple perspectives, and to value the diverse learning styles utilised by students. After 3 months in The Max at least six of the original seven are delighted with the changes wrought in both their teaching practice and their interaction with the students. Other staff at the school, not currently involved in The Max, are keen to be involved as they witness the re-energising of their colleagues’ teaching practices and attitudes.

Within the environment the relationships between teacher/researcher and student, content and assessment are constantly under negotiation. Traditional “chalk and talk” practices of teaching are out of place, challenged by the student’s own discovery of knowledge.

FUTURE TRENDS

Future research into immersive learning theories and environments (ILE) might usefully look towards the incorporation of online learning communities, such as the online learning community of games students at Deakin University, the subject of a study by Nichol and Blashki (2006). Within this community immersive learning has been implemented to enhance and expand the students’ already self-regulated learning within a social and perhaps more youth-friendly context. During the course of their degree studies the students have access to online communities in conjunction with their face-to-face studies of games. Results indicate that the augmentation of classroom learning with an immersive online environment, over which the students have co-operative control, enhances the development of creativity and risk taking in the learning process. The implication of these online environments to ILE requires further investigation.

CONCLUSION

Immersive learning environment factors not only effect what teachers do but also how students learn (Schunk, 2004). In a supportive, engaging and playful learning environment, students generate the energy. They activate their brains, challenge others ideas, have meaningful conversations, and ask questions. Most importantly, they are “doing it”—trying out skills, recalling and reflecting upon previous experiences, making connections based on what they already know, arriving at assumptions and examples, and attempting to resolve problems by themselves (Silberman, 1996). For many students, meaningful learning occurs in relation to a group process (Savin-Baden, 2000): an individual “making sense,” “connecting,” and “seeing things in a new way” by establishing an authentic dialogue within a group context. Learning with, and through others in a group context enables individuals to reflect on prior experience and connect with their life-world experience, and it facilitates the construction of meaning premised on current or previous concerns. In such an environment, new learning opportunities may occur in “informal” ways that reflect a social learning experience or community activity. It is interesting to note the ways in which students in The Max learn to value their own experiences when they are validated by others within the group. It is hoped that with support and nurturing, students will eventually not require peer validation to legitimate their thoughts, ideas, and feelings.

Students do not simply learn the thing they are studying at the time, they also learn about people, contexts, likes and dislikes, and most importantly themselves. (Savin-Baden, 2000, p.55)

Savin-Baden’s “dimensions of learner experience” might be usefully invoked as an evaluation method to investigate the year 7 students and staff experience in relation to their perception of themselves, the learning environment, and their learning outcomes. The framework has three dimensions:

1. Personal stance: the way in which staff and students see themselves in relation to the learning context and give their own distinctive meaning to their experience of the context.
2. Pedagogical stance: the ways students see themselves as learners.
3. Interactional stance: the ways students work and learn in groups and construct meaning in relation to others. (Savin-Baden, 2000, p. 55)

Further research into the changing patterns of behaviour, attitude, and performance in both staff and students over the next 2 years will assist in establishing the impact and long-term benefits of immersive learning environments.
Immersive Learning Theory

REFERENCE


KEY TERMS

Active Learning: Variously described as comprising a type of instruction that teachers employ to involve students during the learning process. It is often associated with the term “learning by doing” and often contrasted with less active forms of instruction (Bonwell & Eison, 1991). In the context of this study, it actively encourages and involves the student in the process of knowledge production and acquisition.

Agency: Whereby the student/learner has active control over the learning process and can effect change over the content, structure, and outcomes of the learning process.

Authentic Learning: Authentic learning allows students to explore, discover, discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that
are relevant and interesting to the learner. (From: M. Suzanne Donovan, John D. Bransford, and James W. Pellegrino (Eds.), How People Learn: Bridging Research and Practice.) In this study the authors would also add that authentic learning describes learning that resonates with the student’s particular search, interest, and/or needs.

**Constructivism:** Is a perspective that considers knowledge as a “construction” according to the particular experiences, ideas, and bias of the learner. Thus knowledge is not granted any external “transcendent” reality, that is, it is not integral, but rather is premised on conventional acceptance perception, assumption, and social experience. It is also a widely held pedagogic theory espoused by many respected researchers and practitioners such as John Dewey, Jean Piaget, Jerome Bruner, Herbert Simon, and so forth.

**Immersive Learning:** In the context of this study, immersive learning embraces a “philosophic” approach which accords learners with agency over their own learning process; that is, learners have the ability to choose their own learning destiny, with control over the decisions they make (and learning by the mistakes), and to manage, structure, and control the learning objectives, delivery, and outcomes.

**Learner-Centered:** Learner-centered concepts are teaching practices that are premised on recognition of the student/learner as the primary focus of the generation and exploration of knowledge/curriculum. Learner-centric practices value the exploratory and past experiences of the student/learner and the student/learner’s attempts to grapple with the transition of knowledge from unknown to known. In this study the authors understand learner-centred practices to be the preferred method of working with students in an immersive learning environment.

**Self-Regulated:** Self-regulated can be used to describe learning that is premised on metacognitive strategic actions such as planning, monitoring, and evaluating personal progress against a standard, and a motivation to learn (Butler & Winne, 1995; Winne & Perry, 2000; Perry, Phillips, & Hutchinson, 2006; Zimmerman, 1990).
Impact of Technology

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INTRODUCTION

Technology plays a critical role in modern society. Everyone is touched by the power of technology in some way, large or small, good or bad, every day (MacKenzie & Wajcman, 1999). While few people would argue the importance of technology in our society, there is a great deal of debate about whether technology has had a profound impact in the fields of education and training. That debate is made even more confused by the great difficulty in separating the effects of any technology from the societal, political, technical, and economic contexts in which the technology is developed and used (Pool, 1997; Tiles & Oberdiek, 1995). Another key issue confusing the debate is the problem of fairly and accurately assessing the impact of technology, especially in educational settings. On a more philosophical level, there is debate about the very nature of technology, the extent to which technology is under human control, and, ultimately, whether technology has a positive or negative impact on human society.

BACKGROUND

Prior to discussing how technology impacts modern society, in general, and education, specifically, it is important to discuss what is meant by the terms technology and impact. Technology can be defined narrowly or broadly. In narrow terms, technology can be defined as any thing or tool employed for a practical use. A saw, a hammer, or even a rock are examples of simple technological tools. A broader definition of technology would include the associated technical and social systems in which a technological tool is used (Hughes, 1996). For example, an automobile is, in itself, a tool, but to fully understand the function and impact of the automobile, one must understand all of the social, economic, political, and industrial systems that influence how automobiles are developed, used, and valued. An even broader definition of technology would emphasize the importance of science and systemic knowledge to the development and use of technological tools and systems (Cardwell, 1995). Returning to the automobile example, the broadest definition of technology would include the scientific, industrial, and managerial theories and practices needed to design, build, distribute, sell, drive, park, maintain, and dispose of automobiles. To summarize this point, a narrow view of technology would limit discussion to specific technological artifacts while a broad view of technology would include a discussion of the socio-technical systems in which the artifacts exist, as well as the theoretical and applied knowledge needed to develop and use the artifacts.

Impact is not a simple term with one universally accepted meaning. Like technology, the term impact can be defined narrowly or broadly. Viewed narrowly, technology’s impact on learning can be defined as increased test scores or improved attendance rates. Viewed more broadly, impact can be defined as a transfer of learning into improved behavior (Kirkpatrick, 2005). This type of impact is harder to determine. The broadest type of impact, and still harder to determine, can be defined as technology playing a pivotal role in school reform and, ultimately, societal improvement.

Difficulty in assessing impact. It is extremely difficult to adequately measure the impact of any technology, even if we define impact very narrowly. One cause for this is the inherently complex and interconnected nature of technology. It is often impossible to separate a single technology from the many other technologies, systems, and theories associated with that technology. This separation problem is especially prevalent when assessing the impact of learning technologies. For example, school improvement initiatives often include the use of new technologies in conjunction with changes in administrative practices, new teaching techniques, modified curricula and schedules, improved community partnerships, and other changes (McNabb, Hawkes, & Rouk, 1999).

Another difficulty in assessing the impact of technology in learning is the interaction between instructional methods and media. As Westra (2004) writes, “edu-
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cational innovation is a diverse and complicated field of action . . . it concerns a mix of new developments in pedagogy and technology” (p. 502). Determining how much of the impact of an innovative learning technology is the result of the technology itself and how much is the result of the underlying pedagogical method is a daunting task. There is a heated debate in the educational literature about whether different media technologies possess certain unique attributes that enable them to impact learning in unique ways or whether the media are merely vehicles by which instructional methods are conveyed (Hastings & Tracey, 2005; Surry & Ensminger, 2001).

A final difficulty in adequately assessing the impact of technology is the lack of well-designed, long-term research studies reported in the literature. This problem is especially prevalent in the area of research related to the impact of learning technologies. Reeves (1995) writes that much of the research in this area is fundamentally flawed due to a variety of problems including specification error, superficial treatments, small sample sizes, and other issues.

IMPACT OF LEARNING TECHNOLOGIES

While it is a complicated task to adequately assess the impact of learning technologies for all the reasons discussed in the previous section, it is possible to draw some tentative conclusions. The literature is filled with reports detailing the impact of learning technologies in a wide variety of areas. Some of those studies, representing an impossibly small fraction of the literature, will be discussed in this section.

Has technology had a major impact on the field of education? There is no agreement on the proper answer to that important question. For example, Guthrie (2003) writes that “electronic technologies have not yet had a profound effect on formal education” (p. 57), while Culp, Honey, and Mandinach (2005) point to “past successes, often unheralded, where technology has had a significant impact” (p. 303). Peck, Cuban, and Kirkpatrick (2002) take something of a middle ground reporting that technology has had a profound impact on a small minority of students while having little or no impact on others.

For the purpose of this discussion, we will use a broad view of technology when discussing the impact of learning technologies. The term learning technologies, when used here, will refer to the tools used to develop and deliver instruction as well as the sociotechnical systems in which the technologies are used, and the knowledge necessary to effectively use the technologies. Learning technologies are designed, developed, and used in a complicated sociotechnical system and require a considerable amount of theoretical and practical knowledge in order to be used effectively. It is inappropriate to view the impact of learning technologies in simplistic or isolated terms. The impact of technology on learning can be viewed in pedagogical, political, practical, financial, organizational, and individual ways. Given the complexity of learning systems and the highly contextualized nature of education, no single study can definitively prove the impact of technology on the learning process. In this section, the tangible and intangible impacts of learning technologies will be discussed.

Tangible impact. The tangible impacts of technology are those that result in specific, measurable outcomes. Learning technologies appear to impact the field of education and training in a number of tangible ways. Perhaps the most commonly discussed type of impact on learning is student achievement. Wenglinsky (2006) calls student achievement the “bottom line” by which the success of technology must be measured (p. 30).

Schacter (1999) reviewed the findings of six large-scale studies into the impact of educational technology on student achievement. The studies in his review reported largely positive impacts of various types of technology on student achievement. Among the major positive findings reported in the review were increased achievement for both regular and special education students, increased scores on standardized tests, and achievement gains in all subject areas (Schacter, 1999). Technology use has also been found to positively affect student achievement in mathematics and history (Wenglinsky, 1998, 2006).

Numerous other studies have found that technology had a positive effect on student achievement in various learner groups and content areas. For example, technology has been found to have a positive impact on the learning of students with special needs and for learners with limited proficiency in English (Svedkauskaite, 2004). A national survey of classroom teachers (Rother, 2005) found that most teachers believed computers were an effective tool for teaching both language
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Arts and mathematics. Most teachers also believed technology was effective in improving the learning of both gifted students and those needing remediation (Rother, 2005).

Enhanced motivational and attitudinal outcomes is another commonly discussed type of technology impact. Research has shown that technology, when used appropriately, can have a positive impact on student motivation and self-esteem (WestEd, 2002). It has also been shown that computer-assisted instruction, especially well-designed educational games, can increase student motivation (Vogel, Greenwood-Erickson, Cannon-Bowers, & Bowers, 2006). Stevens and Switzer (2006) found that students enrolled in an online course reported higher levels of intrinsic motivation than students in a traditional class. It can be argued that even when learning technologies lead to no difference in student achievement, increases in student motivation represent a significant positive impact.

In addition to increased achievement and motivation, technology can impact education in many other ways. Examples include cost reductions, increased access to educational and training opportunities, improved communication, and more efficient administrative applications. A full discussion of all the possible impacts of technology is beyond this discussion, but based on the research, it is possible to conclude that technology can have a positive, tangible impact on the learning process. There is ample documentation within the literature to suggest that technology can, and in many cases, has helped to increase student achievement and motivation. It should be noted, however, that there are numerous studies found in the literature that report no statistically significant gains in achievement when using technology. Learning technologies do not influence achievement independent of other factors. It is likely that the greatest positive tangible impacts of technology can be derived from combining sound instructional methods and effectively developed technology applications for the attainment of well-defined learning outcomes with a specific intended audience (Joy & Garcia, 2000).

Intangible types of impact. The impact of technology can be framed in tangible terms, for example, in terms of student achievement, as discussed previously, but it can also be described in more philosophical terms. The intangible impacts of technology are those effects that are too complex, too holistic, too subjective, or too distal to measure. There are two main philosophical orientations that one can take when discussing the intangible impacts of technology, determinism and instrumentalism.

Determinism is the belief that technology is an autonomous force that develops and evolves largely beyond human control. This belief began to develop at the beginning of the Industrial Revolution (Smith, 1996). While some (e.g., MacKenzie & Wajcman, 1999) argue that determinism in its basic form represents an oversimplification of the relationship between technology and society, the theory remains a common theme (Marx & Smith, 1996). Many advocates of the increased use of learning technologies appear to have strongly deterministic views. Under this view, learning technologies are seen as the driving force in improving the educational process. Determinists believe that the best way to reform education and produce significant measurable gains in achievement is to develop tools and systems that are significantly and demonstrably better, more well designed, and advanced than existing tools and systems (Surry & Farquhar, 1997). While this is a philosophical point, the premise is at the root of most large-scale, top-down educational reform efforts.

Instrumentalism is the belief that the design, development, use, and expansion of technology are processes that are controlled in large part by society. Instrumentalists view technology as a tool, like a knife, under human control and able to be employed for good or bad (Surry & Farquhar, 1997). When applied to learning technologies, instrumentalism is the belief that technology’s greatest impact lies in its potential to be used as a tool by creative, experienced, caring educators to address their unique set of learners, content, and environments.

Utopian views. Those who hold a utopian view of technology believe the ever-increasing expansion of technological capacity is making the world a better place. Utopian views of technology are fairly common in the fields of education and training. Selwyn (2000), referring to research about computers in education, writes “some researchers have tended towards an optimism which, in its extreme form, has approached a utopian outlook on technology” (p. 94). The belief that an increase in the availability of technology will lead to the increased use of technology, better teaching, improved learning, and, eventually, to increased economic competitiveness is widely held among the major proponents of technology in education (Cuban, 2001).
Dystopian views. Those who hold a dystopian view of technology believe the ever-increasing expansion of technological capacity is making the world a worse place. Dystopian views of technology’s role in society as a whole are fairly common. Vicente (2004) describes a number of problems with technology, some small, others large, and concludes that the difficulties are “causing society a raft of problems—psychological difficulties, loss of productivity, economic distress and more—problems we can’t afford…the impact on our quality of life is disconcerting” (p. 18). Such dystopian views of the role of technology in education are not common, but they do exist. For example, Lauzon (1999) writes that the increased use of learning technologies has led to alienation, neo-colonialism, and an over-emphasis on market driven practical skills training at the expense of larger ideas and critical thinking skills.

Cuban (2001) writes that much of technology-based educational reform is rooted in the idea of a market-driven economic agenda that reduces students and schools to mere consumers. He adds that large sums of money spent on technology, specifically computers, have resulted in significantly reduced funding for a host of other, non-technological, school reform efforts that have shown at least as much promise for improving student achievement as computers.

A commonly cited dystopian impact of learning technologies is the “digital divide.” The digital divide is a belief that learning technologies, despite their potential to close the achievement gap (Allan & Wing, 2003), are instead creating a widening gap between students who have access to technology and those who do not. Students who are economically or culturally disadvantaged and those who have special needs are especially susceptible to becoming victims of the divide (Wiburg, 2003).

FUTURE TRENDS

As more and more money is spent on technology, return on investment (ROI) will become an increasingly more important consideration in the future in both educational and training settings. While ROI is not a new process, developments in technology and an evolution in understanding the complex impact of technology will require researchers and practitioners to continually develop new theoretical and methodological approaches to effectively determine the costs of technology, both direct and indirect, and to weigh those costs against the positive and negative impacts of technology.

Accountability, the collection, documentation, synthesis, and dissemination of data about learning outcomes, will continue to be an important activity in the future. In order to ensure continued funding for technology, educational institutions will have to find new ways to document not only the tangible impacts of technology, such as achievement, but also higher-level impacts such as the transfer of learning to behavior, and even broader intangible impacts related to economic and societal issues.

The power and capabilities of technology are constantly expanding. An important future trend will be to develop assessment methods that are sufficiently robust and flexible to capture the evolving nature of technology. In the future, it is likely that new technologies will be developed, adopted by schools, and replaced by newer, better technologies before pedagogical practices can be adapted to take fullest advantage of the technologies or before any meaningful assessment of the technologies’ impact can be completed. Also, the perception about the proper use of technology by parents and other stakeholders will change as new technologies evolve (Culp, et al., 2005). This will likely lead to changes in the very definition of what is meant by learning, and will require the use of innovative assessment strategies.

CONCLUSION

It is unlikely that there is anyone alive today who is not impacted by technology in some way on a daily basis. Technology is a pervasive force in modern life. The impact of learning technologies on the educational process is a more controversial subject. Some claim learning technologies have had a profound impact on education, while others point to a minimal impact.
Impact of Technology

Until there is general agreement about what qualifies as a technology and how impact should be defined and measured, the debate about technology’s role in the learning process will continue.

REFERENCES


Stevens and Switzer (2006)

Impact of Technology


KEY TERMS

**Determinism:** The belief that technology is the driving force in the development of society. It views technology as an autonomous force, largely outside of direct human control.

**Dystopian Philosophy:** The belief that the expanding power and reach of technology results in a gradual worsening of the human condition and will, ultimately, lead to chaos and ruin.

**Instrumentalism:** The belief that societal goals, beliefs, and values shape the design, development, and use of technology. It views technology as a tool, largely under human control, that can be used for good or evil.

**Intangible Impact:** The outcomes of technology that are too complex, too holistic, too subjective, or too distal to adequately measure, most often associated with a general belief that technology is having an overall positive or negative impact.

**Tangible Impact:** The observable, measurable outcomes of technology use, most often associated with achievement gains, increased motivation, and cost reduction.

**Technology:** In simplest terms, technology refers to any tool that is employed for a specific purpose. In broader terms, technology refers not only to the tool itself, but to all of the associated systems and underlying theoretical and applied knowledge needed to develop and use the tool effectively.

**Utopian Philosophy:** The belief that the expanding power and reach of technology results in improvements to the quality of human life and will, ultimately, lead to a perfect, or nearly perfect state.
Individual Differences in Web-Based Learning

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INTRODUCTION

As the Web becomes as an important means to disseminate information, a growing number of education settings are developing Web-based learning (WBL). Unlike traditional computer-based instructional programs, WBL systems are used by a diverse population of learners, in terms of their background, skills, and needs (Chen & Macredie, 2004). Therefore, individual differences are becoming an important consideration. In the past decade, many studies have found that individual differences have significant effects on WBL. In particular, gender differences (e.g., Roy & Chi, 2003), prior knowledge (e.g., Calisir & Gurel, 2003), cognitive styles (e.g., Chen & Macredie, 2004) are the most critical individual differences elements. In this vein, this article will present a comprehensive review on their influences on Web-based learning. The reader of this article is expected to get an overview of the state of the art research associated with these individual differences elements.

GENDER DIFFERENCES

The literature in the computing field has examined gender differences since the early 1980s (Young, 2000) and has recognized gender as an important variable that influences computing skills. In general, males report lower levels of computer anxiety than their female counterparts. In addition, it also seems that males achieved much better outcome than females (Karavidas, Lim, & Katsikas, 2004). As the WBL has become more popular, a growing body of research has been conducted to examine gender differences in the use of the WBL. Research suggests that gender differences have significant effects on students learning on the Web.

Roy and Chi (2003) examined student’s navigation styles. Fourteen eighth grade students, with equal numbers of boys and girls, participated in the study. A searching task was assessed through target-specific prompts and target-related questions. Searching behavior was measured by using field notes along with computer logs of all the Web pages accessed by students during their search. Their findings indicate that boys tended to perform more page jumps per minute, which indicates that boys navigate in the information space in a nonlinear way. The findings relatively concur with that of Large, Beheshti, and Rahman (2002), who examined gender differences in Web navigation. Fifty-three students, comprising 30 females and 23 males from two sixth grade classes, were the subjects of the study. The results revealed that males were using different strategies to retrieve information from the Web than females. Males preferred a broader search strategy than females. In addition, male group was more actively engaged in browsing than the female group, and the male group explored more hypertext links per minute. They also found that the males tended to perform more page jumps per minute, entered more searches at search engines, and gathered and saved information more often than the females while males spent less time viewing pages than females. Other similar results were found by McDonald and Spencer (1998a) and Felix (2001). The former examined gender differences in Web navigation. The results indicated that males express a greater degree of confidence to nonlinear navigation than females. The latter investigated potential of the Web as a medium of language instruction and found that female users have higher demands from human tutors.

In addition to navigation patterns, gender differences also influence the preferences of screen design. Chrysostomou, Chen, and Liu (2006) examined the influences of human factors with 80 students. They found that males preferred a screen with fewer colors while females favored a screen with numerous colors. A possible explanation for this may be that females tend to experience more difficulty when interacting with computers compared to males, so they prefer the use of several colors as a means of maintaining their interest in the task at hand. This potentially implies that females might prefer a screen that incorporates a pleasant visual display by using attractive graphics or...
the use of several complementary colors. These results are in agreement with those of Miller and Arnold (2000), who investigated how gender differences influenced the design of Web pages. They report that females favor the use of pretty images, such as flowers, contrasting with macho technical images, such as a computer favored by males. These different preferences might be caused by their life styles, in which females prefer aesthetics while males tend to be more practical.

These research findings suggest that gender is a major predictor of learning preferences in WBL. In terms of navigation patterns, males prefer broader searching than females. Furthermore, males have higher confidence and interest in nonlinear navigation than females. In respects of screen design, females like that the screen includes numerous color whereas males prefer that fewer colors are used. These imply that males and females might need different levels of navigation support and different types of interface design. As suggested by Ford, Miller and Moss (2001), gender is a relatively fixed variable, thus it requires adaptability from the system perspective, suggesting that it is important that user interfaces of WBL should be developed to support adaptation to gender.

**Prior Knowledge**

In the past decade, a growing body of research has examined the influence of prior knowledge in WBL. Such research has suggested that different levels of prior knowledge suited to different types of content structure (Calisir & Gurel, 2003) and different navigation tools (McDonald & Stevenson, 1998b).

In terms of content structure, of which interactions with learners’ prior knowledge have been examined by a number of previous studies, the findings suggest that experts and novices differ in their performance depending on content structure in WBL. McDonald and Stevenson (1998a) examined the effect of content structure and prior knowledge on navigation performance. Three types of content structure—hierarchical, nonlinear, and mixed (hierarchical structure with cross referential links)—were investigated using 30 university students as the sample. The results show that the performance of knowledgeable participants was better than that of nonknowledgeable participants, as they had a better conception of the subject matter than nonknowledgeable participants did. The results also show that nonknowledgeable participants performed better in both browsing and navigating in the mixed structure condition than in the nonlinear structure condition.

In a similar vein, Calisir and Gurel (2003) also investigated the interaction of three types of content structure—linear, hierarchical, and mixed (hierarchical structure with cross referential links)—with prior knowledge of the learners. In contrast to the study by McDonald and Stevenson (1998a), they examined the influence of text structure and prior knowledge on learning performance (reading comprehension, browsing, and perceived control) rather than on navigation performance. The authors’ analysis of the findings suggests that a hierarchical content structure is most appropriate for nonknowledgeable subjects, probably because this structure provides a clear insight into the organizational framework of the subject content.

In summary, these findings show that experts and novices differ in their performance depending on content structure and that it is necessary to take learners’ prior knowledge into consideration when designing effective content structure for WBL. Experts profit most from a learning system that provides flexible paths, whereas novices seem to benefit more from a learning system that is more structured. This may be explained by the fact that expert learners have acquired a great deal of content knowledge so they are more able to impose structure on the content. On the other hand, novice learners lack the domain knowledge; they prefer content structures that may compensate for their lack of a conceptual structure of the domain. Hierarchical structure is considered as being most appropriate for novice learners (Calisir & Gurel, 2003) as it presents a conceptual structure of the material that helps them to structure the text.

In respect of navigation tools, most of WBL systems today provide various navigation tools to allow learners to use multiple approaches for their learning. Hierarchical maps and alphabetical indices are most commonly used in WBL and each of them provides different functions for information access. For example, hierarchical maps provide a view of the global structure of the context, while alphabetical indices are useful for locating specific information (Chen & Macredie, 2002). Therefore, navigation is a critical design issue in WBL because it influences how students can develop their learning strategies.

Regarding the relationships between learning strategies and navigation tools, students’ prior knowledge is
Individual Differences in Web-Based Learning

an important factor in determining whether a particular navigation tool is useful. A number of empirical studies have evaluated the effectiveness of different navigation tools for high and low prior knowledge users. Farrell and Moore (2001) investigated whether the use of different navigation tools (linear, main menu, and search engine) would influence users’ achievement and attitude. The results indicated a significant difference for high prior knowledge subjects who tended to use search engines to locate specific topics. Conversely, low-knowledge users seem to benefit from hierarchical maps, which can facilitate the integration of individual topics. A recent study by Potelle and Rouet (2003) investigated the influence of navigation tools on students’ comprehension. There were three versions of the system, which organized information with different navigation tools: a hierarchical map, a network map, and an alphabetic list. The hierarchical map was organized with superordinate and subordinate links from the most general to the most specific topics, the network map was organized by connecting the main topics with semantic links, and the alphabetic list presented the topics in alphabetic order without explicit connections. The results show that the hierarchical map improved comprehension for the low-knowledge participants at the global level.

Furthermore, McDonald and Stevenson (1998b) examined the effectiveness of navigation tools and domain expertise in relation to navigation performance. Three conditions were used, including hierarchical map, contents list, and basic design. The findings show that nonknowledgeable subjects performed better in the hierarchical map condition than in the contents list condition. A possible explanation for these findings is that the hierarchical map not only reveals the document structure (i.e., the physical arrangement of a document), but also reflects the conceptual structure (i.e., the relationships between different concepts). In other words, the hierarchical map can help nonknowledgeable learners to incorporate the document structure into the conceptual structure, which is useful for them to integrate their knowledge (Nilsson & Mayer, 2002).

The results of the aforementioned studies reveal that students with different levels of prior knowledge benefit from different navigation tools. Research suggests that structured navigation tools, such as hierarchal maps and structural overviews, are most helpful for novices, as they help them to overcome their lack of conceptual structure of the domain. As indicated by Nilsson and Mayer (2002), hierarchal maps, which provide learners with structural cues between concepts, can help learners to integrate their knowledge. However, such navigational tools, which provide a global structure, may make the users pay less attention to the local structure of the content, in turn limiting their understanding (Hofman & Oostendorp, 1999). This suggests that there is a need to provide less knowledgeable learners with navigational tools that present both global structure and local structure of the content. The global structure aims to help them find the relevant information and reduce disorientation, and the local structure focuses their attention, with the aim of improving understanding.

COGNITIVE STYLES

Within the area of cognitive styles, field dependence has emerged as one of the most widely studied dimensions with the broadest application to problems in education (Messick, 1976) because it reflects how well a learner is able to restructure information based on the use of salient cues and field arrangement (Weller, Repman, & Rooze, 1994). The key issue of field dependence lies within the differences between field dependent and field independent learners, which are presented below:

Field independent learners: The individuals tend to exhibit more individualistic behaviors since they are not in need of external referents to aide in the processing of information. They are more capable of developing their own internal referents and restructuring their knowledge, are better at learning impersonal abstract material, are not easily influenced by others, and are not overly affected by the approval or disapproval of superiors.

Field dependent learners: The individuals are considered to have a more social orientation than field independent persons since they are more likely to make use of externally developed social frameworks. They tend to seek out external referents for processing and structuring their information, are better at learning materials with human contents, are more readily influenced by the opinions of others, and are affected by the approval or disapproval of authority figures (Witkin, Moore, Goodenough, & Cox, 1977).

Several studies investigate the relationships between the degree of field dependence and students’ learning patterns and learning performance. In terms of learn-
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Ining patterns, Wang, Hawk, and Tenopir (2000) found that students with strong field dependence tendencies got more easily confused on the Web than those with strong field independence tendencies. Similar results were obtained by Chen and Macredie (2004), which show that field independent students appreciated the fact that WBL systems allowed them to study topics in any order, whereas field dependent students felt confused over which options they should choose. Regarding learning performance, Cacciamani (2002) found that field independent students outperformed field dependent students in learning from WBL. Ghinea and Chen’s work (2003) shows that field dependent individuals’ performance was hindered by multimedia tools that required the students to extract cues by themselves.

To summarize, all of these studies reviewed in this section explore the influence of field dependence/independence on WBL and their results suggest that different cognitive styles have significant effects on student learning in WBL. Future research should consider how to develop a WBL system that can accommodate the needs of different cognitive style groups.

CONCLUSIONS

This article presents a comprehensive review on the influences of individual differences on WBL. In particular, it focuses on gender differences, prior knowledge, and cognitive styles. The studies reviewed in this article suggest that individual differences play an important role in the development of WBL. Students with different cognitive styles, levels of prior knowledge, and gender, possess different characteristics and use different approaches for their learning in WBL. Therefore, these individual and different elements must be taken into account so that the design may lead to more effective and satisfying design of WBL for all categories of learners. As suggested by Chen and Macredie (2002), “if learning environments can be aware of learners’ individual differences, they may be able to offer appropriate support, possibly resulting in a higher quality of learning” (p. 14).

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Individual Differences in Web-Based Learning


**KEY WORDS**

*Cognitive Styles*: The preferred way in which the information is processed.

*Field Dependence*: A tendency to approach the environment in an analytical, as opposed to global, fashion.

*Gender Differences*: The social and cultural influences that lead to differences between women and men.

*Individual Differences*: Stable patterns of behavior or tendencies, which are independent of each other.

*Prior Knowledge*: The amount of knowledge one possesses about a particular subject matter.

*Web-Based Learning*: Teaching material that is presented via the Internet, specifically the World Wide Web.
Industrial Technology Pedagogy:  
Need for Human Relations Skills

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INTRODUCTION

Interpersonal relationships and communication are always developed in a specific cultural context that has its own values, norms, and even institutions to cope with different types and levels of interpersonal relationships (Mamali, 1996, p. 217).

Since the dawn of mankind, what separates man from beast is man’s ability to use and develop tools and technology. The use of technology has become so prevalent that it permeates all aspects of our lives, schools, business, and our personal lives. Businesses especially have to broaden and improve their technological skills in order to survive in technology-dependant environments.

The field of industrial technology originated and was influenced by the increase in demand for technology in businesses and the lack of knowledge graduates had to perform business-oriented tasks. It was during the 1950s that these graduates began taking on industrial management jobs. Zargari and Coddington (1999) said that:

Technological developments in industries created new occupations that required a balance between management knowledge and technical skills. This has become the technical-management profession, “management” jobs with a decidedly “technical” nature. The discipline of IT was established to meet the needs of business and industry for employees who could use the complex tools of production and at the same time, were able to manage personnel and facilities. (p. 2)

The knowledge that graduates had was not sufficient enough for them to maintain proper work ethics and aid in the development of business or industry. Industrial technology prepared students for management-oriented positions in technology, operation of technological systems, and the maintenance of those systems. Industrial technology pedagogy is a vast field that includes a variety of courses such as electronics, safety, maintenance, and management. Although it is important for the students to have a hands-on approach in a business environment, they should also be familiar with the softer skills of that environment referred to human relation skills. Thus, human relations skills should also be an inherent in industrial technology pedagogy. This will ensure that students possess the pertinent hard skills, that is, hands-on approach to solving a problem and the softer skills such as the ability to communicate with their coworkers and work together in a team environment. Businesses and industries alike are not only looking for individuals who have the ability to perform hands-on tasks but also the ability to communicate effectively with their managers, supervisors, and coworkers. Moreover, individuals need to possess the interpersonal skills to excel in the workplace.

BACKGROUND

Technology is defined in the Merriam-Webster dictionary as “the study, development, and application of devices, machines, and techniques for manufacturing and productive processes” (Merriam-Webster’s Collegiate Dictionary, 2005). Since its outset, technology has taken on several different roles in history, from the first markings of the cave man to the Industrial Revolution to the creation and use of the World Wide Web. Technology education in the United States is presumed to have been founded in the early twentieth century as industrial arts, but there are historic roots that date the field back much farther than that. Industrial arts can be depicted as an extension of those founding roots as opposed to a philosophical convergence of them. It was Lois Coffey Mossman and Frederic Gordon Bonser who had the “greatest influence on the origins of what is now known as technology education” (Foster, 1995, p. 6). Industrial arts evolved from the term manual training. Manual training had a threefold purpose in the
nineteenth century, its objectives were to “keep boys in school,” “provide vocational skills,” and “develop leisure-time interests” (Gerbracht & Babcock, 1969, p. 8). Manual training later grew to include objectives that incorporated instruction in the fundamental principles, processes, and materials of industry. Over the years, Americans began to take a “learning by doing approach” (Butts, 1955, p. 574). Industrial education/arts focused on the idea that children needed to learn about technologies for personal and commercial use to prepare them for a technology-driven society. This led to an increase in graduates taking on industrial management jobs; however, it became evident that possessing knowledge in industrial arts was not sufficient in helping to excel in the workplace; having this signified the beginning of what is now referred as industrial technology. While industrial arts programs concentrated on technology and psychology, industrial technology programs united the facets of technology and management. Industrial technology is defined as “a field of study designed to prepare technical and/or management oriented professionals for employment in business, industry, education, and government” (NAIT, 1997, p. 1). Industrial technology integrated the features of industrial arts, but married the technological and managerial skills to accommodate the needs of industry. Moreover, “Industrial Technology is primarily involved with the management, operation, and maintenance of complex technological systems” (Michigan Tech, School of Technology, n.d.). Accordingly, the focus of industrial technology pedagogy is to prepare individuals to be managers who are equipped with technological skills to operate and maintain complex machinery. However, industrial technology ignored the human side of management. Managers are constantly communicating with their employees, and having the right communication skills is imperative. “Human relation is the study of the interactions that exist between people. These relationships, both formal and informal, occur both in our personal and our work lives” (DeCenzo & Silhanek, 2002). Similarly, Lamberton and Minor-Evans (2002) provide a more robust description of human relations and its role in industry:

*Human relations includes a desire to understand others, their needs and weaknesses and their talents and abilities. For everyone in a workplace setting, human relations also involves an understanding of how people work together in groups, satisfying both individual needs and group objectives. If an organization is to succeed, the relationship among the people in the organization must be monitored and maintained* (p. 4).

Understanding others enables you to be able to communicate with them better. In business you may be partnered with someone in a group who is not comfortable being in that setting but if you communicate with them, you may find out a way to be productive in a way that contributes to the organization. Although human relation is a skill that needs to be addressed in industrial technology, the importance of industrial technology should not be overlooked. As mentioned before, industrial technology is an area of study designed to teach both technical and management skills. It prepares managerial professionals for employment in business, industry, education, and government.

In sum, industrial technology originated out of the concept of manual training for the reasons that manual training did not provide students with the necessary skill to excel in the workplace. Manual training provided the students no concept of how important it was for them to understand what they were doing. Manual training also did not provide any type of organizational structure. The students were in a dictator type of environment; expressing yourself in manual training was not encouraged; neither was the concept of initiative. The product was the only thing that manual training was concerned with. Industrial technology looked at the student as the product; how that student could be a productive individual to the workforce and to society. Industrial technology allowed the students to express themselves freely and explore the creative side of their minds.

**Key Skills the Learner Will Acquire from Industrial Technology Pedagogy**

Manual training was a concept that was great during its time, but educators needed to change its pedagogical approach. Manual training dealt with allowing the student to learn strictly from a hands-on approach. It did not focus on the student, just the end result. There were flaws with the concept of manual training and Lois Mossman and Frederic Bonser (1923) listed several components of manual training, which they criticized by investigating the courses proposed and taught in their schools. The following shows these
prevalent inadequacies in manual training (Bonser & Mossman, 1923):

- Want of relationship of the work to life. The sequence of the models was in terms of tool processes.
- Failure to provide for the individuality of the child. Each must conform to the system.
- Lack of motivation. The work was all prescribed in a fixed course.
- Placing the emphasis upon the product as the objective, rather than upon the growth of the child.

The list looked at the fact that manual training did not provide support for the work that the students were being asked to do. There was no relevance to what they were doing. There was no structure for the student to express themselves on an individual basis and not only did manual training discourage initiative, but it also focused on the end product instead of whether the student actually understood what he/she was doing. Mossman and Bonser’s observation of manual training initiated them to develop a detailed system of industrial education that, at that time, was only implemented on a smaller scale. Their detailed system became the “foundation for industrial education in the United States and has been the theoretical basis for over 70 years” (Foster, 1994, 1995, 1997, pp. 5-6). Industrial technology will teach the student how to apply a practical approach within a technological environment. They will be able to understand the technical, manufacturing, machine operation, and management aspect of their occupation. The industrial technology program of study enables to be more dynamic in their approach to technology, but deals very little with the soft skills such as human relations. Although, the program does include some courses on management skills, the human relation skills are indistinct. Industrial technology pedagogy allows students to acquire knowledge and understanding in an array of subject areas. In addition, students will also be able to obtain advance skills and knowledge to perform and succeed in top-level managerial tasks. In spite of the merits of the newly improved industrial technology program, the pedagogy was lacking interpersonal competency, a pertinent skill required in the workplace. The major focus of industrial technology is to provide students with the comprehension of their technological environment and that enables graduates to gain employment in management and supervisor positions. Human relations is an area that is not studied thoroughly enough in the field of industrial technology. Perhaps future industrial technologists can conduct research to assess how beneficial human relations skills are to this field of study.

THE IMPORTANCE OF HUMAN RELATIONS SKILLS IN INDUSTRIAL TECHNOLOGY

Human relations refer to how we interact with and exist with people. It is “the study of relationships among people.” (Dalton, Hoyle, & Watts, 2000, p.2). The relationships that you develop with people can evolve in organizational or personal settings. That relationship can be intimate or distant, at variance or cooperating, one-on-one or within groups. Human relations embodies how we, as individuals, communicate with people in both formal and informal manners. The more you know about what stimulates a person and what has an effect on their morale, about setting goals and keeping abreast of work performance, and about how conflict change can be dealt with, the stronger your human-relations skills will become. Some key elements of good human relation skills are “being aware of the sources and uses of power, gaining problem-solving and decision-making skills, and understanding creativity, team building, and legal and ethical considerations.” (Dalton et al., 2000, p.2). Considering the fact that industrial technology promotes students to become managers or supervisors, it is important that they know how to communicate effectively in industry. Becoming a manager or a supervisor not only means understanding the industry that you are in, but also understanding how to interact with your employees. In addition to communication skills, industrial technologists need to acquire effective team-work and strong leadership skills, including problem-solving skills. Problem solving is particularly important because in any social institution, conflict is bound to arise and thus, managers in industry must be able to assess how to resolve discord.

Moreover, human relations skills may be the most influential aspect to the success or failure of a person’s career. The Carnegie Foundation stated that “85 percent of the factors contributing to our job success are personal qualities, while technical knowledge contributes only 15 percent.” (Cited in Dalton et al., 2000, pp. 4-5). The
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Harvard Bureau of Vocational Guidance reported that “66 percent of people fired from their jobs were fired because they did not get along with others while only 34 percent because of lack of technical knowledge.” (Davenport, 1993, p.5). As the economy evolves, human relations skills are becoming increasingly important, particularly in industry and business. Industrial technologists will not only be able to interact on an industrial level, but also an interpersonal level. DeCenzo et al., (2002) express the significance of human relations in asserting that:

**Human relations is important in today’s organizations for several reasons. Success in achieving organizational goals requires employees to interact effectively. Furthermore, organizational changes, like the composition of the work force, customer service, work teams, and technology, are placing more emphasis on effective human relations skills for employees.**

Human relations permit managers, supervisors, and coworkers to be able to express their instructions or ideas in an effective and constructive manner.

**INTEGRATING HUMAN-RELATION SKILLS INTO INDUSTRIAL TECHNOLOGY PEDAGOGY**

The integration of human-relation skills with industrial technology pedagogy is vital in industry, the question is how? There are several ways in which this can be implemented, but first you must consider what area of industry/business you need to integrate it into. In the area of production in the business organization, according to Dalton, Hoyle, and Wyatt, the human-relation skills needed include the use of “teamwork to work together effectively to meet production and delivery deadlines and maintain quality. Use other skills such as motivation, goal setting, job performance, problem solving, and decision making.” (p. 16). This can be accomplished in industrial technology curriculums by using several methods: implementing more core courses on human relation skills, allowing more projects that are problem based to be solved in group settings, providing industrial technology students with the opportunity for more practical experiences such as internships or coops. Some other ways that the concept of human relations can be integrated into industrial technology pedagogy is by teaching the student that understanding the goals of an organization can assist them in developing the necessary communication skills needed in that organization. Similarly, teaching students that communicating with the clients and customers in industry helps to enhance your human-relation skills and will also allow them to establish rapport with that client or customer. Integrating human relations with industrial technology pedagogy can also be established by coordinating work with others in the classroom. This can help the student to transfer the concept of coordination from the classroom to the industrial organization. These ideas will help the integration of human relations with industrial technology pedagogy.

**CONCLUSION**

Industrial technology pedagogy enables the learner to understand and work in a technical environment, as well as the ability to manage or supervise in that technical environment. With the change of today’s society, human-relation skills are just as valuable as possessing the mechanical skills. Knowing how to effectively communicate with others is becoming a requirement in businesses and industries. It is important that industrial technologists not only know the technical skills, but also be effective in communicating those skills to their coworkers or peers. Industrial technology pedagogy will greatly benefit from implementing these methods of integrating human relations to the field of industrial technology. The end result will provide educators of industrial technology pedagogy with the opportunity to see first hand how human-relation skills are a vital part to those industrial technologists they are sending out in the real world to be future managers or supervisors. The skills that they will acquire will set them apart from the current managers or supervisors in the technical environment. They will be able to bring relevant human-relations skills to that business or industry. Human-relations skills will also help them to be successful in their careers. It is important that human relations are integrated into industrial technology pedagogy because the students deserve the ability to know how to communicate in point of fact and not only that, but have the opportunity to advance in their careers due to their human-relations skills. Industrial technology produces managers and supervisors, so it is relevant that they know how to delegate instructions.
and authority successfully, how to work in a team environment, and how to work towards accomplishing the goals of that industry or business. In addition, since problem solving and leadership abilities are a factor in industry, it would be in the interest of the individual to acquire human-relations skills. Problems arise in a business environment on a regular basis, and having the ability to know how to solve that problem could possibly lead to further success for you as well as the company.

REFERENCES


KEY TERMS

**Human Relations:** The skills or ability to work effectively through and with other people. Human relations include a desire to understand others, their needs and weaknesses, and their talents and abilities.

**Industrial Arts:** The study of the changes made by man in the forms of material to increase their values, and of the problems of life related to these changes. It is an educational agenda that focused on the fabrication of objects or useful equipment by wood and/or metal using an assortment of hand, power, or machine tools.

**Industrial Technology:** Industrial technology is a field of study designed to prepare technical and management professionals for employment in manufacturing and distribution industries, education, and government. Industrial technology is primarily involved with the management, operation, and maintenance of complex technological systems, including:

- Materials
- Manufacturing Processes
- Management
- Economics
- Human Relations
- Quality Control
- Computer Applications/CAD/CAM
- Electronics and Automation
Industrial Technology Pedagogy: Need for Human Relations Skills

**Manual Training:** The process of bringing a person to an agreed standard of proficiency by practice and instruction that is relating to a hands-on approach to learning.

**Pedagogy:** The principles, practices, or profession of teaching children.

**Rapport:** Relationship, especially one of mutual trust or emotional affinity.

**Technical:** Specializing in industrial, practical, or mechanical arts and applied sciences.
OVERVIEW

Information literacy is a key capability for the 21st century. The distinction between information and knowledge is central to understanding the meaning of information literacy. Information literacy goes beyond that of information retrieval and evaluation. An information-literate person actively uses information to further personal learning and growth with respect to all facets of life. The importance of planning information searches and prioritizing potential sources of information is stressed, as is the need for active engagement with information to seek understanding. It is at this point that the bridge between information literacy and learning occurs; the transformation of information into knowledge that is demonstrated in the production of a unique product (be it an essay, report, media object, etc.). Technology can facilitate learners’ development of information literacy skills but also bring new challenges. The model of a community digital library may be a valuable one in this regard. One challenging but exciting new area is how e-books may contribute to curriculum design in the 21st century. Another emerging area that will impact on information literacy is the nature of online communities and whether Web 2.0 will bring new levels of information literacy to learners of all ages in the 21st century.

BACKGROUND: THE NATURE OF LEARNING

Normally, the goal of searching for information is to learn more about the topic under investigation. It is worthwhile spending a little time looking at the meaning of learning. Learning is a complex process. How do people learn the important ideas they need to know? Do they assimilate information which they then reproduce? This might be possible for certain facts, but even then, if the facts are all unrelated, it is hard to remember them. Learning is much easier if connections can be made between ideas and facts. How can these connections be made? Is it by rules, as in a system of information processing, much like the way a computer can be programmed? This might be possible for learning fixed processes which are always the same, for example, a laboratory procedure such as setting up an electrical circuit from a diagram, or routine clinical procedures such as taking a patient’s blood pressure. But sets of rules are not enough when learners need to solve a problem they have not seen before, or when they want to design something quite new (a bridge, a poem, or a plan for doing new research). Something else is needed then. In these cases, learning appears to be a complex process where knowledge is constructed from a variety of sources. What people learn depends on what they already know, how they engage with new ideas, and the processes of discussion and interaction with those they talk to about these ideas. Learning is thus a personal adventure leading to knowledge construction. The outcomes of one learning process often have deep implications for how future learning might occur.

The outcomes of any education process, especially if we take a lifelong view of learning, are usefully described by broad capabilities, such as the list of clusters of abilities noted by Nightingale, Te Wiata, Toohey, Ryan, Hughes, and Magin (1996): thinking critically and making judgments; solving problems and developing plans; performing procedures and demonstrating techniques; managing and developing oneself; accessing and managing information; demonstrating knowledge and understanding; designing, creating, performing; and communicating. It is with broad view of learning that I now turn to a consideration of information literacy.

SPECIFIC FOCUS ON INFORMATION LITERACY

Meaning of Information Literacy

Information literacy is integral to the development of many of the capabilities listed above. A useful working definition of information literacy might be as follows:
“Information literacy involves accessing, evaluating, managing and communicating information.”

Information literacy is not synonymous with learning and, in order to understand this, the difference between information and knowledge needs to be explored. This difference is often not clearly defined, and indeed there is often a strong overlap in normal conversation. The analogy of the difference between the bricks and mortar and the house can be useful. Information is the bricks, and learning skills and processes constitute the mortar. Combining “bricks” of information together using appropriate strategies (mortar) can result in a new house of knowledge. Knowledge is constructed from information. Thus, an information-literate person is someone who can find and select the right information for any given task. In this sense, information literacy is a prerequisite for learning.

With this basic definition in mind, let us take a more detailed look at information literacy standards and skills. The American Library Association and Association for Educational Communications and Technology (ALA & AECT, 1998) produced a list of nine information literacy standards. By standards is meant goals or benchmarks. There are three areas with three standards in each area. The three areas are information literacy, independent learning, and social responsibility. The fact that information literacy itself is a subset of the information literacy areas is an illustration of the challenges that occur when one tries to define the boundaries of information literacy. What is helpful about this framework is the sense of moving from a more neutral skills orientation to a value-laden position of social connectedness. The nine standards are shown in Figure 1 with the centrality of the information literacy area highlighted.

One other useful term is “critical literacy.” This essentially encapsulates all nine of the standards described above. Van Duzer and Florez (1999) describe critical literacy as encompassing “a range of critical and analytical attitudes and skills used in the process of understanding and interpreting texts, both spoken and written.” The term is often used with adult language learners but its applicability is much wider. It is useful to be reminded that aural (and oral) skills are also needed in developing high levels of information literacy. In our multilingual societies this reminder is especially important.
Acquiring Information Literacy Skills

Just what does a learner need to do in order to carry out a successful information search? What skills does the learner need? Eisenberg’s (2001) Big6™ Skills (Table 1) are a useful set. They indicate clearly the complexity of information searching but also highlight that information searching is best approached in a methodical and meticulous manner. A lot more than random Google searches is involved!

The Role of Technology

Can technology facilitate the development of information literacy skills? The answer is “yes” and “no.” Online environments facilitate access to and retrieval of information. They can also facilitate people’s communication with other knowledge seekers and this can be useful in evaluating the usefulness of any resource.

Honing in on Community Digital Libraries

Several of the functions listed under “implications” in Table 2 are currently performed by university (and other) libraries, digital repositories, and professional subject organizations. The potential of a combination of all three together could be a way forward. Examples of organizations that have these characteristics can be

Table 1. Big6™ Skills (Eisenberg, 2001)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Details of the process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Task definition</td>
<td>1.1 Define the information problem. 1.2 Identify information needed.</td>
</tr>
<tr>
<td>2. Information seeking strategies</td>
<td>2.1 Determine all possible sources. 2.2 Select the best sources.</td>
</tr>
<tr>
<td>3. Location and access</td>
<td>3.1 Locate sources (intellectually and physically). 3.2 Find information within sources.</td>
</tr>
<tr>
<td>4. Use of information</td>
<td>4.1 Engage (e.g., read, hear, view, touch). 4.2 Extract relevant information.</td>
</tr>
<tr>
<td>5. Synthesis</td>
<td>5.1 Organize from multiple sources. 5.2 Present the information.</td>
</tr>
</tbody>
</table>


Table 2. Implications of the challenges of using technology to access information (after McNaught, 2006, p. 39)

<table>
<thead>
<tr>
<th>Positive contribution</th>
<th>Challenges</th>
<th>Implications: Need for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>More information available to more people</td>
<td>Chaotic and fragmented nature of the Web</td>
<td>Guidelines to facilitate searching</td>
</tr>
<tr>
<td>Cross-referencing through hyperlinks</td>
<td>Poor navigation; being “lost in the Web”</td>
<td>Good navigation models</td>
</tr>
<tr>
<td>Large number of perspectives because there are multiple publishers</td>
<td>Difficult to find evidence of the authority of much material</td>
<td>Models of how to display information with adequate authentication</td>
</tr>
<tr>
<td>Finding appropriate information in a given area</td>
<td>Often only low level information is found, or information is out-of-date</td>
<td>Dedicated subject repositories with staff who keep them up-to-date</td>
</tr>
</tbody>
</table>
Information Literacy in the 21st Century

found in a relatively recent move towards the creation of “community digital libraries.” Digital libraries have existed for some time, with the focus being on how to best gather relevant and accessible digital collections. Cole (2002) describes the three primary constructs of digitization projects as digital collections, digital objects, and metadata. His checklists of principles for these constructs are recommended for those embarking or refining a digital library.

However, the “people” aspect also needs attention. As Wright, Marlino, and Sumner (2002) comment, “A community digital library is distinct through having a community of potential users define and guide the development of the library.” They were writing about a community digital library dealing with the broad subject domain of earth system education. The Digital Library for Earth System Education (DLESE, http://www.dlese.org/) has this description which clearly shows the three elements of material, activities, and people, showing a clear focus on “user-centered design” (Lynch, 2002):

The Digital Library for Earth System Education (DLESE) is a distributed community effort involving educators, students, and scientists working together to improve the quality, quantity, and efficiency of teaching and learning about the Earth system at all levels. DLESE supports Earth system science education by providing:

- Access to high-quality collections of educational resources;
- Access to Earth data sets and imagery, including the tools and interfaces that enable their effective use in educational settings;
- Support services to help educators and learners effectively create, use, and share educational resources; and
- Communication networks to facilitate interactions and collaborations across all dimensions of Earth system education. (http://www.dlese.org/about)

DLESE is a partnership between the National Science Foundation (NSF), the DLESE community that is open to all interested in earth system education, the Steering Committee, and the DLESE Program Center, a group of core staff. The concept of the library took shape in 1998, and is now governed by an elected Steering Committee that is broadly representative of the diverse interests in Earth system science education. Its future growth and development is guided by the DLESE Strategic Plan, which outlines the broad functionalities of the library to be developed over the next five years (2002-2006). Its goals cover six core functions: 1) collection-building; 2) community-building; 3) library services to support creation, discovery, assessment, and use of resources, as well as community networks; 4) accessibility and use; 5) catering for a diversity of user needs; and 6) research and evaluation on many aspects of community digital libraries.

It is this final core function that was the reason this example has been chosen for this article; there has been extensive evaluation research on the model. A search of the Association for Computing Machinery (ACM) digital library (http://portal.acm.org/dl.cfm) on “dlese” yields 200 papers. Two examples of particular relevance to the educational potential of DLESE are papers by Marlino and Sumner (2001) and Sumner and Marlino (2004). These papers (and others) show a clear endeavor towards ensuring that the needs of the earth system education community are a strong driving force towards the development of policy for the library.

FUTURE TRENDS

E-Books

There are many who assert that mobile learning (m-learning) will be the area of most significant advances in education. What implications does this have for information literacy? Flexible modes of learning have the potential to increase students’ engagement in learning through giving them more control over the nature of the learning content and activities, and over the time and place they study. Electronic format (e-format) books (e-books) are a recent technology with the potential to support flexible learning strategies by possibly improving access to information. E-books are downloadable and are portable if they are stored in light portable devices such as pocket personal computers (PPCs) or smartphones. The technology has also made possible a growth in the number of publications and a shorter publishing time. The use of electronic format books (e-books) is likely to grow as more books are either only made available in an e-format, or are available earlier in e-format than in the traditional paper-based format (p-books).
Information on collections of e-books is readily accessible on the Web. For example, there are 137 entries on a list of available e-book libraries (http://drscavanough.org/ebooks/libraries/ebook_libraries_list.htm). Collections of academic e-books are now also growing. One of the largest such collections is NetLibrary (http://www.NetLibrary.com), which, at present, houses more than 100,000 titles. The rising costs of p-books and the potential to link multimedia resources to e-books will have major impacts on the strategies used by university libraries in their support of scholarly communication (Ching, Poon, & McNaught, 2006).

E-books have many potential benefits. Briefly, these are: 1) access to more readings; 2) remote access which can save travel time; 3) searchable readings; 4) potential links to allied multimedia resources; 5) portable resources (a PPC can hold many books); and 6) optimizing reading time (e.g., during travel). However, the use of e-books involves several factors associated with 1) using new forms of technology and 2) adapting existing practices for reading and studying. Many innovations involving technology fail because these factors are not addressed. More needs to be learned about the usability and, especially, the acceptability of e-books. Effective strategies and support can then be formulated based on the identified challenges and opportunities.

Concerning acceptability, there is some empirical evidence which indicates that, once students can connect to the technology, they enjoy it (Simon, 2002) and even read faster (Wilson, 2003). On the other hand, there are negative reports of the difficulty of reading long text on the computer screen. “Most studies comparing paper and computer screen readability show that screens are less readable than paper” (Mills & Weldon, 1987, p. 329). Wilson (2003) also reports complaints about the ineffective navigational controls on e-book readers, as being “awkward, difficult or time-consuming to use” (p. 14) and “reading from the small screen was ‘painful’” (p. 11). These uncertainties about usability and acceptability of e-books strongly mandate in-depth investigations.

The “Wikipedia” Phenomenon and Web 2.0

Earlier I advocated the model of community digital libraries for the purposes of providing access to high quality information and relevant learning support for the development of information literacy skills in the domain of interest. Community digital libraries such as DLESE are quite structured entities. Can a model with more freedom offer the same information literacy support? “Wikipedia” (http://www.wikipedia.org/) is undoubtedly an amazing phenomenon with over 100,000 articles in a multitude of languages. There is a degree of self-regulation and some well-known claims to quality, for example, the recent often-cited study in Nature (Giles, 2005) claiming that Wikipedia articles are about as accurate as those in the Encyclopaedia Britannica. However, not all teachers are convinced and there are now some academic “bans” on students quoting from Wikipedia in university assignments (Jaschik, 2007). Wikipedia is just one instantiation of Web 2.0 which is an emerging form of Web design that focuses on structures “such as social networking sites, wikis, communication tools, and folksonomies that emphasize online collaboration and sharing among users” (Wikipedia; http://en.wikipedia.org/wiki/Web_2). It is likely that the next few years will see increasing interest in questions about whether, and if so how, online communities can provide accurate and timely information to people, together with the support they may need in evaluating and utilizing that information. There will be exciting times ahead.

CONCLUSION

In this article, I have indicated that good information literacy skills are a prerequisite to being an effective learner in the 21st century. Information literacy is much more than a simple ability to carry out searches in catalogues, online or off-line. A capacity to interrogate and evaluate information is required, and also an ability to contextualize the information in its social and cultural settings. All this implies a personal approach to the construction of knowledge. Technology can facilitate these processes, both through providing access to information and also through communication support to learners as they make sense of information and use it in knowledge-building. Community digital libraries offer a useful model in this regard. The growth of e-books and the nature of Web 2.0 technologies are certain to alter the opportunities and challenges for the growth of an information-literate society in the 21st century.
REFERENCES


KEY TERMS

**Community Digital Libraries:** A community digital library is a resource collection, often in a defined discipline area, that is developed and managed in a structured fashion by the community itself. The Digital Library for Earth System Education (DLESE) is a well-documented example of a successful community digital library.

**Critical Literacy:** The use of the word “critical” emphasizes two aspects of a holistic definition of information literacy. The word “critical” has connotations of evaluating information carefully, of making a critique of it. Another meaning of the word “critical” relates to its use in discussion of societal power; in this sense an information-literate person is one who realized the social, cultural, and political implications of information. Information is not value-free.

**E-books:** E-books are books available in electronic format, most often downloadable from the Internet. E-books should be distinguished from shorter online articles. The process of accessing and effectively reading significant parts of a book onscreen needs careful investigation in order to see if the electronic format can support the development of information literacy skills.

**Information Literacy:** Information literacy involves accessing, evaluating, managing, and communicating information.

**Learning:** Learning is a personal construction of knowledge. In order to learn a particular concept or skill, the learner needs to consider how new information relates to the existing understandings that the learner has. The process of sifting through available information in order to select the most appropriate information to use in knowledge construction requires the skills of information literacy. Good information literacy skills are a prerequisite for effective learning.

**Web 2.0:** As Web 2.0 is still an emerging set of technologies and standards, it is premature to give a definitive definition. The phrase was coined by Tim O’Reilly in 2004 (e.g., see http://oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-2-0.html) and refers to interactive and communicative Internet-based services where online collaboration is emphasized.

**Wikipedia:** An example of a loosely structured online resource collection where the information resources can be contributed by any person and the process of validating the information occurs voluntarily by members who consider themselves part of that community. The growth of Wikipedia entries has been rapid and there are now over 100,000 articles in many languages.
INTRODUCTION

New products and ideas are continually being developed and introduced into the workplace. A cursory observation of any field, for example, medicine, telecommunications, transportation, information management, or the military, will reveal a wide array of new technologies and techniques that have been introduced over the last decade. Many of these innovations have radically transformed the way we work and live. Innovative technologies are also radically changing the way we teach and learn. Among the most well-known recent examples of these learning technologies are multimedia, educational games, software for developing presentations, video conferencing, and the World Wide Web (WWW). In addition, the continuous expansion of the power and availability of technology means newer, better, faster, and cheaper technologies will always be available to assist educators in transforming the learning process.

The design, development, and use of learning technologies are processes synonymous with change and innovation. Any new technology offers a number of potentially important enhancements to the way people teach and learn (Surry, 2005). In order to better understand the inherent link between technology and innovation, we must first understand the historical development of learning technologies, and become familiar with the different characteristics of learning technology innovations.

BACKGROUND

The field of learning technology has a long history of innovation. Saettler (1968) traces the earliest learning technology innovations back to the instructional practices of the Elder Sophists in ancient Greece. Thorndike’s efforts to make the study and practice of education more scientific (Shrock, 1995) and Pressey’s early work with teaching machines in the 1920s (Troutner, 1991) are commonly cited as key factors in the birth of modern learning technologies. The success of large-scale training efforts during World War II led many researchers to focus on media, especially audiovisual instruction, as an important learning technology (Ely & Plomp, 1996). These seminal developments were followed by a series of major technological innovations including programmed instruction, instructional films, instructional radio, and instructional television (Saettler, 1968). Concurrent with the development of these new learning technologies, innovative theories such as formative evaluation, behavioral psychology, the systematic design of instruction, and criterion-referenced testing represented significant innovations in the teaching and learning process (Reiser, 2007; Shrock, 1995).

In addition to these older innovations, many other innovations in learning technology have been introduced in more recent years. Among the newer innovations are the Internet, electronic performance support systems, and learner-centered environments (Reiser, 2007). Jacobs and Dempsey (2007) describe a number of learning technology innovations that will have an impact in the near future including object-oriented programming to make the development of lessons easier, faster, and less expensive, electronic training jackets, and artificial intelligence. The number of innovations to enhance learning will likely expand at an increasingly fast pace in the future. As the pace of innovation quickens, educators will have to become more critical and better-informed consumers of innovation in order to allocate resources most effectively and to decide between competing technologies. Developing a framework for categorizing types of innovations will be a vital step in helping educators become better consumers of innovation in the future.

TYPES OF INNOVATIONS

Innovations come in a variety of forms. Many of the most well-known educational innovations have been technology-based, for example, computers, smart
boards, digital projectors, and virtual reality simulations. Other innovations have involved new processes or theories. Constructivist learning environments (Jonassen, 1991), authentic assessment, social learning (Bandura, 1977), and multiple intelligences (Gardner, 1993) are examples of process or theoretical innovations that have influenced the learning process in recent years. Still other innovations have had a more organizational scope. Large-scale school reform efforts, national curriculum restructuring movements, standardized assessments, and the emergence of fully online universities are all examples of organizational innovations that are currently in use.

Every change is different. Every new product or process contains a unique combination of characteristics that interact in complex, unpredictable ways. For example, some innovations require widespread modifications to an educational organization while others are limited to a small number of people. In addition to the scale of the innovation (widespread or local), there are numerous other characteristics by which an innovation can be described.

**Dimensions of change.** In an effort to understand the various characteristics of an innovation, to develop a standard terminology, and to create distinctive categories of innovation, many researchers have discussed the various dimensions of change. Pettigrew and Whipp (1991), for example, discuss a change in terms of its content, process, and context. Utterback (1996) describes innovations as being either incremental or radical. Siegler (2006) describes the dimensions of change from a psychological perspective as path, rate, breadth, variability, and source. Rogers (1995) writes that potential adopters perceive an innovation in terms of five attributes: relative advantage, compatibility, complexity, trialability, and observability. Gilbert (2001), writing specifically about learning technologies, offers four dimensions: individualization, standardization and access, personalization, and “communitization.”

At this point, there is no single widely accepted typology of learning technology innovations. Developing such a typology would be an important step in better understanding the potential for different categories of learning technologies to enhance education, and would lead to new insights into the complex problem of fostering innovative uses of learning technologies. It is likely that elements of a general typology would be based on the dimensions of change theories, and would include such basic characteristics as the form of the innovation (technology or process), its scale (macro- or micro level), sequence (synchronous or asynchronous), and intentionality (mandatory or voluntary participation).

**Form.** The form of an innovation refers to whether the innovation is primarily a product, a process, or a system. A product innovation is a tool or aid, such as a computer or a data projector. A process innovation is a new theory, practice, or instructional method, such as moving from pen and paper tests to portfolio assessments. While many researchers (e.g., Joseph & Reigeluth, 2005) combine the terms product and process, and correctly suggest that all innovations contain at least some aspect of both product and process, the two will be discussed separately here.

Product innovations can be defined as any new tool that is employed to the attainment of a goal. Product innovations (e.g., computers, projectors, wireless networks) are the types of innovations most people think about when they talk about technology. They are physical, tangible, and observable. Process innovations are more difficult to observe and harder to describe. They can be defined as any modification to an existing practice that is not dependant on new tools to be effective. Process innovations (e.g., new teaching techniques or theories) are less tangible and are often not thought of as technologies by most people. The current trend, however, is to use a broader definition of technology that includes not only tools and systems, but the scientific and technical knowledge needed to use the tools effectively (Cardwell, 1995). Under this broader definition, learning technology innovations include not only products such as computers, but new theories and practices, as well as new systems for designing, developing, and delivering instruction.

**Scale.** Scale refers to the impact an innovation has, or is intended to have, on an organization. In general, we tend to think about impact as being either macro level or micro level (Garcia & Calantone, 2002; Surry & Farquhar, 1997). Macro level innovations impact a broad spectrum of people or processes within an organization, often requiring significant modifications to the organization’s structures and policies. Macro level innovations are somewhat analogous to Utterback’s (1996) concept of radical (or discontinuous) innovations in that they often require an organization to completely rethink the skills, processes, products, and systems that are currently used. Implementing a macro-level learning technology change, a system-wide school restructuring...
Innovations in Learning Technology

effort, for example, is an extremely difficult process that requires a great deal of systematic planning (Joseph & Reigeluth, 2005). Utterback (1996) writes that macro level change is a “highly random and unpredictable process” (p. 209) and that many organizations fail to implement such changes fully.

Micro level innovations impact a limited number of people or processes within an organization, and usually require minimal modifications to the organization’s overall structure and policies to be effective. These are similar to Utterback’s (1996) concept of incremental (or continuous) innovations. The focus of micro level innovation is often the introduction and use of specific instructional products or practices in a localized setting (Surry & Farquhar, 1997). While more narrowly focused and smaller in scale than macro level innovations, micro level innovations, for example a “computers on wheels” program (Grant, Ross, Wang, & Potter, 2005), are still difficult to implement and use effectively.

**Sequence.** Sequence refers to the timeline in which an innovation is introduced into an organization. Innovations can be introduced synchronously or asynchronously. Synchronous innovations require everyone in the organization to move through the technology adoption process at the same pace, moving from initial awareness, to full adoption, and on to institutionalization (Surry & Ely, 2006) as a whole or in defined cohorts. Asynchronous innovations allow for individuals to adopt, implement, and utilize the innovation at their own pace, usually within broad timeframes. Implementing an innovation in an asynchronous manner accounts for a number of factors that are critical to the success of a change process including trialability (Rogers, 1995) and time (Ely, 1999), but is often impractical for organizational or technical reasons.

**Intentionality.** Intentionality refers to the latitude that potential users have to participate in an innovation. In general, participation can be mandatory or voluntary (Fullan, 1994; Williams & Williams, 2007). There is no consensus in the literature whether mandatory or voluntary participation is more effective in fostering the use of an innovation. For example, while Dawson (1981) found that voluntary participation was not a critical factor in teacher adoption of an educational innovation, Ndahi (1999) found voluntary participation encouraged faculty to use distance-learning technology. Ely (1999) suggests, however, that participation in the adoption process is an important factor in facilitating the implementation of an innovation.

The dimensions of form, scale, sequence, and intentionality provide a basic starting point for developing a typology of learning technology innovations but are probably not comprehensive. Other characteristics will also be needed to develop the final typology. Other characteristics that could be integrated into the final typology include the direction of the innovation (top down or bottom up) (Fullan, 1994), formality (formal or informal) (Williams & Williams, 2007), and a number of pedagogical characteristics such as interactivity and suitability for individualized or group instruction.

**FUTURE TRENDS**

It is impossible to predict with any accuracy the ways that technology will evolve or the rate at which that evolution will take place. It is possible, however, to examine current trends that seem likely to impact future innovations in learning technology, and to discuss potential research and development efforts that could help prepare educators for the rapid technological changes in the future.

Perhaps the most important trend to consider is the instability brought on by the continually expanding power of technology and the increasingly rapid pace of innovation. Nanotechnology, artificial intelligence, virtual reality, electronic performance support, and wireless communication are among the product innovations that will impact the future. New processes, practices, theories, and systems will also be developed and introduced. These innovative products, processes, and systems will grow, evolve, and combine to transform the learning process in the coming decades in ways that few people can fully comprehend today.

One potentially useful line of research, given the unpredictable and fluid nature of technology, is the development of a typology of characteristics of innovation. A well-designed, comprehensive, and widely accepted typology of innovation would enhance communication, foster exciting new lines of research, and provide a framework educators and policy makers could use in organizing and understanding future innovations.

Fostering utilization is a final important trend related to innovation and learning technologies. As more powerful, newer, and more complex innovations become available to educators, it will be essential to understand how to integrate these innovations into the learning environment. The most powerful and in-
novative learning technologies are useless if teachers and learners do not know how to use them effectively. Educational professionals will have to continually refine and upgrade existing educational change models (e.g., Hall & Hord, 1987) to account for changes to educational systems brought about by the rapid advance of technology.

In addition to these trends, researchers and practitioners in the field of innovation in learning technologies will face two major challenges in the future. The first major challenge will be to find the proper balance between innovation and stability. There is a natural tendency to be inspired by the potential of new, innovative, and exciting learning technologies. The danger, however, is that practitioners and researchers will become so seduced by new technologies that they abandon older, less “cutting edge” ones without fully understanding how those older technologies could be used most effectively.

The second challenge faced by learning technologists of the future will be to ensure that the human element of learning does not become secondary to the technological element. Learning is fundamentally a human, social process. Technology has the potential to dramatically improve the way people learn. Used correctly, it can provide powerful tools to teachers and learners, and allow for learning experiences that are unique, inspiring, and life altering. Technology also has the potential to dehumanize the learning process, to perpetuate social injustices, to become overly politicized, and to be used as a tool for propaganda and control. Educators and administrators will have to stay constantly aware of these potential problems, and put in place appropriate safeguards to ensure innovative technologies are used equitably and intelligently.

CONCLUSION

We live in a world of innovation. For better or worse, new products and ideas will continue to be developed and introduced into society. Many of these innovations will eventually find their way into the field of education and training. As newer and more powerful technologies become available at an ever-increasing pace, educators will be forced to become critical consumers of innovation. Educators will have to understand which innovations have the most potential to impact their students, and know how to effectively merge sound, time-tested pedagogy with innovative tools in order to take fullest advantage of the possibilities offered by learning technologies.

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Innovations in Learning Technology


Available at http://www.usq.edu.au/elec/pubs/e-jist/docs/old/vol2no1/article2.htm


KEY TERMS

Dimensions of Change: The characteristics of an innovation that interact to define an innovation’s impact within an organization. Dimensions can include form, scale, sequence, and intentionality.

Innovation: Any tool or process that represents a new or creative method for accomplishing a goal.

Learning Technology: Any tool or practice that is employed to support the acquisition, retention, and transfer of knowledge and skills.

Macro Level Innovations: An innovation that impacts a broad spectrum of people or processes within an organization, often requiring significant modifications to the organization’s structures and policies.

Micro Level Innovations: An innovation that impacts a limited number of people or processes within an organization, usually requiring minimal modifications to the organization’s structure and policies.

Process Innovation: Any modification to an existing practice that is not dependent on new tools to be effective.

Product Innovation: Any new tool that can be employed to the attainment of a goal.

Technology: Any tool or process for accomplishing a goal.
Instructional Design: Considering the Cognitive Learning Needs of Older Adults

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INTRODUCTION

Because of the growing number of older adults per total population, discussion has grown regarding the cognitive learning needs of older adults. In this article, I will look at what research has discovered and what actions have been taken in regard to meeting those needs. I also wanted to know whether instructional designers needed to consider those learning needs in their instructional design practices.

But why should instructional designers even consider the cognitive learning needs of older adults? Aren’t these older adults past the point of learning or having the need to learn? Aren’t they just going to retire, relax, travel, do hobbies, visit the grandchildren, and live off of their retirement income?

Maybe currently, or in the past, older adults would have gone about ageing this way, but we as a society are approaching a new phenomenon that we have not experienced before. Our society is ageing and ageing rather rapidly.

Why? Because the baby boomer generation is beginning to reach retirement age. Baby boomers are those adults born in large numbers after World War II, from about 1946 to 1964. Because of the approaching retirement of such a large number of these workers, there will begin to be a huge economic and social impact on our society. In the 1950s there were seven workers to support each retiree, but by 2030, there will be less than three workers to support each retiree. This will create a huge burden on our society that will require that older workers be kept in the workforce as long as possible to help meet not only their own needs, but the needs of others (Committee for Economic Development, 1999).

Because economically and socially it will be impossible for less than three workers to support one retiree, we have to make sure that older adults remain in the workforce as productive contributors. Also, there will be so many baby boomers retiring that there will not be enough younger generation workers to take their place (Committee for Economic Development, 1999). These facts create an immediate need for instructional designers to begin considering older adults in educational and training instruction. Instructional designers must become more aware of ageing and the cognitive learning needs of older adults. Designers must understand these needs because they will become responsible for creating instruction for older adults to train and educate them to remain in the workforce.

Instructional designers also need to concern themselves with the learning needs of older adults because more and more older adults are remaining in the workforce and continuing to learn. Older adults therefore will need continued training and education on new technologies as they are developed and other issues as they arise in the workforce. Research is also beginning to suggest the importance of lifelong learning for one’s own well-being (Cusack, Thompson, & Rogers, 2003, pp. 401-402).

INSTRUCTIONAL DESIGN AND COGNITIVE LEARNING

If older adults are to continue to be a part of the workforce, they must continue to be educated and trained. Therefore instructional designers will have to develop instruction and training for older adult learners.

During the instructional design process the designer goes through three phases of instructional development: analysis, selecting strategy, and evaluating. During the analysis phase, the designer not only analyses the environment in which the instruction will take place, but also learns as much as he/she can about the learners receiving the instruction. The designer should seek
answers to such questions as: where will the training take place, how much time is available for the training, and what kinds of knowledge do the learners already possess (Smith & Ragan, 1999, pp. 5-6). Because the analysis phase of the instructional design process is so important in analyzing the learner, I wanted to spend the most time looking at this area as it relates to cognitive learning in older adults.

Cognitive learning theories dominate the instructional design practices of today. These theories place much more emphasis on the internal factors of the learner than on the external factors of their environment. “The learner is viewed as constructing meaning from instruction, rather than being a recipient of meaning residing alone within instruction” (Smith & Ragan, 1999, p. 20). Therefore, when considering the instruction of older adults, their cognitive learning abilities must be understood.

Cognitive psychology plays a very important role in the analysis phase of the instructional design process. The analysis phase places much more emphasis on prior learner knowledge and the organization of this knowledge, because the learner plays much more of a constructive role according to cognitive learning theories. Much more information is sought about the learners’ ability to process information, their attitudes, motivation, and interests because these are strong factors influencing their learning (Smith & Ragan, 1999, p. 22). In understanding these factors, the instructional designer is much better prepared to meet the learning needs of older adults.

LEARNING NEEDS OF OLDER ADULTS

One of the most important steps in analyzing the learner regarding factors affecting their cognitive learning is to determine what their learning needs are. Therefore, what are the learning needs of older adults?

In Purdie and Boulton-Lewis' (2003) study of the needs of older adults, they discovered that technical skills and knowledge, health and safety, leisure and entertainment, and life issues, in the order listed, were the main learning needs facing older adults. The most frequently mentioned technical skills were how to use a computer, how to operate an ATM, how to do phone banking, and how to use or program a stereo, VCR, or TV. These older adults also mentioned they would like to know how to use e-mail, a credit card, an answering machine, and a microwave (Purdie & Boulton-Lewis, 2003, pp. 133-134). Older adults are faced with many technical needs that instruction and training could help alleviate.

Regarding health and safety, the Purdie and Boulton-Lewis (2003) study revealed that this older age group wanted to know how to manage their health problems, such as losing sight in one eye. They also wanted to know how to obtain information from their doctors regarding particular ailments they had. Sometimes they felt embarrassed because they did not understand what the doctor was telling them about a health problem and therefore did not ask questions (Purdie & Boulton-Lewis, 2003, pp. 134-135). They wanted to learn more about managing and understanding their own health and health-related matters.

In the area of leisure and entertainment, a variety of learning needs were identified by the older adults in the Purdie and Boulton-Lewis (2003) study. They wanted to learn things like how to garden, how to paint, and how to play a piano. Life issues that they need to know included how to keep their financial records and how to deal with the loss of a spouse (Purdie & Boulton-Lewis, 2003, p.135). With such a broad base of educational and training needs, instructional designers should become very aware of the instructional requirements of older learners.

Maintaining an educated and skilled older workforce creates the same kinds of learning needs that younger workers have. Koopman-Boyden and MacDonald (2003) maintain that in order for us to maintain the older workforce in the future, we will need to invest in ensuring that older workers have the same opportunities for education and training that younger workers have. Older workers need to be challenged and given new roles just as the younger workers are (Koopman-Boyden & MacDonald, 2003, p.). Older workers must be kept in the workforce, they must be kept trained, and they must be treated as well as the younger workforce is treated.

BARRIERS TO COGNITIVE LEARNING IN OLDER ADULTS

Just because the learning needs of older adults can be identified, does not necessarily mean these needs will be met or for that matter will even be considered. Older adults experience many barriers to learning as
discovered by Purdie and Boulton-Lewis (2003). These barriers include not only physical problems, but cognitive matters, self matters, and social factors (Purdie & Boulton-Lewis, 2003, p.136).

Physical problems identified by Purdie and Boulton-Lewis (2003) included “reduced mobility, illness, degenerating sight, and hearing” (Purdie & Boulton-Lewis, 2003, p.136). Other examples of physical problems of older adults included not being able to sit for extended periods of time, poor hearing because of meningitis which was a common childhood ailment that was not medically treated as well as it is today, not being able to get on a bus or train without assistance, and arthritic knees that reduce mobility (Purdie & Boulton-Lewis, 2003, p.136). They also experience safety concerns because many times they live alone and have to take care of themselves because of the passing of a spouse. Also they are not as strong as they once were and feel more vulnerable to violence.

In the Purdie and Boulton-Lewis (2003) study, the largest barriers to learning were identified as cognitive and self matters. The older adults identified such barriers as not being able to remember sequential procedures as well, not being able to concentrate for extended periods, and some had learning disabilities as youth that had never been addressed in their lifetime (Purdie & Boulton-Lewis, 2003, pp.136-137). Research on performance-based behaviors like those above show that intellectual capabilities do not decline significantly if at all until a much older age (Koopman-Boyden & MacDonald, 2003, p. 33). Barriers regarding the self-included references to attitude included statements that said learning was “not necessary,” “don’t need to know,” or “not worth the effort” (Purdie & Boulton-Lewis, 2003, pp.136-137).

Older adults also had less confidence in their learning abilities, particularly as they relate to technology. Cost barriers were present in preventing older adults from acquiring computers and other technology for their personal use (Purdie & Boulton-Lewis, 2003, p.145). Most older adults could not afford the technology they wanted because of their income, and because they did not grow up with technology as younger adults, they were not as sure of themselves in using the technology.

A study in New Zealand showed that while the majority of employers preferred older workers’ expertise, stability, and loyalty; these same employers acknowledged that they discriminated against the older worker by hiring employees aged 25 to 50 years. Employers openly discriminated because they felt that older workers had age-related illnesses or lacked motivation to learn new things or to change. Research has shown that older workers are not incompetent when it comes to training but they are exposed to insufficient training or training that is poorly designed (Koopman-Boyden & MacDonald, 2003, pp.34-35).

Jennings and Darwin (2003) also found that age-based stereotyping plays an important role in how older adults perceive themselves. Older adults tend to see their memory performance and cognitive abilities more negatively than younger adults and discriminatory practices such as stereotyping decrease their confidence in these abilities (Jennings & Darwin, 2003, p. 72).

These discriminatory social practices present learning barriers for older adults by creating low self-worth and the perception that they are no longer needed or wanted in the workplace. Older workers are led to believe that they can no longer learn or contribute because of employer practices such as this. Research on training for older adults has suggested that their perceived incompetence may not be due to age, but to lack of proper training and poor training design (Koopman-Boyden & MacDonald, 2003, pp.34-35).

SUGGESTIONS FOR OVERCOMING BARRIERS TO COGNITIVE LEARNING IN OLDER ADULTS

Koopman-Boyden and MacDonald (2003) find that age-related stereotypes still remain regarding the work performance of older adults, but that cognitive and physical changes associated with ageing can be modified. Older adults can be assisted in overcoming barriers to cognitive learning by properly designed training programs, flexible training schedules, and employer education and recognition of their learning needs (Koopman-Boyden & MacDonald, 2003, p. 29).

Several studies have placed the level of early life education and ongoing intellectual activity as two principal factors in maintaining a high cognitive performance in older age. Successful ageing has also been attributed to an active social involvement where personal isolation is avoided. A positive attitude also tends to increase the life span of the older adult and several studies have found that religion was also a positive factor in the older adult’s life. All of these factors tend to increase the well-being and the cogni-
tive abilities of the adult learner (Koopman-Boyden & MacDonald, 2003, pp. 31-32).

Variations in skill and differences in aptitude should be considered by the instructional designer when considering training for older adults. Designers should realize that older adults do not learn the same way or at the same rate as younger workers, but that this does not mean that they cannot learn. Older workers learn better among their own age group and at their own pace. Instruction for older workers must be flexible and relaxed in order to reduce their anxiety (Koopman-Boyden & MacDonald, 2003, pp.35-36).

CONCLUSION

Halpern and Hakel (2003) in their article, “Applying the Science of Learning to the University and Beyond,” discuss how although every college teacher has an in-depth study in their academic area, they have little if no formal training in adult learning, memory, or learning transfer. College teachers learn about adult cognition through practical trial-and-error teaching rather than through formal training, and use what they know about this subject very little if at all in the classroom. The science of human cognition is based on a solid foundation and research-based applications that can and should be used in the college classroom and by instructional designers in developing instruction for older adults. Halpern and Hakel (2003) reveal in their article that what cognitive training instructors receive is rarely practiced. Most instructors practice instruction as they received instruction themselves (Halpern & Hakel, 2003, p. 36-37). Thus, in order for the learning needs of older adults to be understood, barriers overcome, and successful transfer of learning accomplished, it is vitally important for the instructor as well as the designer to receive more instruction and application on the cognitive learning needs of older adults.

Research has provided evidence that mental decline is not a consequence of aging. There is hope that continued learning prevents or delays mental decline. Results also show significant improvement in memory and confidence in one’s mental abilities through personal physical and mental fitness.

Learning is the best medicine after all. The greater challenge is to position education as an essential life practice for quality of life across the lifespan. (Cusack et al., 2003, pp. 395-402)

After reviewing this article, maybe you have a clearer understanding of why it is necessary for instructional designers to consider the learning needs of older adults. The designers need to not only understand the learning needs, but also the barriers to learning and how to overcome these barriers. After all, with the approaching retirement of so many older adults from the workforce, the continuation of the older worker in the workforce is our future and their learning needs have to become important to all of us.

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KEY WORDS

Baby Boomers. Those born during the post-World War II period of increased birth rates. In the United States the term applies to those individuals who born during this period of increased birth rates from about 1946 to 1964.

Barriers. Anything that bars passage to learning or discovery. The obstruction or limitation of learning by a number of factors in the particular environment.

Cognitive. Refers to the information processing view of an individual’s psychological functions. The process of knowing consciously or subconsciously.

Cognitive Psychology. The school of psychology that examines internal mental processes including language, memory, and problem solving. Cognitive psychologists are interested in how people understand, diagnose, and solve problems.

Instructional Designers. Those who practice the arrangement of media that helps learners and teachers transfer knowledge most effectively. Designers who determine the current state of the learner understanding, define the end goal of instruction, and create media-based intervention to assist in the transition.

Performance-Based. Performances that are created or produced to do something often in settings that involve real-world applications of knowledge and skills. Performance behaviors that involve real-world applications.

Stereotyping. Ideas that may be positive or negative that are held about members of particular groups. These ideas may be used to justify certain discriminatory behaviors.

Technologies. Material objects that benefit humanity and include machines, hardware, and utensils. These materials are predominantly used to assist a species’ in controlling and adapting to its environment.
The field of nursing is presently subject to keen changes and these processes of change are determined by different variables. On the one hand, stringent cost pressure is being exerted on all western health systems from which an increased need for transparency, measurability, feasibility, and design potential is derived, and on the other, the nursing sciences are academically a highly prospering field at the moment. Within the nursing sciences, efforts for standardisation, process design, quality assurance, and evidence-based nursing are currently being made. Putting these two currents together, it is almost inevitable that the relevance of nursing informatics (NI) increases and not just because a greater need for IT tools has arisen through increasing digitalisation of the nursing process in applied nursing. This has two consequences. First, the nursing staff—irrespective of whether they are still in training or already practicing—has to deal increasingly with nursing informatics and nursing IT tools and learn how to put this into practice. Second, the specifications of knowledge transfer have to be considered within the nursing sciences if this process is to be successful. This means that IT tool application programmes cannot be restricted to acquiring particular functionalities, rather it revolves around the observation and organisation of actual nursing scientific knowledge transfer. If one desires to approach the topic of integrated curricula in nursing education, then the focal point surely lies in the perspective of integration. The combining of IT tools, nursing scientific knowledge transfer, and applied nursing portrays a necessity. Alternately, the term ‘nursing education’ is a broad one. It concerns vocational and academic training as well as the interactive element between applied nursing and the nursing sciences.

Through standardisation and the thereby feasible digitalisation of the nursing process, the specialist area of nursing informatics is beginning to take up more and more room within the nursing sciences. Against this background, we have to ask the question of the necessary knowledge transfer actually between the nursing sciences and applied nursing and also of the training of practicing nurses in the area of nursing informatics. Looking at international programmes which are supposed to train practicing nurses in the use of nursing IT tools, the national orientation of these programmes can be noticed. For example, a nursing informatics group from the University of Sao Paolo in Brazil was formed in 1990 which developed a multilevel top-down programme in the training for nursing informatics. Beginning with the integration of NI into doctorate programmes, a broad-ranging trainings concept was then developed (Marin, 1998). Similar national strategies were carried out in other countries and the USA in particular took a leading role (Herbert, 2000). Even early on, the need for skills in the branch of NI for nurses had been worked on by scientists (Adam, 1996) and the dimensions of NI defined (Simpson, 1999). Practically all academic schools of nursing now offer wide IT training programmes (Nursing Informatics Programs, 2007). On the one hand, the training refers to specialists in the branch of nursing informatics who create data organisation and knowledge transfer (Graves & Corcoran, 1989), and on the other, the programmes attempt to familiarise practicing nurses with the IT tools and support and further develop the nursing scientific information process (Staggers, Gassert, & Skiba, 2000). In Europe, these training programmes are also being increasingly developed and offered. In Finland for
example, a programme for the technologically orientated training of nursing instructors has been scheduled \{7\} and in Denmark it is being attempted to combine informatics and pedagogics in a special programme \{8\}. The particular challenge in the branch of nursing informatics and knowledge transfer in nursing is the fact that a notably broad field for knowledge transfer in nursing science has been opened due to standardisation processes. However, we must observe that the gaining of knowledge in nursing is not exclusively one-dimensional. It is rather more a transfer process from science into practical experience and vice versa. Also, when considering the question of this knowledge transfer which concerns both nursing scientific findings and nursing informatics skills, it is not just the trainee nurses who are the main focus, but also the nurses who are already practicing (Bakken, 2001).

**NURSING PROCESS AND KNOWLEDGE TRANSFER VIA ICT**

**The Nursing Theory-Practice Gap**

An important question posed by knowledge transfer within nursing systems is that of the theory-practice gap as described in nursing science (Staudinger, 2006). Here it is about the problem of how the findings of nursing science are to be implemented in practice.

Within the subsequent consideration, the question is primarily posed to the requirements for the transmission of scientific findings into nursing practice. We can see this as a question of process-orientated operation quality and the application of a possible knowledge transfer (McDaniel, 2003).

It is striking that the fact that this ‘gap’ exists has not been challenged in newer literature. Rather, practically all significant authors presume the existence of this gap and develop—according to their viewpoint—various theories for the solution of the problem. This problem, however, is principally discussed in context with knowledge transfer within the framework of nurse training. The European Union Advisory Committee (1989) has also taken on this problem.

In the introduction, the committee states, ‘The Advisory Committee on Training in Nursing had recognised that in all member states there is a gap between the theoretical and practical aspects of several training programmes for general nursing.’

In the justification and presentation of the facts within the guidelines, the committee concentrates on the discussion taken up by Anglo-American and English nursing scientists.

In the presentation of the facts, six points are listed which are given as the cause of the gap between practice and theory. It is noticeable that this reasoning shows considerable restraints to current nursing literature on this topic and does not concern itself at all with the structure quality of knowledge transfer from science to practice. Rather it refers to the form, content, and social status of teachers and students of nursing schools\(^1\).

Already in the early nineties one can find the perception that methodical knowledge transfer has to be awarded new significance (Hawkett, 1990) even if the nursing professions are practice-orientated and important learning processes take place in practice (Rafferty, 1992).

For nursing informatics, this means that information or gaining of knowledge from practice has to take a systematic reflex into consideration, either in the nursing sciences or in generally accessible sources of information (Bemmel & Musen, 1997).

Larsen, Adamsen, Berregaard, and Madsen (2002) have presented an important study regarding this problem. In their study, the authors examine the relationship between the academic nursing sciences and applied, practice-orientated nursing on the basis of social scientific methods. The focus of the study was placed on the knowledge and essential content of the various approaches and formulated the statement that nursing science ‘has the right’ to develop academically based knowledge irrespective of the practicability on operative levels, and vice versa, practice-orientated nursing has a justified autonomy in connection with the generation and dissemination of practice-orientated ‘know-how.’

Clinical nursing is defined among other things by the fact that the members of the nursing profession would learn from each other and therefore would become ‘active producers’ of relevant nursing scientific knowledge admittedly based on other methods, than is the case in academically orientated nursing.

The authors therefore assume that there is no gap ‘per se’ between theory and practice, rather it has to be examined which orientation and self-image is predominant in theory and practice with respect to the question of the gaining of knowledge and which barriers have to be overcome on exchanging knowledge.
Two vital research questions were posed: How is knowledge produced and transformed within the profession?; and, From where do researchers and practitioners obtain their inspiration for their research activities, and to whom do they disseminate their knowledge?

In the part of knowledge acquirement in practical nursing, the authors were able to prove that the contents of the nursing sciences do not play an important role in a closer academic tenor.

They also state that practicing nurses cannot expect theories and models to be directly in the position to rectify tasks and objectives or clinical-nursing problems. But reciprocally, the nursing scientists indicate that their own research themes are massively influenced by clinical practice issues which have to be answered with academic methods employed in theoretical nursing sciences.

Following these statements, the challenge of integrating the standardisation and classification of new findings into the whole system in context with the development of a uniformly international specialised language and a uniform nursing minimum data set (NMDS) for nursing informatics will most certainly arise (National Health Service [NHS] Information Authority, 2004).

Referencing the international nurse education, it seems important to develop strategies to bridge the gap between theory and practice. In newer literature, the consensus seems to rule that such a conception has to be comprehensive on the one hand and take as many aspects of the problem into consideration as possible. On the other hand, the strategies have to take the different profiles of theory and practice knowledge acquisition into account.

J. Bevan (2003) describes such a comprehensive approach. The author reports on a programme which had been developed, introduced, and evaluated at the Adam Linton Dialysis Station in London. This extensive approach assumes improvement of nurses’ professional skills with the aid of clear and communicated standards. These standards are underlayed with knowledge content from both theory and practice. The focus is on the connection between theoretical findings in this area as well as in clinical issues and findings. The patients are also involved in this process. The clinical outcome orientates itself on the clinical data, patient satisfaction, and satisfaction of the nursing staff.

The presented figures show that through integrative, theory supported model on the basis of evidence-based, IT-supported nursing, a remarkable improvement of nursing outcome was able to be achieved (e.g., a considerable decrease in the infection rate). Simultaneously the satisfaction of the nursing staff increased as well as that of the patients.

An important requirement for the success of this model was that from the beginning of the project nurses were involved in defining the working processes in work-groups and that open communication was encouraged continually both during the designing and implementation of the model.

Even without it being mentioned by the author, we can assume that the ‘straightforwardness’ of the project had a positive effect on the success of this exemplary model.

The Role of Nursing Informatics

Against the background of the claim for evidence-based nursing, nursing informatics tools in association with knowledge transfer are of particular importance (Staudinger, 2006). It is likely that the motivation for structuring nursing work originates from different ambitions (Ammenwerth, 2003), but the fact remains that highly structured nursing in connection with clear quality structures on evidence-based foundations have to be realised almost inevitably IT-supported. This implicates the necessity to grant high priority to training and education in IT employment, respectively IT integration into practice (Toofany, 2006).

As a survey from Schaubmayr (2004) has shown, the demand for and acceptance of informatics tools of Austrian practical nurses is described as very high. Facing this is the fact that more than 90% of Austrian nursing care facilities have no digital nursing documentation systems. Additionally the systematic integration of research findings in the area of nursing sciences can not be credibly identified. This concerns the scientific background of the nursing process as well as the field of quality assurance and outcome measurement. This also corresponds to Ammenwerth’s (2003) acceptance study which states that important groups of nurses have ‘reservations’ about computer-supported nursing and digitally-supported, scientifically orientated nursing processes.

Regarding with newer examinations it seems to be interesting that Hacker Chana (1992) declares that ‘Keeping a written care plan for each patient is the best
way to document the nursing process.’

In literature, a broad compliance exists about the need for nursing informatics as a structural element in order to support the practical nursing process scientifically.

As also stated at the 2003 AMIA Symposium, the increased need for electronic nursing documentation arises particularly from the fact that patients who are documented by hospital information systems throughout their entire hospital stay then require case-relevant data within the framework of their medical, but also nursing, aftercare.

To exclude nursing care facilities from this stronger networked chain of treatment and to not define the interfaces between the facilities would mean a contradiction in terms (Poon, Wald, Bates, Middleton, Kuperman, & Gandhi, 2000). On the whole, a trend in literature towards an ‘integrated patient record system’ can be recognised. The reasoning being that due to altered treatment processes, a higher degree of standardisation on every level of the treatment chain is claimed on the one hand and this degree of networking results in processual and data-wise integration on the other (Guise, 2003).

Particularly where not only vertical connections between single treatment stages but also interdisciplinary horizontal networks based upon persistent treatment pathways develop an integrative nursing informatics and a nursing process designed with respect to evidence based nursing can be considered as an elementary condition for successful network integration (Staudinger, 2002, 2004).

The tools for planning and documenting the in-house nursing process serve as a core element, whereby a distinct scientific nursing process definition has to be adhered to. Obeying the nursing science standards the researcher will be enabled for a comprehensive patient observation on a timeline as well on nursing intervention categories.

According to newer literature, no medical facility in an integrated health system is seen as a ‘closed shop,’ rather as a part of a network which ultimately leads to internal processes and documentation as well as support of IT tools being made able to communicate with other facilities (Canadian Nurses Association (CNA), 2006).

Within a healthcare system, healthcare providers such as hospitals, doctors, nursing homes and other caring facilities act on an operative level and are engaged as a coequal network partner (Boswell & Canon, 2005). As western healthcare systems are hierarchically structured, the healthcare providers are controlled and financed by superior institutions which allocate and exploit the single case data collected within the caring facilities on a multitude of criteria and aspects in order to prepare for strategic decisions concerning the entire system.

The requirements for suggestive data allocation are clear structures, traceability of data, consensus about data formats and interfaces, a common terminology a feasible scientific background, clearly communicated quality and output criteria, and finally transparency in the area of case management.

In this context, nursing informatics is to be understood as an important structural element both internally—within nursing care facilities—and externally in combination with all other healthcare providers and higher-ranking structures (CNA, 2006).

Knowledge Transfer via ICT

As mentioned earlier, attention is put on a desired bidirectional exchange of information and knowledge between practical and theoretical nursing (Käppeli, 2005). Nursing sciences developed under the aspect of standardisation of nursing activity levels. This development occurred under an international perspective and brought up a uniform nursing language and nursing taxonomy systems that shape of nursing activity catalogues.

Actually the nursing activity catalogues in the shape of nursing classification systems have not yet reached sufficient implementation into practical nursing (Simpson, 2006). Application of these catalogues into nursing practice leads to remarkable extension of nursing documentation, resulting from the comprehensiveness of all nursing classification systems. If nursing activity catalogues shall be successfully implemented into nursing documentation, the registration of the data should not only serve for knowledge acquirement for theoretical nursing or as a calculation basis for economic yields, but rather working nurses directly should benefit for their work, all the more as practical nurses already criticise the actual amount of documentation work which prevents them from the patients and clients.

This complex situation in generating nursing data can only be realised through specific nursing informat-
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informatics tools which are suitable for supporting documentation work from both a nursing scientific viewpoint as well as a practical nursing viewpoint (Coopey, Nix, & Clancy, 2006).

Primarily, the nursing process should be clearly pictured in documentation systems so that it is possible for nursing staff to intuitively allocate nursing data to the individual process steps of the nursing process. On top of that, all catalogues compiled by the nursing sciences should be worked into the NI tool so that the individual formulation work done by the nurses is minimised (without restricting patient-related individualisation possibilities) and the relation to nursing scientific foundations is given.

Analyses about data collected in this way also consequently fulfil the requirements—particularly with regard to terminology and classification of data—of the structures of theoretical nursing science. For practicing nurses—especially in long-term care—the use of the data represents a certain advantage for their work. They are able to complete the reports needed for the nursing process and use them directly for the care of patients according to arbitrary criteria. Further, they have the possibility to produce analyses for nursing science. Particularly in the field of evidence-based nursing, they are able to make a valuable contribution to the further development of the nursing profession through correctly reported and analysed nursing data.

As another important aspect, with the background of solid nursing data, nursing executives (Titler & Everett, 2006) are able to take part in decision making either in the scope of their own care facility or even contribute into decisions about health and social politics (Werley et al., 1991).

Necessary ICT Integration into Education

In the training of the nursing professions, many countries have reacted to the necessity for IT skills of future nurses. Various investigations (Yee, 2002) were carried out on the IT requirements for the later career (Hobbs, 2002) and the IT skills were taken into consideration in the curricula. It is noticeable in current training plans that primarily general IT skills such as word processing and the use of spreadsheets are promoted. Increasingly, training for the particular documentation system that is used in the training hospital is also integrated into nursing education. Future demands on nursing staff will comprise understanding of data structures of nursing documentation as well as being able to answer issues which arise from daily clinical life deploying quantitative research methods focusing on evidence-based research. Through this they are able to achieve feedback to theoretical nursing (Reno, Ferket, & Reshoft, 2005).

In the future, graduates of the nursing profession need more basic knowledge of abstraction of data structures, the preparation and analyses of databases, the integration of nursing research into nursing documentation, and means and instruments of quantitative research (Smedly, 2005), additionally to the basic skills in the use of standard software and hospital medical and nursing documentation.

Under the condition that information and communication technology (ICT) find entry into daily nursing as a means of communication between theoretical and practical nursing, the resulting permanent bidirectional flow of information and knowledge will considerably contribute to closing the theory-practice gap and further promote the development of nursing as a profession and a science.

Development of Nursing Informatics Professions

Nursing informatics has established as a discrete profession within the last view years. Its focus is the development of electronic tools which cover the need for information in nursing science and practical nursing. It will expand in the direction of technical development, as is the case with medical informatics, and on the other, data management and the management of data structures, which have a technical as well as nursing scientific relation, will be needed as interface professions. The main task of nursing informatics is to realise nursing information systems integrating the wide spectrum of nursing scientific requirements (Masys, Brennan, Ozbolt, & Shortliffe, 2000). Beside this, all over the world nursing education has risen in its academic level and has been brought from nursing schools to university bachelor, masters, and doctoral programs. This academic level is also the condition for fundamental education in the specialist field of nursing informatics.

With the growth of importance and the changeover to academic level, IT skills are also taught on a broader scale. For nursing scientist, less technical skills are
required than for nursing informatics specialists, but both need capabilities in quantitative and qualitative research methods. Basic skills in knowledge management and information retrieval shall be integrated into education.

FUTURE TRENDS

Triggered by the structuring of the nursing process and the following digitalisation of nursing activity into retrievable nursing data the mechanisation by implementation of nursing informatics into nursing care facilities will rapidly precede. This represents also a remarkable enrichment of decision support in nursing care provision.

Due to this achievement, nursing informatics will quickly establish on the scientific as well as on the economic market. Although the trend is already visible the situation will enforce strongly.

For nursing professionals the extension of technical support as well as the integration of health and nursing care institutions into networks means a further mechanisation of their working environment. Theses changes have to be considered in the various education pathways by extension of IT skill training for all education levels.

Particularly the challenges surrendered by evidence based nursing practice cannot be taken without technological assistance. At least the nursing curricula of higher education levels will be broadened by information technological and communication technological basics additionally to appliance training for nursing IT tools.

Facing the high velocity of mechanisation in the field of nursing practice a huge need for further education for employed nurses is expected to increase.

CONCLUSION

Within the last two decades not only the field of nursing itself but also the nursing professions and their educations were subject to a remarkable evolution. The development results from various impacts. Increasing cost pressure perceived in the entire healthcare systems certainly is one reason why the nursing profession had to define and systematise its scope of work. But also nursing professionals themselves raised numerous initiatives in rethinking and modernising of the occupational image of nursing.

Through the definition of nursing working fields the foundation for nursing sciences was laid which gained their field research. The effort made in describing and structuring nursing in order to generate a basis for quantified report on nursing performance as well as for future oriented calculation of nursing needs have led to the necessity of registration of nursing data. Nursing documentation—due to the bulky nature of nursing data and nursing data sets—can not be accomplished without electronic support. Although professional nurses have apparent reservation against computer deployment in their daily nursing practice the information technology can not be abandoned by nursing. The resulting necessity of information technology skills of nursing professionals had been registered by the education executives and IT training was integrated into nursing curricula, particularly in the curricula of academic apprenticeship. The manifold tasks nurses are confronted with particularly in context with evidence based nursing practice is not sufficiently charged in actual nursing education systems. The cardinal trend of IT training in nursing curricula is of a general basic target. Primarily word processing and use of spread sheets, on various occasions also training for the usage of medical and nursing documentation system deployed in a training hospital, is given. Superior knowledge of information technology such as database management, or similar rather technical basic knowledge like information retrieval, have not yet become part of the training.

Traditionally nursing education consists of a theoretical component and a practical experience component which nursing students acquire under supervision and support of experienced practical nurses. Between the two educational components exists a cleft which is experienced as discrepancy. This gap—termed in literature as theory-practice-gap in nursing—could be considerably reduced by managing the opportunity of a permanent information and knowledge transfer.

As a result of the extensive evolution of nursing science, another scientific field rather than a technical discipline has developed, called nursing informatics. Systematic education pathways have been set up in the last few years. Regarding the enormous need of data and software of nursing sciences, but also nursing care facilities, this discipline can be assumed to
be briskly prospering; even more as single health and nursing care institutions get stronger networked not only in an organisational but also in a technical sense. This tendency is due to the endeavour of developing an integrated electronic health record which should grant continuity in medical and nursing treatment to the patient.

Bringing the abovementioned aspects of the nursing environment into account it becomes apparent that the actual training of basic IT skills can not be considered to be sufficient, especially for the higher graduation levels. An extension of information technology knowledge and skills seems to be obligatory. Though nursing hardly is a technical discipline in basic levels, for higher education levels the presence of rising technical support of nursing profession should be regarded and the qualification for coping technical issues related to nursing should be given.

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**KEY TERMS**

**Evidence Based Nursing Practice:** An attempt to more uniformly apply the standards of evidence gained from the scientific method to certain aspects of nursing practice.

**Knowledge Transfer:** The transfer of knowledge from one part of an organisation to another, but not just on a communication level (i.e., email, letter, and telephone).

**Nursing Informatics:** A specialty that uses a wide range of information technology based processes to enable nurses to work more proficiently. Here nurses have to collect, interpret, and document data and put this knowledge into practice when caring for their patients.

**Theory-Practice Gap:** The gulf between what is taught to student nurses and the practical experiences they have while working. A theory-practice gap can also exist between nursing science theory and nursing practice.

**ENDNOTE**

1 Under point 2 of the guidelines, the following sub-points were listed: 2.1 lack of nurses with suitable requirements for teaching; 2.2 inadequacy of the training programme; 2.3 the appointment of student nurses as employees; 2.4 missing further education (for teachers); and 2.5 reduction of conflict.
Integrating E-Government into the Business Curriculum

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Asli Yagmur Akbulut
Grand Valley State University, USA

INTRODUCTION

Citizens around the globe are demanding better services and more responsiveness from their local, state, and national governments. Governments are responding to this challenge by implementing a vast range of information technologies (IT) to reengineer government processes, deliver services, and manage resources more effectively. As such e-government (electronic government), which can be defined as the government’s use of IT to exchange information and services with citizens, businesses, and other government agencies, is increasingly becoming a crucial concept for practitioners, researchers and educators.

Recognizing the importance of the topic, many universities have started offering undergraduate and graduate level courses in e-government. These courses are typically being offered as a part of the public administration curriculum. However, there is also a pressing need for incorporating e-government topics and concepts into business curriculum. Developing a sound understanding of the technological, organizational, political, social, economical, and legal aspects of e-government applications might prove extensively helpful to business graduates in their lives and chosen careers.

The incorporation of e-government into a business curriculum requires careful consideration of backgrounds and interests of business students as well as faculty. In this article, we will discuss the importance of integrating e-government into business curriculum as well as the most suitable mechanisms and procedures for teaching e-government to business students.

WHAT IS E-GOVERNMENT?

According to several researchers, the term “e-government” represents an evolutionary process, and is yet to be defined by universal standards (Basu, 2004; Jaeger, 2003; Jaeger & Thompson, 2003; Seifert, 2003). Described broadly, e-government is the application of the IT tools and techniques (such as wide area networks, the Internet, and mobile computing) to the work of government. These tools and techniques are intended to serve both the government and its citizens (Howard, 2001). Backus (2001) defines e-government as a form of e-business in governance which includes the processes and structures related to delivering electronic services to the public (citizens and businesses), collaborating with business partners and conducting electronic transactions within organizational entity. According to the World Bank, e-government refers to the government’s use of IT in a way to transform relations with citizens, businesses, and other branches of government. Seifert (20003) defines e-government in terms of specific actions (e.g., obtaining documents, accessing information, creating a shared database), or simply as the automation of services.

A 2002 Improvement and Development Agency study categorized e-government into three high-level types: e-governance, e-services, and e-knowledge. On the other hand, the Center for Democracy and Technology categorized e-government programs by three objectives:

1. Publishing or expanding access to government information,
2. Interacting or broadening civic participation in government, and
3. Providing online transactions and government services (Center for Democracy and Technology, and Information Development, 2002).

Typically, e-government is viewed as an incremental progression. The five stages of e-government include:
Emerging Web presence: A country may have a single or a few official national government Web sites that offer static information to the user and serve as public affairs tools.

Enhanced Web presence: The number of government Web pages increases as information becomes more dynamic with users having more options for accessing information.

Interactive Web presence: A more formal exchange between users and a government service provider takes place, that is, forms can be downloaded; applications can be submitted online.

Transactional Web presence: Users easily access services prioritized by their needs, conduct formal transactions online, such as paying taxes, and registration fees.

Fully integrated Web presence: The complete integration of all online government services through a one-stop Web portal (United Nations Online Network in Public Administration and Finance, 2006).

INCORPORATING E-GOVERNMENT INTO THE BUSINESS CURRICULUM

The business world is changing rapidly every year. Successful management in the digital age is demanding new IT-based skills and knowledge. Business schools are doing a great job in preparing their students to meet the challenges of an electronic future. They must now begin to rethink how and what students are learning about government activities and services and how they can educate students who want to make a career in the e-government field.

There are several options that the business schools can pursue to incorporate e-government concepts and topics into the business curriculum (See Figure 1). One option is to have a dedicated track/emphasis on e-government. This would involve having five or six cross-disciplinary courses on e-government. This track would be beneficial for those students who would like to work for a governmental agency upon graduation or for those students whose companies work closely with government agencies. This option involves a long-term commitment in terms of additional resources. If a business school is considering this option, we recommend they joint do it with the School of Public Administration.

The second option would be to integrate e-government concepts and topics into several existing foundation courses. For example, business schools can integrate e-government into the following two business courses: business, government, and society/small business management, and business law. The business, government, and society/small business management course can be revised to focus on the most recent approaches for developing and implementing e-government applications.

Figure 1: Integration of E-government into the business curriculum
Integrating E-Government into the Business Curriculum

Table 1. List of e-government examples/exercises

<table>
<thead>
<tr>
<th>Information Access and Delivery</th>
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<tbody>
<tr>
<td>Examples of the use of the Web for Information Access and Delivery are:</td>
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<tr>
<td>• Arizona's Most Wanted Fugitives</td>
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<tr>
<td>• ABAG (Association of Bay Area Governments)'s information on El Nino</td>
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<table>
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<tr>
<th>Online Documents</th>
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<tr>
<td>• Arizona Transit System Route Maps (Bus Book)</td>
</tr>
<tr>
<td>• The Oklahoma Tax Commission has its tax forms available for download; scroll down the entire page</td>
</tr>
<tr>
<td>• South Dakota Purchasing Contracts Index (complete with downloadable purchasing contracts)</td>
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<table>
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<tr>
<th>Online Databases</th>
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<tbody>
<tr>
<td>• Alaska Unclaimed Property Searchable database</td>
</tr>
<tr>
<td>• Idaho vendor database (for purchasing purposes)</td>
</tr>
<tr>
<td>• Maryland's searchable database of charitable organizations</td>
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<tr>
<th>Mapping / GIS Applications</th>
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<tbody>
<tr>
<td>• Arizona Internet Map Portal</td>
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<tr>
<td>• Current Alaska weather</td>
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<tr>
<td>• ABAG's earthquake hazard maps</td>
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<tr>
<th>Multimedia Applications</th>
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<tr>
<td>• Georgia Navigator</td>
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<tr>
<td>• Los Angeles Real-Time Traffic Information</td>
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<td>• Montana Road Conditions</td>
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<tr>
<th>E-Commerce Applications</th>
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<tbody>
<tr>
<td>• Massachusetts Express Lane</td>
</tr>
<tr>
<td>o Driver Registration Renewal Form</td>
</tr>
<tr>
<td>o Citation Payment Form</td>
</tr>
<tr>
<td>• U.S. Department of Defense EMall</td>
</tr>
<tr>
<td>• Washington State Central Stores Online</td>
</tr>
</tbody>
</table>

This course could be designed/redesigned to examine the fundamental issues concerning e-government, both technical and managerial, and at the strategic and operational levels. In this course, students should learn the basic concepts, the impact of the Internet on traditional tools of public services, government-business-citizen relations in the digital age, government information systems, and management. Table 1 provides specific examples of e-government topics and exercises that can be incorporated into this course.

Governmental activities are strongly regulated and driven by legal framework including national constitutions, laws, and other regulations. Since legal reform aimed at creating a favorable legal environment is a very important part of e-government, business law courses need to be revised to incorporate these changes. For example, questions of electronic signatures and electronic documentation, electronic communication among governmental agencies and citizens, data protection and data security, access to public information, networking of authorities and databases, and other legal issues of e-government now need to be incorporated into this course. An approach to regulating and teaching legal issues of e-government would be to generalize and formalize fundamental legal principles, needs, and requirements for the development of e-government and its processes. Of course, we are not restricted to these two courses; there are several other courses such as business strategy, service management, international business, and e-commerce that can effectively incorporate e-government concepts.

The third option available to business schools is to develop a specialized course(s) in e-government that students can take as an elective(s). This dedicated course(s) should incorporate both theory and best practices. This option is a good starting point for business schools interested in incorporating e-government as a part of their curriculum.
CONCLUSION

The society of today is an information society and the government of today is an information government. As a result, many universities in the world are: (1) evaluating or recognizing the need to evaluate the reflections of the new economy and technology usage in the areas of economy, culture, and politics, and (2) reviewing or planning to review their educational programs and their contents on the above mentioned basis. In this article, we demonstrated the need for integrating e-government into the business curriculum and provided three options that administrators of business schools can follow to successfully incorporate the contents of e-government into the business curriculum.

REFERENCES


KEY TERMS

Curriculum: A curriculum is composed of those classes prescribed or outlined by an institution for completion of a program of study leading to a degree or certificate.

E-Government: E-government or electronic government can be defined as the government’s use of IT to exchange information and services with citizens, businesses, and other government agencies.

E-Government Integration: E-government integration is the coverage of important e-government topics in existing courses.

Foundation Courses: Foundation courses are designed to prepare potential students who otherwise do not meet matriculation requirements to qualify for admission to undergraduate courses.

Web-Portal: A Web-portal, also known as a gateway, refers to a World Wide Web site that serves as a major starting point for a particular set of users when they interact with the Web for a particular reason. A portal usually provides a wide variety of services and resources such as forums, search engines, links to other related Web sites, and the like.
INTRODUCTION

In today’s dynamic business environment; customer needs, competition, globalization, and technology have combined to produce a powerful effect on the process of delivering goods and services to the marketplace. According to Closs and Stank (1999, p. 59), businesses have abandoned the “vertical, functional organizational structure characteristic of traditional procurement, manufacturing and physical distribution operation in favor of a more horizontal, cross-functional structure that permits integration of knowledge across functional areas.” Enterprise resource planning (ERP) systems, by their multidimensional, integrative, and normative nature, offer the depth of functionality and breadth of integration required for managing global operations of business organizations. Hammer (1999) concludes that the use of ERP software forces firms to become integrated enterprises that demand strong understanding of key business processes and very high level of teamwork. The effectiveness of ERP systems as an integrating mechanism in businesses suggests that ERP software can be used as an integrating mechanism in business school curricula, too. As a result, an increasing number of universities have attempted or are planning to incorporate popular enterprise system software products such as SAP R/3 into the business school curricula (Bradford, Vijayaraman, & Chandra, 2003; Corbitt & Mensching, 2000; Johnson, Lorents, Morgan, & Ozmun, 2004). This article attempts to provide a proactive approach to implementing ERP systems into a business school curriculum.

BACKGROUND

In response to the widespread application of ERP systems by the business community, business schools are becoming more concerned about how to integrate ERP into the curriculum. Various frameworks and approaches have been utilized to meet this critical demand. Gibbon and Aisbett (1999) suggest that ERP systems be taught through understanding the history of business information requirements. Hawking, Shackleton, and Ramp (1999) provide a mechanism to integrate ERP teaching in the information systems (IS) curriculum model across 11 levels of knowledge relating to fundamentals of IS. Ongkasuwan (1999) proposes a cost-effective approach for incorporating R/3 into the management information systems (MIS) curriculum of MBA and BBA programs. Quinton (1999) provides recommendations and guidelines concerning the inclusion of R/3 into a business curriculum in the context of a strategic alliance with an ERP vendor. Rivetti, Schneider, and Bruton (1999) consider the ERP educational strategy as a curriculum integration mechanism to re-adjust the educational delivery that focuses on standard functional areas towards a more integrated business process approach. Watson and Schneider (1999) recommend the concept of a multilayered approach to ERP concepts and education. Specific methodologies to teaching ERP in the undergraduate curriculum have also been explored by researchers such as Becerra-Fernandez et al. (2000) and Guthrie and Guthrie (2000). Wagner, Najdawi, and Otto (2000) discuss how business schools are using ERP software as an integrative teaching tool.

Stewart and Rosemann (2001) propose the use of case study and action research approaches in researching and teaching aspects of postgraduate ERP related programs. Bradford et al. (2003) highlight the reasons for adopting or not adopting ERP for classroom use based on a business school survey. Selen (2001) proposes the inclusion of basic business skills as part of ERP education. Joseph and George (2002) suggest the use of learning community to instruct students in ERP systems. Davis and Comeau (2004) provide a good example of how to design, deliver, and measure the outcome of a course on enterprise integration at
Integrating ERP into the Curriculum

Table 1: Example of approaches to integrating ERP in the business curriculum

<table>
<thead>
<tr>
<th>Institution</th>
<th>ER Approach</th>
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<tbody>
<tr>
<td>Grand Valley State University</td>
<td>Uses a dual approach to achieving ERP integration in the business curriculum. The approach entails the use of a fictitious model company and its simultaneous implementation in an ERP environment.</td>
</tr>
<tr>
<td>John Carroll University</td>
<td>The ERP curriculum is centered around three interactive exercises that last approximately one week each. The exercises are: (1) a case analysis of an ERP novel, (2) Systems Development Life Cycle (SDLC) analysis of ERP implementation failures, and (3) Some ERP hands on exercises either with a live ERP system or computer based training (CBT) courses.</td>
</tr>
<tr>
<td>Northern Arizona University</td>
<td>Use ERP as an integrative theme for a 9 credit hour “block” of core business courses (Finance, MIS, and Operations Management). They use a single professional staff member to develop an integrative set of tutorials and cases around a simulated company that supplies the data across all of the participating courses.</td>
</tr>
<tr>
<td>Penn State University</td>
<td>Developed a 12 step three-course approach to ERP education. Within these courses, a strong emphasis is given to business function fundamentals, processes, and management.</td>
</tr>
<tr>
<td>University of New Brunswick</td>
<td>The faculty members designed a capstone ERP-based undergraduate e-business management course that focuses on enterprise integration in businesses. Students are evaluated in three areas: (1) completion of literature log containing literature summaries and reflections, (2) completion of configuration exercises on SAP R/3, and (3) completion of a take-home business case.</td>
</tr>
</tbody>
</table>

Source: Cannon et al. 2004; Davis and Comeau 2004; Grenci et al. 2004; Johnson 2004; Peslak 2005

Table 1 provides a summary of five business schools that have used different approaches to integrating ERP into their curriculum.

The use of ERP systems can provide a variety of benefits in a business school curriculum. One of the most important benefits is the ability of ERP systems to help students understand the underlying need of business processes and to serve as a focal point for integration of knowledge across functional areas. Other important benefits for students include:

- Exposure to real world software that illustrates real-world business processes,
- Enriched cross functional curriculum in which students obtain a broader perspective of the organization,
- Exposure to the caliber of technology with which they will work in their careers,
- Desirable and higher paying jobs because of stronger knowledge of company operations and substantially less training required,
- Ability to contribute earlier than most new people to the projects that they are assigned,
- Ability to translate requirements in meaningful analysis for applications,
- Bringing a higher level of confidence to work, and
- Better prepared for challenges and also less whining when the going gets rough (Peslak, 2005; Vluggen & Bollen, 2005).

The challenges to integrating ERP into the business curriculum include:

- Very time consuming,
- Resource drain,
- Alteration of course content,
- Pedagogical challenges,
- Faculty resistance,
- Faculty reward structure (teaching load issue),
- Faculty members’ lack of understanding of other disciplines,
- Difficulty in accommodating part-time students and transfer students, and
Integrating ERP into the Curriculum

• Student resistance to limitations in schedule flexibility, among others (Fedorowicz et al., 2005; Johnson et al., 2004; Michaelsen, 1999; Still & Petty, 2000).

PROACTIVE APPROACH TO ERP INTEGRATION

Figure 1 provides a proactive four-phase approach to ERP implementation into business curriculum. Specifically, this figure outlines the issues administrators and faculty should consider when implementing ERP. The key to successful ERP implementation is to have a road map to systematically integrate the business curriculum.

In the first phase of the model, the administrators and faculty must develop a complete understanding of what ERP is and how they plan to implement it. A good starting point would be to evaluate the existing literature, visit a few schools that have implemented ERP, and also discuss strategic alliance opportunities with vendor partners. A preliminary cost-benefit analysis should be conducted to evaluate the scope and feasibility of ERP implementation.

Once the understanding and initial commitment is made, in the second phase of the model the administrators should establish a project team/committee (comprised of faculty members from different functional areas) to lead the efforts. The role of the committee is to initially set objectives/expectations and facilitate the implementation. Some of the specific tasks that the project team would initially perform would include:

- Determining the extent to which ERP would be incorporated into the curriculum,
- Determining the faculty who will be trained and how much training will be required,
- Identifying faculty/staff that will be responsible for developing exercises and course materials, among others.

In order to answer these questions, the project team/committee should meet with the appropriate stakeholders and should be realistic in arriving at timelines and cost estimates. For example, the committee might decide

Figure 1: A Proactive Approach to Implementing ERP
Integrating ERP into the Curriculum

that the basic ERP knowledge and skills a student must possess on graduation should include:

1. A basic background and understanding of business processes (flow of information, cash, material, etc.),
2. Exposing students to ERP through a live demonstration of SAP R/3 or an equivalent ERP package along with a specific assignment, and
3. Supplementary readings (including case studies) to explain the theory and practice of ERP.

The third phase, referred to as “analysis and implementation” should involve the customization of the ERP package; the completion of necessary paperwork and program change procedures, the process of setting up hands-on ERP module training with vendors, the establishment of a process of sending e-mail updates to all faculty members, among others.

The final phase of the model should involve evaluating success or failure of the ERP initiative. This should be conducted annually. For example, if the program is not achieving its goals, it should be redesigned. Also, as part of this phase, administrators should recognize and reward improvements.

CONCLUSION

In today’s competitive global environment, it is critical that business schools graduate students with an integrated understanding of business processes and the ability to work effectively in teams to solve key business problems. In response to these changing needs, a number of schools have made changes across their entire business core intended to achieve a higher level of integration. In this article, we propose a four step proactive approach to integrating ERP in the business curriculum.

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Annual SAP Asia Pacific Institute of Higher Learning Forum, Singapore.


**KEY TERMS**

**Enterprise Resources Planning (ERP)** is a software application that integrates all departments and functions across a company—such as accounting, marketing, and purchasing—into a single computer system that can serve each department’s particular needs. When something happens in one area, the impact is immediately known throughout the entire organization.

**Business Process** can be defined as a set of activities that creates value for an internal or external customer. On the one hand, business processes refer to the workflows within a company. On the other hand, business processes refer to the transactions that take place between companies, such as: offers, price negotiations, purchasing agreements, and orders. Software that reproduces these business processes, therefore, can be both internal (ERP system) as well as external (e-commerce software).

**SAP R/3** is SAP’s integrated software solution for client/server and distributed open systems. SAP’s R/3 is the world’s most-used standard business software for client/server computing. R/3 meets the needs of a customer from the small grocer with three users to the multibillion dollar companies. The software is highly customizable using SAP’s proprietary programming language, ABAP/4. R/3 is scalable and highly suited for many types and sizes of organizations.
Integration of Digital Primary Sources

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INTRODUCTION

At the end of the twentieth century, the Library of Congress (LOC) began archival digitization of its holdings in order to share its rich collections with the public. The digitization process has made available, via the internet, over ten million items, many of which are primary source items (LOC, 2006, para. 5). These digital primary sources are defined by the LOC (2006) as “actual records that have survived from the past, like letters, photographs, articles of clothing and music. They are different from secondary sources, which are accounts of events written sometime after they happened” (para.4). As result of the digitization process, access to these primary sources is no longer limited to people physically present at the Library of Congress. Additionally, other libraries and organizations have begun to digitize and make their primary sources available to the public via the internet. We have listed the URLs of several of these organizations at the end of this article. The ease of accessibility through the internet creates an opportunity for teachers within K-12 settings to begin integrating these digital primary sources into the classroom. This article discusses the research on primary sources in the classroom, defines primary source-based instruction (PSBI), connects practices used in PSBI to higher order thinking skills, and offers examples of PSBI practices.

BACKGROUND

The availability and ease of access has contributed to the increased attention by teachers and the integration of primary sources into the classroom for instructional purposes (Wineburg & Martin, 2004; Pitcher, 2005; Eamon, 2006). Additionally, the collaborative effort between archivists, historians and educators has led to the development of lesson plans that utilize the most interesting and relevant digital primary sources in the classroom (Eamon, 2006). Access to these sources may have also resulted in the shift from memorizing historical facts to an inquiry based instructional approach that engages students in higher order thinking processes (Pitcher, 2005).

Primary sources have often been utilized in social studies and history classrooms. Historically, the use of primary sources in social studies instruction has provided the foundation for deeper understanding and critical thinking by students (Singleton, & Giese, 1999; Pitcher, 2005; Eamon, 2006). This deeper content understanding and critical thinking is often termed as historical thinking (Singleton, & Giese, 1999; Pitcher, 2005; Eamon, 2006). Although critical thinking and content understanding can result from instruction that does not use primary sources, Drake and Drake-Brown (2003) describe historical thinking as needing a “temporal bearing” (p. 474). Primary sources provide this “temporal bearing,” and provide contextual corroboration that allows students to develop a richer and deeper appreciation for the content. Contextual corroboration is a combination of two (of four) common historian practices that Wineburg (2001) has explained as corroboration heuristic and contextualization. Contextual corroboration refers to comparing information gained from reviewing several different primary sources related to a given topic and within a conditional framework of both time and place. Through the use of digital primary sources, teachers can create contextual corroboration and facilitate deeper understanding while moving students beyond the perception that learning in this area consists mainly of rote memorization of facts, dates and places (Eamon, 2006). Additionally, primary sources provide an affective connection to the content that is often not developed when students learn through secondary sources.

Although we have discussed digital primary sources only in relation to history and social studies subject areas, we do not perceive the use of these sources as being limited to these areas. We advocate the use of
primary sources across disciplines and even encourage the use development of collaborative discipline utilization of primary sources. For example, a teacher could integrate primary sources in both Language Arts and Social Studies for literacy skills and historical content knowledge development.

At this point it is important to describe what is meant by a digital primary source. Although we presented the LOC definition of a primary source, it might be more useful to describe the types of digital primary sources. Digital primary sources are primary sources that have been converted into a digital format and made available via the internet. The LOC has digitized not only original manuscripts and periodicals, but has also digitized and made available personal writings, letters, diaries, maps, and original documents. Where these examples may fit most individuals’ connotation of a primary source, the LOC also has made available original cartoons, flyers, taped speeches, interviews, music recordings, photographs, and film recording of events. Each of these digital primary sources can be integrated into instruction and provide students with multiple perspectives and contextualizes the content being studied.

Digital primary sources are unique educational tools, whether a diary excerpt, document, photograph, or taped interview, these tools expose students to “multiple and original perspectives of events,” (Singleton & Giese, 1999, p. 148). L. R. Singleton & J. R. Giese (1999) continue that students working with primary sources are also more likely to “engage in asking questions, thinking critically, making reasoned inferences, and developing reasoned explanations and interpretations of events and issues in the past and present” (p. 148).

With a keen and critical eye, students are also able to develop an understanding of bias and subjectivity when analyzing and contextualizing related primary sources. These sources serve as tools that provide the contextualization of the content being studied and give students a deeper and richer learning experience.

The practices often associated with primary sources involve classroom or learning activities described as inquiry based instructional methods. Because the definition of inquiry based methods would require a separate article, for the purpose of this article the definition of inquiry based methods will cover all activities designed to help students acquire deeper understanding of content while using primary source items as tools to reach the deeper understanding. For example, a document analysis or photo analysis is an instructional method in which students are required to examine the primary source document or photo in order to answer specific questions about the given source. Questions that might facilitate this type of examination include: Where do you think the source is from? Who do you think made it? When do you think the source was created? Why do you think the source was created? (LOC, 2006; National Archives and Records Administration, 2007). This line of questioning leads to greater examination and critical thinking. It also requires the application of inferential skills in order to create a better understanding of the primary source being examined. This also enables the student to establish a context for a specific time and a place of actual event. From this context, the students will be able to inquire further about the given primary source(s) which, in turn, often leads to greater depth of understanding of the content area.

**PREVIOUS RESEARCH USING PRIMARY SOURCES**

The use of primary sources in instruction is not new. Newman (2007) noted that textbooks from as early as 1787 were integrating primary source documents within textual narratives. As such, the practice of PSBI is also not a new innovation. The National Center for Educational Statistics (NCES) (1994) report indicated that teachers across the nation had integrated primary sources within instructional practices in grades four, eight, and twelve. Further, the NCES (2002), report noted increases in all grades and the use of primary sources overall. Assessments also indicate that instructional activities with primary sources can lead to higher levels of student achievement. However, students in the United States are currently not receiving primary source-based instruction on a regular basis.

Recent research has shown that PSBI does lead to increases in student knowledge gains as well as increases in critical thinking, or higher order thinking, skills. NCES (1994), reported that tools and resources, such as primary sources, can “invite students to engage more fully with the content of geography and history and can serve to increase students’ ability to think analytically” (p. 201). The NCES 2001 report on eighth graders added that “weekly use of primary documents was associated with higher scores than less frequent use” (2001, p. 95). This report further indicated that eighth grade teachers
who used primary sources in the classroom at least once a week had students with average scores higher than students of teachers who used primary sources once monthly or never in the classroom. Concurrently, this report indicated that twelfth grade students, who did not use reading materials beyond the textbook, such as primary sources, had the overall lowest assessment scores.

The aforementioned findings are not alone. Other research indicates that the integration of primary sources into instructional practices can have a noticeable impact on student achievement as related to the cognitive processing domain, as well as student motivation and achievement. The following research describes related studies that used primary sources as learning tools. The studies presented used different instructional methods; however, all methods fit with the inquiry based method definition we provided previously.

One study (Tally & Goldenburg, 2005) focused on the use of primary sources with technology integration in rural and urban, United States’ middle and high schools. The heterogeneous sample of 129 students was from classes in Language Arts, Geography and History. Students were surveyed to describe their primary source learning experiences as compared to traditional lecture and textbook learning experiences common to secondary classrooms in the United States. The researchers found that primary source integration was better received by students as compared to traditional instruction. The conclusions also indicated increases in students’ learning gains as well as historical thinking skills.

Baker, Dimino, Gersten, Smith-Johnson & Peterson, (2006) found primary source based instruction can also help increase special needs students’ achievement. The researchers performed an experimental study to examine if students with special needs could better learn history within certain experimental conditions. First, the experimental instruction included comprehensible and accessible materials such as primary source readings and a documentary video that supplemented the lessons. These lesson suppletions were different from the control group, which relied solely on traditional textbooks for instruction. Second, the experimental group’s instruction incorporated strategies that provided numerous opportunities for students to interact with peers and the teacher during the lesson (rather than relying on lectures and whole class discussions). Control groups were based on traditional history textbook learning and whole class lecture.

The experimental design included two social science classrooms in two Northwestern middle schools. 76 students participated: 33 were classified learning disabled (LD), 3 were classified other health impaired (OHI). Students with learning disabilities were represented equally in both the experimental and control groups. Both classrooms focused on the Civil Rights Movement and related curriculum materials. The documentary film Eyes on the Prize and primary source supplementary documents served as the main content sources.

In the experimental condition, students with and without disabilities scored significantly higher on 2 of 3 content measures. Both the written test, pretest-posttest scores (effect size 1.0) and content interview scores (.72 effect size) between groups indicated significantly higher levels of content knowledge with the experimental groups as compared to the control groups. The matching posttest scores were also higher for the experimental groups. These findings suggest that students of varying learning abilities—LD, Non-LD, and OHI alike—experience knowledge and content gains with varied instruction that integrates primary sources in classroom learning.

Another study using fifth graders had similar results with PSBI as other studies using middle school, high school, and learning disabled students. VanSledright (2002) studied a classroom of 23 fifth graders and found that the students had greater interest in the content and larger learning gains through the use of PSBI. This study examined the effects of combining primary sources with an investigative approach to teaching history. VanSledright, performed a pre/post historical analysis investigation and collected quantitative data in the form of pre-tests and post-tests and qualitative data in the form of primary source, inquiry-based lessons and videotapes of his instruction The analysis of the data indicated that students’ reached higher order cognitive processing domains and used critical thinking skills along with historical investigative skills (such as contextual corroboration), when working with PSBI. These findings indicate that even elementary school age students benefit from the use of primary sources in the form of increased critical thinking skills and deeper content understanding.
Overall, research indicates that primary sources in classroom instruction can facilitate greater student interest, deeper understanding of content, critical thinking skills, and “historical thinking.” Further, research suggests that students of varying learning and/or physical abilities, whether LD or non-LD, or OHI, can all increase in their academic achievement when exposed to primary source based instruction with inquiry activities. Studies are also indicating that inquiry activities with primary sources in classroom instruction can increase critical thinking skills, or historical thinking, in students of elementary school age. Further research with the elementary age group and PSBI is warranted, along with more research of PSBI in content areas beyond social studies.

PRIMARY SOURCE BASED INSTRUCTION PRACTICES

Because primary sources are technically instructional tools, it can be difficult to separate the instructional method from the primary source. We have chosen to define primary source based instruction (PSBI) as the use of primary sources as tools that can provide contextual corroboration, deepen students’ content understanding and encourage higher-order thinking processes as related to a particular issue or event. The PSBI practices we present in this section align with the cognitive domain of Bloom’s taxonomy. The following section describes each of the practice, links the practice to Bloom’s taxonomy and provides an example of the practice.

Illustration. This primary source based instruction practice involves the use of primary source(s) as examples to illustrate an event or some fact for students. As the name states the primary sources is used principally to assist student’s basic acquisition of knowledge of the event and to simply present a focal point, or to communicate facts or information. Illustration is linked to Bloom’s taxonomy Level One- Knowledge, as the activity only aids the student in acquiring basic knowledge or recalling specific facts, information, or answers, (Bloom, 1956).

An example of illustration would be a map of Washington D.C. from 1888 that illustrates or draw focus to the nation’s capital location on that map. The student could then later tell you what city is on the map. In this case, a primary source could be used to focus student attention on instruction.

Association. This practice involves the use of the primary source(s) to deepen the students’ understanding by helping the student develop content ideas and concepts related to a specific event or topic. It involves using the primary source to make connections with facts and ideas. Students may also use the primary sources to make comparisons that lead to deeper associations between concepts. Association is linked to Bloom’s taxonomy Level Two – Comprehension since the goal of the activity is to help students acquire concepts and the “main idea,” (Bloom, 1956).

An example of association would be comparing the Washington D.C. map from 1888 to a present day map of Washington D.C. and having the students describe the city’s similarities and differences between the two maps.

Utilization. This practice involves using the primary source(s) to demonstrate students’ understanding and comprehension of content knowledge along with a developed, greater contextual understanding of an event or topic. Students use the primary source as a tool for demonstrating their knowledge and understanding of an event or topic. Utilization is closely linked to Bloom’s taxonomy Level Three-Application. Application is using new knowledge and being able to solve problems using previously learned ideas, rules, or techniques in a different way, (Bloom, 1956). This also includes illustrating, examining and discovering new information and ideas.

An example of utilization with primary source would be using both the 1888 Washington D.C. map and the present day map to locate and identify Washington D.C. on a wordless, 2007 political map of the United States.

Examination. This practice involves the use of primary source(s) for the purpose of inquiry and analysis. Through this activity students begin developing inferences and explanations in relation to the primary source(s). This activity leads to a deeper content and contextual understanding as students examine and explore the topic or event through the primary source. This is practice is similar to the activities engaged in by historians and archivists who use primary sources for contextual corroboration. Examination is similar to Bloom’s taxonomy Level Four-Analysis, which includes examining, investigating, inquiring, identifying
Integration of Digital Primary Sources

and breaking information into parts, seeing patterns, and looker for deeper or underlying meanings, (Bloom, 1956). Inferences and explanations are common with analysis.

An example of examination with primary source use would be closely scrutinize both the 1888 map of Washington D.C. and the present day map and asking students to make connections between what is the same and what appears different due to the passage of time (such as new streets, new towns surrounding the area, and new monuments). Students would then be asked to describe how this difference may have influenced living in 1988.

Incorporation. This practice involves the use of primary sources to integrate content knowledge gains into a new understanding and explanation of a topic or event(s). Students work with the primary source(s) to generate their own ideas and interpretations of the event or issue being studied. In this practice students often draw on varied primary sources that are linked to the event or topic being studied. Incorporation is similar to Bloom’s taxonomy Level Five-Synthesis, which is using older ideas to create newer ones as well as being able to generalize from collected or given facts. Ideas from many areas can come together to draw conclusions and make predictions with synthesis, (Bloom, 1956). Integrating, inventing, designing, and formulating are also common with synthesis.

An example of incorporation with primary source use would be integrating information from all Washington D.C. maps that span the time frame from 1888-2007 then creating a historically accurate digital story that describes changes in Washington D.C. from 1888 through present day. Within the digital story, the student could elaborate on population shifts, building changes, and transportation changes using additional primary source(s) from the given time span.

Interpretation. This practice involves the use of primary sources to demonstrate a deeper level of understanding that extends beyond the initial content and context of a given event or topic. Historical writings from historians and the like are regular implementers of interpretation with primary sources. This practice includes the use of primary sources to defend and/or better articulate a reasoned consideration or point about a specific event in time and in a specific place. Students engage in critical examinations of primary sources, both familiar and unfamiliar, as well as extensive contextual corroboration. For this practice students will need a considerable background and a well-developed understanding of the content knowledge so they can solidify and postulate a new idea or concept related to an event or topic. Interpretation is similar to Bloom’s taxonomy Level Six-Evaluation, which includes the following: comparing and discriminating between ideas, assessing value of ideas or theories, making reasoned choices and value judgments, as well as recognizing subjectivity, (Bloom, 1956).

A simplified example of interpretation using primary source(s) would be comparing and summarizing changes in Washington D.C. and the White House from the time of the 1888 map to the present day map. Using historical maps of Washington D.C. as well as other primary sources to evaluate others ideas or theories related to the city’s historical population disruption, building development, and expansion. The student would use the primary sources as evidence to support their conclusions of the validity of the theories proposed by others.

FUTURE TRENDS

Although primary sources are often viewed as historical in nature, new trends involve students creating their own digital primary sources. Students use digital cameras, videos, and audio recordings to create projects that communicate their personal stories and life events. The Mobile Learning Institute (MLI) (2007) provides schools access to the technological resources to create their own oral histories. The MLI sponsored a project with a middle school that allowed students in Bay St Louis, Mississippi to create digital stories about the destruction caused by Hurricane Katrina. Students researched landmarks within their town, digitized historic photos, and recorded images of the landmarks post Katrina. Students then recorded their personal reactions, stories, and feelings. The MIL has worked with multiple schools providing students with the resources to create digital stories that can help present day students record events and tell their stories. As projects like this become common in schools the products development by today’s students will become the digital primary sources for future generations. Organizations such as libraries need to begin to value these projects and determine methods for gathering and making them available for teachers to use in PSBI.
CONCLUSION

As libraries and organizations continue to digitize their primary sources, teachers in K-12 environments will find it easier to gain access to these primary sources to use as tools in the class. Research indicates that the use of primary sources in conjunction with inquiry-based instructional methods can increase student engagement, increase motivation, encourage higher-order and critical thinking skills, provide contextual corroboration, and lead to a deeper and richer understanding of the content on both cognitive and affective levels. The primary-based instruction activities listed above are linked with Bloom’s cognitive domains and can be used to move students towards higher-order thinking, and the practice of critical thinking skills. The aforementioned suggests that future trends in PBSI may increase as the use of digitized primary sources becomes more mainstream in the education world.

REFERENCES


KEY TERMS

**Association**: PBSI practice that involves using the primary sources to make connections with facts and ideas, the use of the primary sources to deepen the students’ understanding of content ideas and concepts. The outcome of the practice is an understanding of the connections between “main ideas” of a specific event or topic.
Integration of Digital Primary Sources

**Contextual Corroboration:** refers to the development of concepts, ideas and understanding, through the activity of reviewing several different primary sources related to a topic or event, through the context of both the time and the place associated with topic or event.

**Digital Primary Source:** A primary source (e.g. original manuscript, photo, audio or film recording) that as been transferred into a digital format and made available via the internet.

**Examination:** PBSI practice that involves the use of primary sources for the purpose of having students develops inferences and explanations about a topic or event. Students generate contextual corroboration in this practice. The outcome if this practice is the deconstruction of the primary sources to discover underlying meanings in order to explain of the topic or event.

**Illustration:** PBSI practice that involves the use of primary sources as examples to illustrate an event or some fact for students. The primary sources are used principally to assist student’s basic acquisition of knowledge of the event and to simply present a focal point, or to communicate facts or information. The outcome of the practice is the simple recall facts or information about the event.

**Incorporation:** PBSI practice that involves the use of varied primary sources to integrate content knowledge, and understandings to create their own explanations of a topic or event. The outcome of this practice is students own ideas, thoughts, or theories about a topic or event based on the primary sources.

**Interpretation:** PBSI practice that involves the use of multiple primary sources to demonstrate a deeper level of understanding that extends beyond the initial content and context of a given event or topic. Students use the primary source to defend and/or better articulate a reasoned point about a specific event in time and in a specific place. The outcome of this practice is the evaluation of existing, ideas/theories, or the substantiation of generated ideas/theories through assessing how primary sources provide value to the ideas/theories.

**Primary Source Base Instruction (PBSI):** the use of primary sources as tools to provide contextual corroboration, deepen students’ content understanding and encourage higher-order thinking processes as related to a particular issue or event. Specific practices related to PBSI include Illustration, Association, Utilization, Examination, Incorporation, and Interpretation.

**Utilization:** PBSI practice that involves using the primary sources to demonstrate students’ understanding and comprehension of content knowledge. The outcome of this practice is applying of the student’s contextual understanding of an event or topic in a new situation or to solve a problem.
APPENDIX 1

Useful Internet Web Sites for Digitized Primary Sources

1. Cornell University Library Collections: http://library5.library.cornell.edu/moa/
3. Repositories of Primary Sources Online: http://www.uidaho.edu/special-collections/Other.Repositories.html
5. University of Chicago Digital Library Collections: http://www1.lib.uchicago.edu/cgi-bin/nand/search/diglist?search-keywords-0=*&search=::CONFIG::defsearch
Intellectual Property

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INTRODUCTION

The study and generation of knowledge is a fundamental focus of education. With changing technologies, digital publication, and information access, the issue of intellectual property has become increasingly important. Some of the issues that have to be dealt with are the transition from a paper-based “economy” of knowledge and publication to a digital economy and understanding. Indeed rather than a transition, this change needs to be more fully understood as a transformation.

On several accounts the very dimensions of intellectual property have exploded with the digital information age. And as we continue to lunge forward into rapid technological change, we cannot attempt to know what it will be in the future. Not only does the scope of information extend far beyond what we could comprehend in an analog knowledge society, but the development of new knowledge also expands at a rate that would be previously incomprehensible.

It is immensely curious that at this time, the most mission-centered function of educational institutions—creation of knowledge—is perhaps the least formally documented activity on the organizational level. This article will describe the issues of intellectual property and knowledge management, a prominent, effective approach to the development and management of intellectual property within organizations.

BACKGROUND

Intellectual property is the right to protect the published or unpublished work of the person who created it. Such work may include patents, trademarks, designs, and copyrighted materials (including literary, dramatic, musical, artistic, and certain other intellectual works) (see www.copyright.gov, para 1). Rights to a work may be assigned or licensed in part or in full to others for a specific period of time or indefinitely. Because of this situation, intellectual property is a controversial topic which has many interpretations; but the best solutions bring people back to clear documents that are authorized by the relevant governing bodies.

The digital and information age has created not only a global economy, but also a closely connected global community. Information is shared transparently across most of the globe through various networks of connectivity and makes time zones, geographic barriers, and immigration limits transparent and/or irrelevant at times.

While this article addresses specific examples from the United States of America (USA), other countries have their own intellectual property legislations and practices, or they may have adopted those of other countries or national unions (i.e., European Union (EU)). Caslon Analytics (2006) provides a well-researched, clearly written, and well documented online reference regarding international intellectual property laws and practices (http://www.caslon.com.au) which will be referenced in this discussion.

Certainly all nations of the world do not function under the guidelines of the USA, but it is an indicator of some prominent perceptions and government policies on this topic in 2006. This brief examination of U.S. intellectual property law and practice in light of educational application is meant to provide a point of reference for discussion.

Intellectual property is a basic right in the USA which is protected by the Constitution. As described by lawyer Judith Silver,

intellectual property rights originated with our Founding Fathers in Article 1, Section 8, Clause 8 of the U.S. Constitution which states that Congress shall have the power “to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.” The right to exclusive ownership and use of one’s inventions and the monetary rewards from giving others permission to use them work in conjunction with the other beliefs of our Founders. (2003, para. 2)
Yet the protection of such rights is far from simple. The very basic issues in the situation include balancing the rights of the creator/author and the rights of any related organization. However most creators of intellectual property do not want their content to be locked away; instead they want others to access it, continue to develop it and, in many cases, also pay them for use of it. Given this situation the complexity of the situation increases:

- How does a knowledge based global community protect the rights of the author/creator?
- How are these rights protected while providing for dissemination and access to information to libraries and users?
- How can colleagues be encouraged and protected in sharing information in order to further build the field of study, without compromising any of the above?

In the USA, the USA Patent and Trademarks Office coordinates intellectual property concerns. Visiting their online resources reveals the wide extent to which the Internet has impacted this governmental agency (http://www.uspto.gov), policies, and issues related to intellectual policy.

Coping with Intellectual Property in Education

Where does intellectual property arise in the life of educators and educational organizations?

Consider the following situations and same question with each:

- Who owns intellectual property?
  - Faculty members design distance learning courses. Does it make a difference whether it is part of the usual compensation, as a separate stipend, or as a course release assignment?
  - Outside consultants design distance learning courses.
  - Adjunct faculty design distance learning courses.
  - Faculty members create their own Web pages on the university Web site.
  - Faculty members edit and publish a journal for a professional association. Does it make a difference if the journal is hosted on the university Web site?
  - Faculty member publishes a book? (or an article, departmental report, or university accreditation report).

- Who owns the national, international, and digital rights?
  - Faculty member writes a grant for the university on the university Web site as part of their usual compensation, as a separate stipend, as a course release assignment.
  - Faculty member co-authors a grant, but her institution is a partner, not the lead applicant.
  - Faculty member creates a new scientific patent (such as a medication) while under usual compensation, separate stipend, course release, or while funded by grant monies.
  - A university team of faculty and administrators create a new patented design (such as a mechanical design).

Based on experience in this burgeoning digital age, intellectual property and copyright were always matters of concern in terms of plagiarism and attribution. But the above examples bring different concerns to the surface than the traditional print media, and for those involved in distance learning, these issues arise every week. In distance learning and technology, the matter of intellectual property, ownership, compensation, and royalties has become a very hot and make-or-break issue.

Thompson (1999) addresses the critical risks that are inherent to intellectual property identification in an institutional/organizational setting. Any organization which is intent upon supporting the development of new intellectual property must have standards and processes to ensure the accuracy, appropriateness, and fairness of that which is publicly identified and claimed as its intellectual property. There must be a reliable procedure which is put into action and applied in the same manner for each case. This need raises the question as to what support is needed for educational organizations to cope with intellectual property matters.
SUPPORT

In the matter of developing and protecting intellectual property, Thompson (1999) identifies three areas of support which higher education institutions could contribute: financial, intellectual, and reputational. In these respects, institutions need to provide the financial resources in research, salaries, staff, and facilities to support research and development (including scientific, technology, literary, etc.); it needs to support the endeavors through a rich intellectual culture of inquiry and evaluation and depth of the intellectual ranks to support the research team. Finally, broadly interpreted, institutions need to look at responsibility to build, communicate, and sustain the reputation of those involved in research, both immediately and long-term.

One integrated solution that fulfills several of these needs is that educational institutions can support educators and students by providing the cultural and fiscal resources to implement a knowledge management system that can be used institution-wide and also for the individual. Such a system will not only help to track individual’s work, but also help the individual discover new relationships and synergies within their own work and research and potentially with colleagues, if the systems are open among colleagues to a certain degree.

Digital Model for Education

A dynamic model for the support of intellectual property and organizational management began emerging most prominently in the 1990s. Knowledge management provides a consistent framework and set of processes to discover, capture, filter, and arrange knowledge. In addition, great value is derived from sharing and using the knowledge throughout the organization (Bernborn, 2001, p. xiv). This model originated in business and its primary purpose was to document and protect company knowledge in the development of new products.

In a capitalistic, for-profit organization, understandingly protecting “trade secrets” from the competition is an important task to which policies, resources, and personnel are assigned. The need for these pursuits is never brought into question. If a company did not protect their proprietary secrets, they would lose their profit making capability in the marketplace.

In the 1990s, organizational strategy was brought to bear in more effective ways to support the efforts to protect company intellectual property. Knowledge management models emerged which formalized the process of identifying organizational knowledge, organizational learning, best practices, workflow, intellectual property management, document management; customer-centric focus, using data effectively, collaboration, and authorship.

According to a study by Dyer and McDonough (2001), the reasons business engage in knowledge management are to:

- Capture and share best practices (77.7%)
- Provide training, corporate learning (62.4%)
- Manage customer relationships (58.0%)
- Deliver competitive intelligence (55.7%)
- Provide project workspace (31.4%)
- Manage legal, intellectual property (31.4%)
- Enhance Web publishing (29.9%)

About 1998 and later, distance learning and digital publication were emerging more prominently in higher education. In the early 2000s, both trends were widespread and institutions were grappling with the related impact on intellectual property because digital content was (1) proliferating so much more rapidly through distance learning and publications, and (2) widely disseminating it so much more quickly and easily.

In the late 1990s, higher educational institutions grappled with digital copyright issues (Tomei, in press). In the 2000s, higher education began addressing intellectual property and trying to sort out the issues. However, it would seem that there could be an even greater benefit in educational settings in using a Knowledge Management approach because historically such tracking and analysis had been done so minimally on an institutional level. Could not the digital age provide the tools for education to understand its creation of knowledge, and the breadth, depth, and potential of such work as well?

Examining the list of reasons that businesses engage in knowledge management, educational institutions also would benefit from data regarding their work wherein they: capture and share best practices (teaching evaluations), provide training, corporate learning (professional development), manage customer relationships (student affairs, administration), deliver competitive intelligence (public affairs and admissions), provide project workspace (facilities), manage legal, intellectual property (human resources, publications),
and enhance Web publishing (distance learning, public affairs, faculty Web sites. All of these functions apply directly to education, and gathering information on a timely and regular basis provides tremendous opportunities for evaluation and improvement.

Thus, a knowledge management system provides a systematic way to approach the generation of new knowledge, as well as its documentation and tracking. The more recent development of integrated software and Web-based digital dashboards takes this process further by providing an interface to coordinate the knowledge management process. Such digital dashboards enable live updates of the information and for it to be grouped, analyzed, and cross-referenced all in one place.

Other tools used in the business sector for researching knowledge management include not only digital dashboards, but also data warehouses, data mining, virtual reality modeling, and distance learning for “just-in time” training (Milam, 2001). It is evident that just as educational organizations are becoming used to comprehensive solutions to coordinate financial, human resources, and student registration systems, they need to quickly address the need to adopt a comprehensive solution to coordinate, track, and analyze intellectual property. Indeed it is immensely curious that the most mission-centered function of educational institutions—creation of knowledge—is the least formally documented activity on the organizational level.

This process of gathering data on a regular and timely basis and being able to evaluate and make decisions based on it can be implemented on a grassroots level or a hierarchical top-down level. In fact, in business sectors they have found that the knowledge management model can result in a strengthening of grass roots efforts. In an educational setting where faculty are the strength of knowledge creation, this dynamic would be fundamentally important.

In addition, I would encourage individual faculty members to develop and tailor whatever knowledge management system is being used for their own individual professional purposes. Use the tool to track your projects, your development, and your research. Faculty will not only be able to see the progress, but also perhaps see new relationships and connections that may have been otherwise been invisible. The analysis tools of such systems are powerful beyond the basic data gathering aspects.

FUTURE TRENDS

Educational organizations need to continue to develop a perspective of examining themselves as organizations within a much larger context than the educational sphere. That is the same technological, legal, global, economic, organizational, and political issues that affect other organizations impact educational organizations, albeit in unique ways. With this in mind, educational organizations need to keep pace with advancements in other arenas of development. In the case of intellectual property, future trends may well include knowledge management, technology innovation, distance learning, and global political relationships.

Among the major reasons that knowledge management is used in business that relate directly to interests of education are customer (student) satisfaction, efficiency, and protection of interests (Dyer & McDonough, 2001). Such are matters of proactive preservation of current and future equity and interests. Education organizations are knowledge-generating communities; knowledge management consistently documents, assesses, and protects those valuable interests in an age when fraud is frequent. Organizations who do not protect their intellectual property have the risk of not only seeing it gradually dissipate, but also of it being aggressively wrestled from them as individual and organizations attempt to engage in fraudulent activity to claim ownership and authorship of work which is not their own.

Technology innovation is rapid; new formats of digital publication are emerging frequently. In this stimulating environment, education needs to be up to date with intellectual property approaches and new digital formats. Distance learning converges the innovation of technology with education and may be the most obvious area of concern for education in intellectual property (National Association of State Universities and Land Grant Colleges, 1995). There are scores of issues that education organizations need to address now and in the future as their adoption of this field starts, continues, or escalates. In addition, the forms and place that distance learning has in education and in the lives of traditional and nontraditional students will also circumscribe additional and continuing issues.

Finally global, political relationships are of importance in this issue. As countries develop and change, and relationships among countries change around the globe, education needs to be aware of these relationships. The most direct relationships among nations
will be publicized, but less widely discussed will be the critical concerns for education as to how intellectual property is handled among nations. In a global society “all things are not equal.” Different countries have different digital policies and different intellectual property regulations. Precisely because educators interact internationally so easily, current information about these similarities and differences will be essential for organizations and individuals. Therefore, a critical point is presented here: before decisions are made in the area of intellectual property, continued study of current references should always be done.

CONCLUSION

The fundamental focus of education is the creation of knowledge. In times of rapidly changing technologies and facile world-wide communication, intellectual property has become increasingly important and complex. Knowledge management is described in this article because it has emerged as an example of a significant approach for organizations and individuals to gather track and analyze knowledge related information. However the significant finding of the research is that intellectual property is not in a period of “transition” from a paper-based “economy” of knowledge and publication to a digital economy and understanding, but rather a period of transformation. The field of intellectual property has many complex aspects to it: a moving scope of limitations as nations continue to revise their legal definitions and organizations continue to try to come to grips with their policies and procedures. It is a vibrant arena of development in itself. However, a reminder is presented here: before decisions are made in the area of intellectual property, research for additional and current references, their analysis and interpretation need to be carried out for the specific context.

REFERENCES


KEY TERMS

Copyright: Copyright is a form of protection provided by the laws of the United States (Title 17, U. S. Code) to the authors of “original works of authorship,” including literary, dramatic, musical, artistic, and certain other intellectual works. This protection is available to both published and unpublished works (www.copyright.gov, para 1.).

Creative Commons: The Creative Commons framework provides a means for authors of audio, images, video, text, or educational materials to make and communicate their choices about property use and rights through a series of designations (www.creative-commons.org).
**Digital Dashboard:** An integrated computer software program and related analytical and collaborative tool which gathers information from many sources so that individual, team, corporate, and external information (Milam, 2001).

**Intellectual Property:** The intangible property right to protect the intellectual work of the person/s who created it (includes patents, trademarks, designs, and copyright).

**Knowledge Management:** Discovery and capture of knowledge, the filtering and arrangement of this knowledge, and the value derived from sharing and using this knowledge throughout the organization (Bernbom, 2001, p. xiv).
Interactive Multimedia

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INTRODUCTION

Media is a Latin word used to describe ways to convey information. Media can be related to newspapers, magazines, radio, television, audio-video programmes, computers, and others. Many prefixes are used with the word media such as multimedia, electronic media, and interactive media. The most common reference used in education is multimedia, which is the integration of text, audio, video, graphics, and animation into a single medium. Instructional multimedia is the integration of various forms of media in the instructional process. It is the technology that combines print, radio, television, animation, photographs, and other forms of illustration (Usha, 2003). Interactive refers to the way the user engages in the integration of different media (text, audio, video, graphics, and animation) to enhance the user’s learning process. The use of multimedia as an educational medium is becoming increasingly popular in various fields of study including medicine, science, engineering, and arts. Interactive multimedia courseware (software used by students in their learning) in particular, developed on a CD-ROM, is adding a new and interesting dimension to both teaching and learning. This new approach can effectively complement the conventional methods of teaching and learning. The multisensory input of this media provides possibilities for higher performance ratings and higher retention (Usha, 2003). With effective feedback, this method makes learning and teaching more meaningful. Students with different learning abilities can work at their own pace, time and place; and with interactively and self-assessment it can make learning a highly personalized, independent, and a rewarding experience. Today, new media and technologies for learning technical courses have influenced education in higher learning institutions. This trend has posed an immense challenge to academicians who wish to employ multimedia in their teaching activities.

BACKGROUND

Interactive multimedia systems for learning came into existence in the early 90s (Robert, 1994). Cairncross and Mannion (1999) state that interactive multimedia systems have the potential to create high quality learning environments that actively engage the learner. For example, they can combine explanations with illustrative examples, online assessment with feedback, and provide opportunities to practice and experiment. Additionally, Cairncross (2002) points out that the key elements of multiple media, user control over delivery of information and interactivity, could be used to enhance the learning process.

Present multimedia courseware has been designed to incorporate multimedia to allow learners to perform multiple tasks simultaneously during a tutoring session. For example, a learner can read text and be narrated by displaying a video clip to explain certain concepts of the subject matter. Information is presented in a predetermined sequence, regardless of how knowledgeable the student is at the beginning of the learning activity, or how quickly or slowly the learner absorbs and understands the course material (Rickel, 1989). The incorporation of multimedia in courseware, on the other hand, provides the learner with the opportunity of exploring information in various media formats in addition to conventional text and graphics which focus on presenting information in a way that maximizes the student’s learning process. In addition multimedia can be programmable, that is, it gives the possibility of engaging the learner in activities, that is, reacting, or responding, to selections made by the learners (Cairncross, 2002).

This article addresses the use of interactive multimedia in the field of engineering. The study of motion has always played an important role in the education of science and engineering. In view of this, efforts to incorporate multimedia technology into courseware to facilitate teaching and learning have been initi-
Interactive Multimedia

This article further describes the path taken to achieve this goal and discusses pertinent development issues on how interactive multimedia can be used as a supplement to aid the learning process. In addition, key features of multimedia are explained and its potential benefits and pitfalls are discussed from an educational perspective.

The purpose of this present work is to explore the issues surrounding the role and benefit of interactive multimedia courseware. The results can provide a useful framework to help educators, instructional and multimedia designers in particular, to appreciate and understand the use of such multimedia technology to enhance engineering education.

ATTRIBUTES OF MULTIMEDIA

Multiple Media

Multimedia enables courseware developers the freedom to select from a variety of media elements to express a particular message in the form of text or motion to represent a process. The key attributes of multimedia are shown in Figure 1.

In addition, a given piece of information can be delivered using one or more media elements (Cairncross & Mannion, 2001). For example, an image can be used to illustrate a text-based description. The information originally presented on screen can be supplemented by the use of audio, video, and pop-up boxes. Audio is useful as text can be minimized on the screen. Multimedia can thus support multiple representations of the same piece of information in a variety of formats.

Delivery Control

Every multimedia tool demands some kind of user navigation. The nonlinearity offered by many multimedia learning applications provides a learner greater navigational and freedom (Cairncross & Mannion, 1999). Users may go onto any section in a multimedia tutorial they wish and in any order. Dynamic media such as video and audio can be controlled, that is, by pausing, playing, and repeating clips. Thus users can skip sections they are familiar with.

Interactivity

“Interaction” refers to the reciprocal action of two phenomena and has both a physical connotation (one entity operating on another) and a psychological connotation (two entities influencing each other’s behavior). In human context, interaction can be people-to-people or people-to-objects. Multimedia itself is not inherently interactive. It can be made interactive through authoring software. In interactive multimedia, it is the user’s interaction with the program that is explored. Researchers into learning styles show that students learn better through specific modalities such as visual, oral, and kinetic. The goal of interactive multimedia is to provide the student with the choice of these modalities in learning environments. Rhodes and Azbell (1985) have identified four levels of interactivity:

- **Reactive**: Refers to relatively simple responses by learners such as pressing the space bar to advance the program or simple menu choices which generally do not require hypothesis generation or a deeper understanding of the material to be learned.

Figure 1. Key attributes of Multimedia
Interactive Multimedia

- **Coactive**: Providing learner control for sequence, pace, and style. When users have somewhat more control over lesson content and structure through learner choices concerning feedback and presentation style.

- **Proactive**: Based on a constructivist approach to teaching and learning. Involves learners as significant decision makers in their own learning through self-initiated activities and self-monitoring.

- **Transactive**: When learners communicate through and interact with a wide range of media and develop their own problem definitions, analytic procedures, and potential solutions to various problems.

Interactivity in multimedia assisted learning applications can and should go further than simply allowing learners to choose their own path through an application by pointing and clicking at various menus items and buttons (Cairncross & Mannion, 2001). To say that a software package is interactive means little. Any software package provides some interactivity in that it responds to user instructions. What makes the difference even in simple educational software is whether the software allows the user to work at the user’s own pace, in the order desired, repeating sequences at will, and manipulate virtual objects on screens. Simulation of experiments or industrial processes can also be provided. Multimedia provides the opportunities to meet these demands. It allows the users to experiment safely, enabling them to examine the consequences of taking wrong approaches, as well as correct ones, thereby assisting the user to have a deeper understanding of the theory involved in the particular subject.

In general, the benefits of human machine interactivity in engineering must always be seen in light of specific contexts and courses. Virtual environments may facilitate learning technical courses, but they must not become an escape from reality. In effort to elucidate the meaning and value of interactivity, a program’s quality and pedagogic pertinence should also be considered.

**DEVELOPMENT OF INTERACTIVE MULTIMEDIA TUTORIAL**

**Engineering Materials Tutorial**

To address the issues discussed, a number of engineering courseware incorporating multimedia are under development which embody real interactivity that engage users in active learning. Although the applications are still in the infancy stage, the ultimate goal is to develop a comprehensive learning facility incorporating the multimedia technology to facilitate and assist mainly nonmaterials science students, in the hope that the students will be able to comprehend and gain a better understanding of engineering materials.

This project is attempting to face the challenges of introductory-level courses by putting the entry-level transfer of information at the disposal of the student, who can then control the pace of delivery, including the ability to stop and replay portions of the lecture that seem unclear. Although, one may say that the textbook is there to serve this purpose, however, experience...
Interactive Multimedia

Interactive Multimedia shows that most students are unable to do this, whether for reasons of time, motivation, ability to absorb new information from a printed medium, or others. In any case, a textbook is a monomedium that has great difficulty in presenting moving or evolving processes.

The proposed multimedia lecture, as in a book, is divided into chapters typically shown in Figure 2, and each chapter is subdivided into sections (see Figure 3). Each section contains up to a maximum of 20 screens called pages, and any page can be identified and accessed by simply double clicking the section titles. The interface is a blackboard on which the navigation controls, the words or phrases that a lecturer would typically write on the board, and the diagrams, photographs, animations, video clips, and derivations that appear during the play-through presentation of a page are displayed. Similarly, one can get to see the diagram of particular structure, for example, such as the exaggerated grain growth phenomenon of a ceramic as shown in Figure 4.

Another interactive multimedia application that has been developed in engineering materials tutorial covers the topic on phase diagrams. A typical screen shot of the interactive system for delivering this part of the lecture of engineering materials is shown in Figure 5.

As can be noted in Figure 5, the use of pop-up boxes and glossaries by either utilizing the same media format or an alternative one can supplement the information originally presented on screen. The user has the advantage at this point to revert back to another screen in order to get detail explanation of a particular term or phenomenon. Such advantage, that is,

Figure 4. An image illustrating the grain growth of a ceramic

Figure 5. Screen shot of the Eutectic type (with limited solid solution) phase diagram.

Figure 6. Typical exercises as a measure of counter check
fast information at the tip of the finger, is not provided in the textbook. Multimedia can thus support multiple representations of the same piece of information in a variety of formats.

In order to gauge the level of effectiveness of this prototype system, the user has the opportunity to apply the knowledge gained through the lesson by simply going through the prepared exercises as shown in Figure 6. The exercise is designed in such a way that the users can interact with the system and keep on trying until they obtain the correct answer to all the wrong ones.

**Engineering Mechanics Statics Tutorial**

The subject of engineering does not lend itself to the sole use of a traditional guided instructional approach, as it is, by nature, an abstract subject (Lloyd & Moore, 1994), nor does the subject contain a generally accepted core syllabus such as identifiable in most other engineering disciplines. It lays an emphasis on the application of skills in addition to the acquisition of knowledge and understanding (Hill, Bailey, & Reed, 1998). To exploit further the effectiveness of multimedia, another system was developed and tested in the engineering mechanics statics tutorial for an undergraduate engineering program. Since engineering mechanics statics concept follows in a linear fashion, the software is structured to present information sequentially. The tutorial contains several sections that are made up of any number of pages. Each page builds a piece at a time, so that a particular concept is built as the user clicks the “Continue” button. While it is intended that learner will proceed through the content in a linear fashion, the capability to jump anywhere throughout the tutorial is also incorporated into the software. As each page builds, several elements such as text, equations, photographs, graphics, and animations are displayed and manipulated.

In order to facilitate user control over the lessons, the navigational interface includes the following functions:

- Move forward and backward one screen at a time within the lesson.
- Jump to sections of interest of the analysis.
- Search and find related information on the solutions that are presented.
- Exit the tutorial easily.

The application’s format is of a menu structure leading to tutorials. A menu comprising the itineraries of the analysis is included (as shown in Figure 7) that enables users to skip a page when necessary. Although the main structure of the courseware is fairly rigid, learners have the freedom to access any tutorials in any order they wish and so are only constrained within the tutorials themselves. An extensive glossary could also be made available to the learners either by hypertext links or by looking at the index and then selecting a glossary entry in the form of a drop-list from that index.

The most effective way of learning the principles of engineering mechanics is to solve problems. To be successful at this, it is important always to present the work in a logical and orderly manner. In the case of structural analysis as in Figure 7, since all the forces acting at a joint must be taken into account, the
importance of drawing the free-body diagram (FBD) (Figure 8) before applying the equations of equilibrium to the solution of a problem cannot be overemphasized. However, prior to this the support reactions must be determined.

In the FBD, the forces that are given should be labeled with their proper magnitudes and directions. Letters are used to represent the magnitudes and directions of forces that are unknown, for example in Figure 8, the reactions force components at the supports \( A \) and \( C \) are designated as \( A_y \), \( C_x \) and \( C_y \). In particular, if a force has a known line of action but unknown magnitude, the “arrowhead,” which defines the sense of the force, can be assumed. The correct sense will become apparent after solving for the unknown magnitude. By definition, the magnitude of a force is always positive so that, if the solution yields a negative scalar, the minus sign indicated that the arrowhead or sense of the force is opposite to that which was originally assumed. At the click of the “Continue” button, the analysis to compute the unknown reactions is carried out in a step-by-step approach.

### MULTIMEDIA AS AN ENGINEERING TOOL

Engineering subjects such as engineering materials and engineering mechanics statics are essential components of the mechanical engineering undergraduate course at UNITEN. Much research has been devoted to provide adaptive guidance during problem solving (Layton, 1993) but other instructional activities may benefit from custom support, because their effectiveness generally depends on the students’ learning styles and attitudes. Poorly designed computer-based interactive multimedia systems can be extremely annoying to users' (Lee, 1999). Many students find the problem-solving skills that are an integral part of any introductory engineering course difficult to develop. In particular, working on homework assignments without the benefit of instructor feedback is often a frustrating experience. In order to alleviate this situation, a number of interactive multimedia tools have been initiated.

In general, these multimedia tools allow students to visualize and understand the selected topics better. The objective is to supplement learners with extra tutorials that can provide immediate feedback, hints, and more importantly to learn at their own time pace. Interactive learning with real animation, audio, graphics,

### Table 1. Multimedia elements and principles

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Text</strong></td>
<td>The most common medium of presenting information. Appropriate to use to communicate a concept or idea. It should effectively complement the other media. Factors that influence the textual communication are typeface, font and style, kerning (adjustment of space between two characters), antialiasing (a technique of making the edges of text smooth), special effects, special characters, and hypertext. While dealing with text in multimedia it is very important to note that it is not the only means of communication. In multimedia text is most often used for titles, headlines, menus, navigation, and content. Overcrowding of text on a single page should be avoided.</td>
</tr>
<tr>
<td><strong>Audio</strong></td>
<td>Audio is another vital media in a multimedia presentation. Audio is available in different file formats and the appropriate file format is chosen to maximize its performance. Sound editors play an important role for converting file formats and also for enhancing the quality of sound. In most cases sound files are imported and edited for a multimedia application.</td>
</tr>
<tr>
<td><strong>Video</strong></td>
<td>Video in multimedia is an extremely useful communication tool for presentations. It illustrates ideas and concepts besides capturing real world events. Video files occupy enormous space, so it is recommended to use short video clips or highly compressed video files such as MPEG (motion professional experts group).</td>
</tr>
<tr>
<td><strong>Graphics</strong></td>
<td>Graphics are the most commonly used element of multimedia. The richness of the multimedia and the effective communication are through graphic presentations. The attributes of color, texture, pattern, and animation enrich a multimedia presentation. Some of commonly used graphics formats are GIF (graphics interchange format), and JPEG (joint photographic experts group). GIF images are very small in size and so load faster than formats. JPEG images are used to display photographic images.</td>
</tr>
<tr>
<td><strong>Animation</strong></td>
<td>A very popular element of multimedia is animation. Animations are designed as a simulation of movement created by displaying a series of pictures or frames. Animation strictly is a visual illusion. It builds dynamism and motion to animate objects. The file formats for animations depends on the nature of software used.</td>
</tr>
</tbody>
</table>
Interactive Multimedia

feedback, and expert advice keeps learners interested and reinforce skills. Interactive multimedia can also help prepare learners for physical experiments, thereby allowing them to make more effective use of their time in laboratories. In summary each multimedia element has its own purpose to convey information to the learner in an appropriate way. Some of the principles of each element can be summarized as shown in Table 1.

CONCLUSIONS

In conclusion, the pedagogical strength of multimedia is that it uses the natural information processing abilities that we already possess as humans. This article presented an overview of interactive multimedia and presented some engineering multimedia courseware. The multimedia courseware provides an effective platform to teach basic engineering subjects such as engineering materials and mechanics statics. In general, mastery and retention rates improve when interactive multimedia is used as more senses are involved in the learning process and the process becomes more active with the user being in control.

There is some concern over the expense involved in developing special-purpose computer-aided-learning (CAL) packages, however, this research provide an example of an application which has led to the development of an economically-viable CAL package which serves the needs of a restricted users. It is believed that technological advances will make lectures and laboratories much more accessible and effective in the future.

REFERENCES


KEY TERMS

Courseware: Software packages that students use in their learning to supplement or replace traditional course activities.

Delivery Control: The means to provide a learner greater navigational and freedom when interacting or engaging in the learning environment. Learners may go onto any section in a multimedia material they wish and in any order in the learning environment.

Interactivity: Refers to the way the user engages in the integration of different media (text, audio, video, graphics, and animation) to enhance the learning process.

Multimedia: Is media that uses multiple forms of information content and information processing (e.g., text, audio, graphics, animation, and interactivity) to inform or entertain the (user) audience.
IntroductIon

The foundation for much of the technology being used in today’s classroom is the Microsoft Office suite. It is fast becoming the integrated software package of choice for many schools and school districts. Word, PowerPoint, Excel, and Access are the staples for many students and teachers. Complementing these capabilities, Internet Explorer and Netscape Communicator are the tools of choice for accessing the World Wide Web. Why not help teachers utilize these same tools to develop text, visual, and Web-based materials for the classroom, and leave the more complex and costly packages to multimedia designers and commercial artists? The success of this philosophy has been borne out by a blistering growth in applications from K-12 classroom teachers, technology coordinators, and corporate trainers.

The Interactive Lesson Defined

More and more teachers are using Microsoft Word to create text-based class handouts, lesson study guides, and student workbooks based on their own classroom learning objectives. They use Microsoft’s Front Page and Netscape’s Composer to produce online Web-based Virtual Tours. And, they use Microsoft’s PowerPoint to create an “Interactive Lesson.” Interactive lessons take the form of a self-paced, student-controlled, individualized learning opportunities embedded with assessment events along the way. In practice, these lessons are offered to students who need individualized instruction; corrective instruction, additional practice, or topical enrichment activities. Special education teachers are also utilizing these programs to help them individualize lessons, assess IEP goals and objectives, and teach their students at each individual ability level.

Specifically, an interactive lesson:

• Is a visual-based, behavioral-oriented teaching strategy appropriate for kindergarten through adult learners who benefit from concrete learning experiences that graphic presentations offer.
• Contains self-paced instructional content appropriate for students who learn best when instructed at their own pace, or who need the benefits provided by remedial instruction outside the classroom.
• Offers specific, logical, systematic lessons that foster individualized instruction and sequential learning.
• Is student-initiated and student-controlled learning that places a good deal of the responsibility for mastering the material directly in the hands of the learner.
• Embraces all phases of the Mastery Learning instructional technique. It suggests alternatives for presenting the initial mastery objectives, corrective instruction, and enrichment activities.

Creating an Interactive Lesson

The instructional system design model offered by Jerrold Kemp is a common tool for creating the interactive lesson. For each of Kemp’s Nine Elements, a practical, hands-on task is completed as evidence that the skill has been mastered. Here’s how it goes:

1. Identify instructional problems, and specify goals for designing an instructional program. Task: Select a topic for an interactive lesson
2. Examine learner characteristics that should receive attention during planning. Task: Identify target learners for the lesson
3. Identify subject content, and analyze task components related to stated goals and purposes. Task: Identify the specific behavioral-based elements that students must master during this lesson
4. State instructional objectives for the learner. Task: Prepare the behavioral learning objectives providing the specific behavior, condition, and criteria for success
Lesson design by the numbers…seems fairly simple, right? The best way to grasp the fundamental power of the interactive lesson and to understand the component that make up successful visual instruction is to investigate an actual presentation that exhibits the best the interactive lesson has to offer. Special education teachers, in particular, are keenly aware of the difficulties that lie in preparing a lesson. Taking into account the myriad of student interests and academic capabilities is of particular importance to those teaching special needs children. Therefore, the lesson, “A Whole New World: A Look at the Nine Planets,” is a natural for examining how to construct an effective interactive lesson (See Figure 1).

### How to Create an Interactive Lesson Using PowerPoint

A menu of options and features make PowerPoint a powerful graphics development and presentation package. Four features in particular make the interactive lesson possible:

- Action buttons
- Hidden slides
- Kiosk browser
- Assessment slide

#### Action Buttons. PowerPoint comes with several built-in responses that are easily inserted into a presentation. There are Action Buttons that go to the next slide, indicate an available movie or sound clip, or request help or information. The Slide Show pop-down menu accesses the Action Button option (Figure 2). However, any element in a PowerPoint slide can serve as an Action Button: text, images, even Clip Art.

#### Slides. A more important use of the Action Button is to assess student understanding. By creating a simple question with several possible responses, PowerPoint transfers students either to new information (if correct),
or to remedial information if additional instruction is necessary. Figure 3 shows a slide that uses the True/False method of assessment. On this slide, the statement, “There are 10 planets in our solar system” offers two possible answers. If students select the incorrect response “True” they advance to Slide 57 (Figure 5), containing information telling them to review the information learned and try again, and, from there, back to Slide 31 to reread the original material. A correct response of “False” triggers the Hyperlink shown in Figure 4 to advance to the feedback (Slide 56) and from there, continue the lesson with Slide 36. Action Buttons enable this interactive feedback, but they would be confusing to the student without the Hidden Slide feature of PowerPoint.

Hidden Slides. In its typical mode, students view PowerPoint slides sequentially from the first to the final slide at the end of the presentation. There are times, however, when a designer might wish the individual to see certain slides only under particular circumstances. An assessment question is the best example.

Unless the feedback slides are hidden, they will be viewed in order as the presentation unfolds. This may result in unnecessary confusion for the student. In “A Whole New World: A Look at the Nine Planets,” the feedback slide is hidden using the pop-down menu shown in Figure 6. Once hidden, a null icon (a diagonal slash through the slide number) appears when viewing the presentation in the Slide Sorter mode. Now, the only way to view this slide is by directly accessing it using the Action Button—and the Kiosk Browser.

Kiosk Browser. Kiosks are self-running presentations found at many trade shows, amusement parks, and conventions. PowerPoint’s kiosk feature supports unattended slide shows that run continuously unaided, restart automatically after each showing, or require user intervention to advance the slides. It is this last characteristic that makes our lesson interactive. Figure 6 shows how to set up the show as a kiosk presentation.

Figure 3. What did you learn?
The student must manually advance every slide for this to work properly. Accordingly, each of the slides in the presentation has its own Next slide button on each slide, otherwise the presentation would stop dead in its tracks. We need the Kiosk feature to ensure that the student does not skip around the presentation—the teacher alone controls the sequence through the Action buttons, Hidden slides, and Kiosk browser.

**Assessment Slide.** Earlier in the article, the interactive lesson was presented as a mastery learning instructional technique. An important premise with this teaching strategy is its underlying dependence on behavioral psychology. To be successful, the Interactive lesson must follow a few basic rules. First, it
Interactive PowerPoint Lesson

Figure 6. Setting a kiosk show

Figure 7. Summative assessment slide

must be logically sequenced. Significant time must be spent structuring the progression of information from beginning to end, least important to most, simple to complex. Second, there must be some form of immediate feedback; again, this is accomplished using the hidden slides. And third, there must be a summative (final) assessment.

A final slide (see Figure 7) in the presentation can meet this requirement while ensuring that students have completed the lesson, mastered all the learning objectives, and received some reward for their efforts. In a computer lab environment, this final Assessment Slide, displayed in bold colors on each individual computer monitor, alerts the teacher that the lesson has been completed and the student is ready for the next instructional challenge.

CONCLUSION

Interactive lessons are not new. They have existed almost since the beginning of instructional technology. But now we offer a structured format for designing such lessons using a popular, highly effective, and relatively easy to use software package, PowerPoint. Once created using Kemp’s Model for Designing Effective Instruction, the presentation can be captured onto a 1.44 megabyte single floppy diskette (unless there is an inordinate amount of graphic images), copied many times, and provided to students who can take the lesson in a formal multimedia classroom, informal computer lab, or even on their own home computers. The interactive lesson has many practical applications for content rich subjects and is highly recommended for your next technology-rich lesson.

What did you learn?

You will have three (3) multiple choice questions to answer. Click on the correct answer. Make sure you record your answers in your Workbook.

Remember, if you need help. raise your hand and I will be around to help you with the questions.

1. Mercury is the planet closest to the Sun in our Solar System.

2. There are 10 Planets in our Solar System.

3. The Sun revolves around the Earth.
REFERENCES


KEY TERMS

**Concrete Learners:** Individuals that learn best with hands-on methods and show the most success when doing it themselves, being involved with their learning process and “doing” rather than “watching.”

**Individualized Instruction:** Instruction focused on the individual learner and their needs, making sure that they master the skills being taught in the way that the individual student learns best. This can be done by using a variety of medias to produce a lesson that “fits” many different ability levels at the same time.

**Interactive Lesson:** A self-paced, student-controlled, individualized learning opportunity embedded with assessment events along the way. In practice, these lessons are offered to students who need individualized instruction as well as immediate feedback.

**Kiosks:** Self-running presentations found at many trade shows, amusement parks, and conventions. PowerPoint’s kiosk feature supports unattended slide shows that run continuously, restart automatically after each showing, and advance without user intervention.

**Multimedia:** Refers to integrated collections of computer based media including (but not limited to) text, graphics, sound, animation, photo images, and video.
Interactive Videoconferencing

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INTRODUCTION

The convergence of once disparate voice, video, and data telecommunication technologies and the increasing adoption and cost effective availability of high bandwidth network services among educational institutions, businesses, and home users has rapidly altered the landscape of technology-mediated communications (TMC) in instructional settings. In combination with the use of distance learning technologies, such as Web-based chat and threaded discussion boards that facilitate both synchronous and asynchronous collaboration, many instructional environments are increasingly adopting a blended approach to instruction that includes video communications. One of the evolving and dynamic technology tools that schools and institutions are increasingly utilizing or planning for in learning environments is videoconferencing because of its ability to offer media rich interactive learning opportunities (NCES, 2001; USDOE, 2004). The extent to which the adoption of TMCs and the closely related subject of information communication technologies (ICT) has transformed education is an ongoing debate that continues to be the focus of a variety of academic and industry research studies. One subset of both TMC and ICT that continues to substantially alter classroom pedagogical practices and the perceived viability of distance education is two-way interactive video communications also known as interactive videoconferencing (IVC). The use of videoconferencing in education has rapidly grown over the past several decades. As technology rich learning spaces continue to be constructed, videoconferencing has the ability to substantially alter both face-to-face and online learning. Through numerous authentic learning opportunities, social interactions, virtual field trips and experiences, global communications, and increased personalized contact, videoconferencing facilitates diverse instructional strategies in support of multiple learning styles and cognitive development. To fully and effectively utilize this tool, it is essential that educators are continuously trained on and informed of the evolving teaching and learning methods, styles, and strategies enabled through the dynamic advances in videoconferencing and related instructional technologies. With these changing pedagogical practices and the increasing use of blended learning, new ways of measuring interaction and evaluating instruction need to be developed and teachers will need to be trained on its use and best practices. This and the institutional sustainability of these endeavors are critical aspects of this author’s ongoing research as well as that of several others (Caspi & Gorsky, 2005; Cox & Webb, 2004; Kozma, 2003; Lim, Pek, & Chai, 2005; Lou, Bernard & Abrami, 2006).

BACKGROUND

As educators and administrators in K-20 learning environments work to blend videoconferencing technologies into the instructional process in order to expand and facilitate student learning and interaction in face-to-face and distance education settings, a number of factors that impact its sustainability as a viable instructional tool must be examined. While the acquisition and deployment of the technology itself is a concern for administrators, as is the training and preparation of in-service and preservice teachers, teachers and researchers themselves have varying viewpoints on the efficacy of videoconferencing for learning, design of instruction, and the best approach to acquiring the skills to use it (Byrne & Staehr, 2002; Greenberg, 2004; Schiffman, 1986). One aspect of the necessary teacher preparation with regard to the use of two-way videoconferencing involves implementing pedagogical strategies that provide an engaging and interactive instructional experience for both face-to-face and distant students. Critical to this experience is the design, development, and delivery of instructional content and mastery of the interconnected system of technology tools used in this environment.

The design of instruction with respect to videoconferencing can take on a number of different focal points. Looking at the early uses of technology and media in
the classroom, instructional design processes tended to take on a media view approach to lesson development (Schiffman, 1986), that is, the technology was center stage and the designer planned the instruction around it and its limitations. Some of these limitations include aspects of physical classroom design such as seating arrangement, viewing angles and distances, temperature, environmental and mechanical noise, lighting, and acoustical transmission, to technical limitations such as noise in audio telecommunications, which reduce the ability to ensure quality dialogue in an atmosphere conducive to learning. The effects of noise in communication and the distance between instructor and learners have been investigated through varying perspectives. Shannon and Weaver’s early investigation into the effects of noise in information processing is demonstrative of how dialogue can be disrupted and misinterpreted between its original source and final destination (Griffin, 1997). Related to this aspect of communications over a distance, the theory of transactional distance introduced by Michael G. Moore, in 1989, examined the success of distance education as a factor of structure and dialogue with dialogue being significantly impacted by the selection of the communications media and structure being impacted by the design of the course and delivery of content and materials through the chosen media (Moore, 1989). While focusing on distance learning, Moore points out that transactional distance theory is applicable to multiple learning environments including classrooms where the distance is relatively insignificant to large lecture halls where students in the back tend to be impacted by the increased distance (Moore, 1991).

In looking at the development of a framework to further examine the transactional distance and classroom discourse while keeping the adoption of new technologies and learning modalities in mind, varying modes of interaction have emerged as a theoretical basis for analysis. Moore and Kearsley (2005) investigated the concept of interaction by describing three modes of interaction, Learner-Content, Learner-Instructor, and Learner-Learner. In a similar vein, Terry Anderson (2004) described three additional types of interaction: teacher-teacher, teacher-content, and content-content. Anderson (2004) goes on to define the relationships of all six types of interaction with each other and to illustrate their influences relevant to the type of educational media (face-to-face, videoconferencing, teleconferencing, computer conferencing, radio, Web-based learning, etc.) being employed.

**Six Core Types of Interaction**

- **Learner-content:** This is the interaction between the learner/student and the instructional materials, which can range from passive interaction with paper handouts or Web pages, to active immersion in virtual environments. Critical to the success of this interaction is the design and delivery of the content, as it facilitates the learner’s ability to retain the information and construct new knowledge (Anderson, 2004; Moore & Kearsley, 2005).

- **Learner-instructor:** This second interaction involves the communications with the instructor as well as the instructor’s interest, motivation, and rapport. Dialogue is an essential component of the instructor-student communication and can occur synchronously through video, audio, or text media, as well as asynchronously through the same media (Anderson, 2004; Moore & Kearsley, 2005).

- **Learner-learner:** This third type of interaction is characterized by peer discussions and group collaboration. Learner-Learner interaction can lead to the development of communities of learners, interpersonal skills, and social development. This interaction can be facilitated in face-to-face or videoconference-based groups or within virtual groups online (Anderson, 2004; Moore & Kearsley, 2005).

- **Teacher-teacher:** The fourth type of interaction can be found within professional development activities and communities of learners, as well as mentoring programs and, in many cases, in team taught instruction with subject matter experts that may or may not be present face-to-face. Teacher-Teacher interaction is also found in the design and development of shared curriculum (Anderson, 2004).

- **Teacher-content:** Teacher-content interaction, as its name implies, pertains to the development, selection, and design of the actual content. The process through which teachers continuously monitor and update curriculum and instructional materials can also be included in this interaction (Anderson, 2004).
**Interactive Videoconferencing**

- **Content-content**: This sixth form of interaction is evolving and generally pertains to dynamically updated information systems that provide real-time learning contexts as well as content that has controlled deliveries programmed into it (Anderson, 2004). There are numerous examples of the growing use of dynamically updated content in environmental monitors, financial systems, geographic information systems, and evolving online social networks.

In looking specifically at interactive videoconferencing as the media of instruction and how it has been used to enhance learning and interaction, a brief examination of the technology itself and its relation to the development of course content is in order. In the 1980s, the use of satellite and microwave based teleconferences/videoconferences were growing in educational environments and because of the potential for technical problems and quality concerns an increased emphasis was placed on teaching strategies that compensate for this (Massoumian, 1989). As the use of more cost effective integrated services digital network (ISDN) telecommunications lines and standards based H.320 communications operating at 384Kbps expanded during the 1990s, the acceptance of videoconferencing as a viable instructional tool grew. However, while the reliability and cost effectiveness of the telecommunications circuit was improved, the technical nature of the equipment used to facilitate these videoconferences caused the focus to remain on the media and its limitations, more so than the content delivery and participant interaction (Kelsey, 2000). During the past 10 years, the quality and ease of use of videoconferencing technologies has significantly improved, as has the availability of content. These improvements are facilitating the use of more systematic design models, such as the analysis, design, development, implementation, and evaluation (ADDIE) and Dick and Carey models when planning for the use of videoconferencing in instruction (Cole, Ray, & Zanetis, 2004; Dick, Carey, & Carey, 2004). In line with the ADDIE approach to design, the reduction of technical barriers allows for increased flexibility and creativity in the design and development as well as the delivery of instruction. This can serve to increase the level of interaction and facilitate lessons that focus on the development of higher order thinking skills and authentic learning experiences.

**Teaching and Evaluation**

With the development and delivery of lessons in mind, the administrative aspect of evaluating and training teachers must also be a consideration of utilizing and deploying interactive videoconferencing in instructional settings. Focusing on the teacher-student and teacher-content aspects of interaction and the transactional elements of instruction, the Framework for Teaching that was developed by Charlotte Danielson in conjunction with the Educational Testing Services and the Association for Supervision and Curriculum Development provides 4 key domains and 22 subcomponents for use in professional evaluation. Among the components of this framework the “Selecting Instructional Goals,” “Demonstrating Knowledge of Resources,” and “Designing Coherent Instruction,” subcomponents of Domain 1, can be used to effectively evaluate the teacher preparation aspects of utilizing videoconferencing (Danielson, 1996, p.3). While Danielson’s framework has been widely adopted education and it can be applied to interaction and technology tools such as videoconferencing, it appears to be best suited for face-to-face classroom instruction. In looking specifically toward distance learning Roblyer and Wiencke constructed a distance learning based rubric for measuring five primary elements that contribute to the overall level of interaction and interactivity in a course. These five interactional elements are: Social/Rapport-Building Designs for Interaction, Instructional Designs for Interaction, Interactivity of Technology Resources, Evidence of Learner Engagement, and Evidence of Instructor Engagement (Roblyer & Wiencke, 2003, 2004).

As the uses of interactive videoconferencing in both face-to-face and distance instruction evolve, a blended model for guiding teacher preparation and evaluation combined with the theoretical foundations for research into interaction and instructional design methodologies provides us with a comprehensive lens through which the uses, applications, and effectiveness of interactive videoconferencing can be brought into focus.

**Current and Emerging Applications of Interactive Videoconferencing**

Evidence indicates that the educational model of the past will require crucial and systemic changes as tools and concepts needed to succeed in the global
information age are incorporated into the instructional process (Friedman, 2005; USDOE, 2004). These tools and concepts include information communication and electronic collaboration technologies. This being said, as ICT and TMC along with a range of interrelated technology tools and concepts become a focal point for learning in K-12 and higher education, it must also become a focal point for teacher preparation and development (Wise, 1997).

It has been this author’s experience in both K-12 and higher education settings that while the extended classroom approach to reach distance learners is a much researched and typical use of videoconferencing, there are increasing opportunities for faculty and trainers to not only increase the frequency and quality of communications with distance learners, but to bring a broader range of instructional content into the face-to-face classroom (Lou et al., 2006; Machtems & Asher, 2000). Numerous opportunities exist for authentic and virtual learning experiences as well as global social interactions. Just a few of the opportunities I have personally facilitated and observed as a technology administrator, student, and researcher, include international discussions with student peers, content experts, and literary authors, pharmaceutical research studies, scientific discussions, and virtual explorations with NASA astronauts and earth science studies with paleontologists. In higher education, this author has found the use of videoconferencing (VC) in the discussion of academic progress with faculty and the facilitation of simultaneous class participation between face-to-face, out of state and international students highly valuable. This author has also observed that desktop VC is now being adopted by K-12 cyber schools as a means to facilitate student mentoring and learning as well as increase socialization among distance learners.

Based on personal experiences and the ongoing analysis of available literature, it can be conceptualized that the levels of instructor preparation go hand-in-hand with the levels of interaction. That being said, what preparation have instructors received, or should they receive, to provide quality interaction with students, when utilizing two-way videoconferencing systems in the classroom? There are varying factors involved in answering this question. First the instructor should be well versed in their subject area and capable of successfully delivering the lesson in a face-to-face environment. Second the instructor must be comfortable with, but not necessarily well versed in the technology, provided that a trained technician is in the room for the purpose of facilitating the use of the technology. Third, exposure to the technology and the process of being on camera, enables instructors to observe themselves and their teaching habits, which can subsequently lead to conscious improvements by overcoming subconscious habits. To this same regard, student reactions to seeing themselves on camera or talking to a video display can create a level of distraction that pulls focus away from instruction. In these situations, teachers must be prepared to utilize classroom management techniques that overcome these potential issues. As the comfort level grows and the use of IVC and related technologies in the classroom becomes transparent, content delivery and interaction should be enhanced. With this thought in mind, classroom management will inevitably remain a key aspect of the educational environment. In much the same way as turning your back on the class to write on the board can open the door to unwanted behavior, turning your back on the camera or not speaking at a level picked up by the microphone can lead to lost student focus.

Also, in observing videoconference based instruction and in reviewing published research studies, certain areas of interaction do not appear to be as immediately applicable to the IVC media. For example content-content interaction does not appear to be as applicable as currently defined. In the case of IVC, there can be a level of interaction between technology sources at different sites and within the classroom, but that is not readily seen as dynamic content-content interaction. Anderson described content-content interactions as something that is increasingly occurring in automated/intelligent technologies, where content is programmed to interact with other content in order to keep itself up to date (Anderson, 2004). Anderson used the specific example of weather systems that collect and share current meteorological data for analysis and instruction as content-content interaction. With regard to the visualization aspects of this type of data there conceivably remains a great potential for incorporating this type of live content interaction into videoconferencing. This, in fact, is one advancing use of high bandwidth Internet2 connections now being utilized by university researchers and K-12 institutions.
CONCLUSION

In the past few years, the growing adoption of high speed broadband network technologies among universities and home users combined with the increased interoperability of classroom and desktop videoconferencing systems has served to further facilitate and validate the expanding range of engaging instructional IVC opportunities beyond the traditional classroom lecture (Greenberg, 2004; Horrigan, 2006). Furthermore, the growing use of the high quality Internet Protocol (IP) based H.323 standard for videoconferencing equipment has helped to lower the total cost of ownership and is accelerating the adoption of videoconferencing as a communications tool and instructional resource. As with other evolving technologies (Web collaboration and socialization tools, streaming video, electronic whiteboards, the telephone, television, etc.) and their acceptance in society, as the comfort levels of learners and educators grows through personal and professional use, a corresponding increase in its acceptance for classroom instruction and research into its effectiveness should be observable. In the same way technology is rapidly changing global communications and workforce dynamics, it is inevitable that the traditional brick and mortar and face-to-face educational environments will be significantly impacted by it as well. As interactive videoconferencing continues to evolve, we can expect to see new and innovative pedagogical strategies emerging and, as with other technologies, there will continue to be a need for ongoing research into their effectiveness and best practices. In fact one might consider that the pace of research will have to accelerate in order to keep up with the rate of technological innovation and change.

REFERENCES


Interactive Videoconferencing


Interactive Videoconferencing

**KEY TERMS**

**Broadband:** Telecommunications circuit that typically uses wireless, coaxial, or fiberoptic links to transmit digital voice, video, and data at speeds greater than 1.544 Mbps.

**Information Communication Technology (ICT):** A concept originating out of the United Kingdom, ICT is generally viewed as the study and practice of using technologies in communicating, accessing, and interpreting information.

**Instructional Systems Design (ISD):** Systematic process-based views and models used in developing instructional content, learning strategies, objectives, and media. These processes are founded in learning theory and typically include learner analysis, evaluation, and assessment relevant to both the learner and instructor.

**Interactive Video Conferencing (IVC):** A form of synchronous two-way video and audio communications in which participants in two (point-to-point) or more (multipoint) physical settings interactively collaborate with each other and instructional content.

**Internet:** Started in 1969 as ARPAnet by the U.S. Department of Defense Advanced Research Projects Agency, this is now a globally connected publicly accessible network of networks used in standard internet protocol based data communications such as Web access and electronic mail.

**Internet2:** A second-generation network comprised of more than 200 universities working with industry, government, and schools operating at speeds up to 100Gbps, this system provides for advanced network applications and technologies.

**Technology-Mediated Communications (TMC):** Communications that are controlled and facilitated by technology tools and applications. Examples include, telephone conversations, Internet based text chats and discussions, videoconferencing, and other mediated communications including computer-mediated communication (CMC).
Internet Citizenship: Course Design and Delivery Using ICT

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INTRODUCTION

This article presents the design of an undergraduate course that focused on how the Internet may be used as a medium for discovering information about citizenship, in general, and for advocating and practicing citizenly conduct, in particular. The goal is to share with the reader a set of guidelines to specify course objectives and requirements, to select relevant materials, to engage students in self-directed learning, and to appreciate the process of working with the students over a semester. Applications of information and communication technology (ICT) were integrated into the course management and delivery, and they also formed the basis of the topic for the course content.

The title of the course was “The Voice of an Engaged Citizen: Vote, Advocate, Volunteer, Respond, Act...How?” This course was one of 14 first-year seminars (FYS) intended to be taken by high-achieving freshman at the University of Maryland–Baltimore County (UMBC). These seminars, which are limited to 20 students, are intended to create an active learning environment. The students’ development of effective oral and written communication skills and the mastery of techniques to seek and evaluate information are the cornerstones of these seminars. This particular course was intended to explore the ways that ICT could foster the practice of citizenship. The course also had the objective of teaching students to use the Internet to search for reputable evidence in support of the Internet’s use in such an application area.

COURSE DESCRIPTION

First, the students taking part in this course should use the Internet to learn what citizenship is. From there, they can look for ways that the Internet can be used to practice citizenship. Practicing citizenship via the Internet may include, but is not limited to, finding and evaluating Web sites that provide information about important issues and that provide the opportunity to communicate with our representatives. Likewise, students are also encouraged (1) to look for research that has been done to see if and how citizens are using the Internet to participate in democracy, (2) to seek information about political activist groups on the Internet, and (3) to determine how effective those groups are in attracting members and influencing decision making.

Students should then attempt to find out if the Internet has information about character development and the learning of moral values.

The overall objectives for the coursework are formulated as the class progresses. This way, the class will allow itself the flexibility to pursue an avenue it finds interesting. The format of the work should include group discussions and seeking out information on the Internet. During some of the classes, students present their findings for discussion, ensuring that the students learn how to prepare and deliver PowerPoint presentations and how to write evaluative essays of journal articles and other material.

COURSE MANAGEMENT AND DELIVERY

A Blackboard site was available in support of this course where material, such as readings and Web site links, were posted for the class to review. It should be noted that the “syllabus” of this course evolved in the form of an “Assignments Log” posted on the Blackboard site that specified the requirements for each particular class. This log evolved because there was flexibility in
the pacing and type of assignments required from the students; typically, the due dates for written essays and presentations were posted two weeks in advance.

However, the most important use of Blackboard was its function as a forum for students to provide immediate written comments on class events, whether led by the instructor or by the students themselves. Furthermore, Blackboard was also used for students to post their PowerPoint presentations, their review essays of journal articles, and their evaluations of Web sites so they could be reviewed by the instructor as well as other members of the class.

COURSE CONTENT AND STRUCTURE

This particular seminar course met twice each week for 75 minutes over a 14-week semester. Class time was devoted to the following types of activities.

First, the instructor (HHE) posted on Blackboard a collection of journal articles (Evans & Yen, 2005; Froomkin, 2002; Thomas & Streib, 2005), related reports (Best & Wade, 2005; Clift, 2002; Emurian, 2004; Noveck, 2004; Vance, 2000), and surveys (Horrigan, 2004). This material was used for reading and discussion in class. The preferred style for engaging this material was found to be a type of “round robin” where each student would lead and read several paragraphs, later passing that role to another student. The student leader and reader was free to make comments and ask questions as he or she engaged the material, and other class members were encouraged to present their own questions and comments. At the conclusion of a reading and discussion, each student posted his or her own thoughts on the reading on a designated Blackboard discussion forum. Students were encouraged to give an evaluation of the material read and discussed in relationship to the overall objectives of the course. These class exercises, which were interspersed throughout the semester, provided the occasion for open discussion and the rehearsal of tools of analysis that were applicable to the students’ written reviews of journal articles that they themselves selected.

Second, as briefly mentioned above, each student reviewed six journal or other reputable articles throughout the semester (Coleman & Norris, 2005; Gil-Garcia, 2005; LaVigne, Simon, Dawes, Pardo, & Berlin, 2001; Lourenço & Costa, 2006). Each review was based upon a set of guidelines for evaluating an article, ultimately resulting in a two-to-three page, single-spaced essay. The articles selected by the students were posted on the Blackboard site for approval, and the review served as a basis for a PowerPoint presentation to the class. The set of guidelines was discussed in class, and anonymous examples of reviews written by students in similar seminars were also presented and discussed. For the first review, the instructor met with each student individually to provide feedback on a draft of the review. This meeting ensured that both the students and the instructor were in agreement with regard to what was expected from the review; consequently, both the instructor and students found this initial feedback session to be invaluable to the production of subsequent quality essays.

Third, several classes were devoted to examination and open discussion of various Internet portals and Web sites thought to be relevant to the course topic of Internet citizenship. This activity was made feasible since the class was able to meet in a PC lab or in a seminar room, depending upon the needs for each particular class. Based upon the feedback from the students during these open discussions, it was decided that PowerPoint presentations would be delivered by each student to evaluate a Web site. Consequently, each student shared his or her findings with the class. The pace of this course allowed each student to make three of these PowerPoint presentations. Among the cornerstone sites investigated, in open discussion or by student presentations, were the following:

This site contains a wealth of Web sites organized into the categories below. From among the many sites presented within a category, one example is presented for each category.

   a. Advocacy Resources
      ➢ CITIZENOUTREACH
         (www.citizenoutreach.com)

   b. E-Government General
      ➢ E-DEMOCRACY
         (www.e-democracy.org)

   c. Communicating with Elected Officials
      ➢ YOUR CONGRESS
         (http://www.yourcongress.com/)

   d. Nonprofit Resources
      ➢ NONPROFIT BASICS
         (www.nonprofitbasics.org)
e. Online Political Networks and Conversations
   - E-THE PEOPLE
     (http://www.e-thepeople.com/)

   • This is the U.S. Government’s official Web portal.

   • On this U.S. Government Web site, you can find, view, and comment on regulations for all federal agencies.

   • The National Issues Forums help people of diverse views find common ground for action on issues that concern them deeply.

   • The Study Circles Research Center helps communities develop their own ability to solve problems by exploring ways for all kinds of people to think, talk, and work together to create change.

   • The stated vision is to encourage the growth of a more open set of intellectual communities than those spawned by the traditional university system.

   • AmericaSpeaks is developing a national infrastructure for democratic deliberation that institutionalizes the links between decision-makers and citizens in determining public policy.

An initial attempt was made for the student presentations of the Web sites to be a demonstration; that is, the student would show the features of the Web site by navigating through it in front of the class. This approach turned out to be awkward and unsupportive of communicating the evaluation of a site. Therefore, embodying the student led nature of the class, the students decided that the presentations of the Web site should follow the PowerPoint presentation format similar to that used for presenting the review essays. By using this format, screen shots of the features of the Web site were able to be included into the presentations, and it became easier to point out the strengths and weaknesses of a site. Figure 1 presents an example of a screen shot used for a student presentation. The screen shot was more beneficial than an open navigation Web site presentation because it allowed the student to focus on a specific aspect of a given Web page. In this example, the student chose to focus on the types of study circles offered in the state of Maryland.

Figure 1. Slide from a Web site PowerPoint presentation on StudyCircles.org
Internet Citizenship

In addition, classes that were scheduled between assigned deliverables consisted of such exercises as the investigation of Web sites that occurred during the third class of the semester.

1. Overview in class
   a. Congress.org
      (http://www.congress.org/congressorg/home/)
   b. U.S. Senate Portal
      (http://senate.gov/)
   c. U.S. House of Representatives Portal
      (http://www.house.gov/)
   d. The White House Portal
      (http://www.whitehouse.gov/)

   These portals were investigated and discussed in class and the students used them to express an opinion, anonymously to the other students and instructor, on a topic of interest.

STUDENT MILESTONES, CONTRIBUTIONS, AND FEEDBACK

In administering the course, there were several milestone instructional events that provided the occasion for the students’ acquisition of background skills and knowledge that became instrumental to the successful deployment of this seminar to undergraduates.

One such instructional event was posted on the Blackboard site on the date of the second class, and it was due on the date of the fourth class:

“This assignment is to prepare a PowerPoint presentation covering the below three topics. Find sources on the Web for this exercise.

a. Give a definition of citizenship,
b. Give core values needed for the practice of citizenship, and
c. Give specific behaviors regarded as exhibiting the practice of citizenship.

Give your opinion on the quality of the sources of information and defend your opinion. What makes a resource of information have high quality? Give the links on your PowerPoint presentation.

This was the first major assignment for the students in this class, providing the occasion for each student to express his or her opinions on the course’s content while challenging each one of them to provide reputable support for those opinions.

Another one of these instructional events occurred during the second class of the seminar. It consisted of a lecture by a reference librarian who taught the students how to search for information using the library’s various databases, research portals, and search engines. The importance of this lecture cannot be overemphasized. Students were familiarized with access to electronically available journal articles and other material that were essential to their success in seeking information related to the topic of this course. Although most students were highly experienced in using Internet search engines, the library offered additional and secure paths to information that many students had yet to explore. Other instructors would be well advised to offer this type of lecture early in the academic careers of students, to include graduate students where necessary.

One very important class milestone occurred during the fourth class, as given in the Assignments Log:

1. Founding Documents
   b. We will read in class the Declaration of Independence and parts of the Constitution, to include the Bill of Rights.
   c. Assignment: Post your comments today about your reaction to reading these formative documents.

   The instructor and students shared the reading of these documents, accessed via the Web site above. As it turned out, the Declaration of Independence and the entire Constitution were read during the 75-minute class. This class event turned out to be a vital as well as inspirational milestone for the students and the instructor.

   Last, the final milestone, which, as the schedule would have it, occurred during the last class, consisted of student presentations of “Reflections on Internet Citizenship.” These presentations were summative evaluations of the course by the students in terms of what was accomplished by each learner. Through these presentations, students were given the opportunity to share lessons they learned while taking this seminar as well as express their opinions about how they believed the course could be improved for future classes. The strengths and weaknesses addressed in those presentations even served to aid the writing of this instructional
article. A collection of observations made by several students is given below:

- The Future of E-Government:
  - Overall, E-Government seems to have a bright future
    - People are “getting out of line and getting online”
    - “E-the-People”

- Article Reviews:
  - One of the best parts about this class
    - Very unique activity for a FYS class
  - One activity provided tons of knowledge for future reference
    - Learned a new writing format
    - Improved critical thinking skills
  - Preparation for graduate school
    - Really enjoyed the fact that this activity will be of use to me in furthering my education—kind of like a “heads up”
    - Excellent “plan-as-we-go” class that developed us as writers, presenters, and analysts of academic writing.
    - All assignments had a purpose and we achieved the goals together.
    - I also learned how to critique.
  - Finding trustworthy articles and sites
  - Determining methodology
  - Finding strengths and weaknesses
    - Enjoyed going over articles in class.
    - I liked the course.
  - The ability we had to discover such a variety of information in such detail through the presentations of topics we each went out and chose on our own was really neat.

**CONCLUSION**

This article presented an effective design for structuring and implementing an undergraduate seminar course on the topic of Internet citizenship through the applications of ICT.

It is very important to note that the evolution of this course from a flexible “Assignments Log” allowed the students to undertake a wide variety of activities, from writing those aforementioned journal article reviews to giving Web site presentations using PowerPoint technology. Furthermore, the types of activities pursued in this seminar class (as well as in most other seminar courses) served to strengthen the students’ overall writing and presenting skills, which will continue to be of use to them as they proceed with their education. In the same sense, the student-led nature of the course allowed the class to pursue topics within the concept of Internet citizenship that they saw as particularly intriguing, ensuring that the students remained actively involved in the course content throughout the entire semester. This was easily accomplished, as much of the coursework was designed for the individual student (e.g., allowing each student to select his or her own journal articles to review). As a result, while one student may have chosen to investigate the security concerns surrounding Internet citizenship, another student could have decided to research the technology needed to further the practice of Internet citizenship. Such material variety kept the coursework fresh and interesting as the semester progressed.

Overall, student feedback indicated that the approach described here regarding the instruction of an undergraduate seminar course on Internet citizenship was highly effective. Both the students and instructor gained valuable insights on the course content through the interactive group activities that became one of the cornerstones of this class. Similarly, having the opportunity to make several presentations clearly had a positive impact on the students’ skill level as it was observed that students’ presentations increased in length and quality over the semester. Therefore, it is the hope of the authors that, after reading this article, the reader will have gained a better understanding of the undergraduate seminar program offered at the University of Maryland–Baltimore County and will also be able to execute successfully the methods previously described to create an Internet citizenship seminar of his or her own in the future.
Internet Citizenship

REFERENCES


KEY TERMS

Citizenship: Although the typical definition of citizenship refers to the rights and privileges of those designated legally to be citizens, the concept was extended in this article to include motivation to participate in shared governance.

First Year Seminar: At UMBC, outstanding freshman are allowed to enroll in a course that has a seminar format similar to what graduate students might experience.

ICT: Information and communication technology was used as the medium studied for political engagement and for course delivery and management with Blackboard.

Internet: The term “Internet” includes the World Wide Web because that is a common way to refer to the media for electronic communications and exchanges of information.

Internet Citizenship: This reflected the use of the Internet for political engagement and empowerment, from local, state, and national perspectives.

Instructional Design: In the present context, this refers to the techniques that were adopted to encourage the students to seek and evaluate information and to provide written and oral reports to the instructor and to the class.
ENDNOTES

1 Internet is used here to include the World Wide Web because that is a common way to refer to the media for electronic communications and exchanges of information.

2 http://www.umbc.edu/undergrad_ed/fys/index.html

3 The junior author (MMC) was a student in this seminar. The senior author (HHE) was the instructor and is an associate professor of information systems.


5 The authors appreciate the lecture by Drew F. Alfgren to this and other classes and his ongoing support of our students’ development of research skills.
Internet Field Trip: Conception and Development

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INTRODUCTION

A field trip is typically a group excursion to a place away from their normal environment for performing firsthand research on a topic. Field trips have been widely used in teaching and learning, and have been considered as the effective way to promote students’ active and inquiry-based learning. As Prather (1989) noted, “compared to other traditional teaching techniques, field trips may provide an especially rich stimulus setting for content learning and may excel in generating a natural inclination to learning”. Similarly, Woerner (1999) indicated that field trips offered excitement, adventure, and visual, auditory, kinesthetic, olfactory, and gustatory experiences for students to learn about the real world and how it worked.

However, despite their advantages and popularities, actual field trips do have a number of limitations, including issues of logistical and preparation problems, such as the difficulty of making accurate assessments in advance on risk, timing, and weather; relatively high cost; difficulties faced by disabled students; too many objectives in the “lesson” and the site is too overwhelming on a single actual trip; and the lack of right places with certain subject areas, and so forth. (Bellan & Scheurman, 1998; Stainfield, Fisher, Ford, & Solem, 2000; Woerner, 1999). As a result, the literature suggests that Internet field trips can be designed and developed for teaching and learning.

BACKGROUND OF INTERNET FIELD TRIPS

An Internet field trip, also known as a virtual field trip, is a journey taken via the Internet site without making a trip to the actual site. Foley (2003) defined an Internet field trip as a guided exploration through the Internet that organized a collection of prescreened, thematically based Web pages into a structured online learning experience. Although Internet field trips cannot completely replace the sensory experience of actual field trips, they may sensitize a student’s sense of touch, smell, and sight to the plethora of the stimuli to the encountered at the actual site (Bellan & Scheurman, 1998). Stainfield, Fisher, Ford, and Solem (2000) indicated that an Internet field trip should not be an attempt to create a virtual reality, and should be “simply an attempt to place further autonomy in the user’s hands, by allowing observations to be made without being on the actual site or having a lecturer at hand to explain.” Related studies have found that Internet field trips could provide a variety of advantages on teaching and learning. They can be accessed and repeated from place to place and time to time; can allow the teacher to focus on one specific aspect of the trip at a time; can give students great flexibility to learn at their own pace and explore things to their own depth; can take students to sites and subjects they would not otherwise go; can have an easier management and lower cost of production; can be safe and free of hazards; cannot be lost; can increase students’ information literacy; can improve technology integration; can provide integration of the multiple aspects of the field trip into a number of different curriculum area and tap into more expert resources on a single topic; can allow for commonality of experiences by all participants; and so forth. (Hosticka, Schriver, Bedell, & Clark, 2002; Stainfield, Fisher, Ford, & Solem, 2000; Tramline, nd).

Beal and Mason (1999) classified the use of Internet field trips into four categories. Firstly, Internet field trips can be used for the post-field-trip activity. This type of Internet field trip is designed to help students synthesize what they have learned on an actual class field trip. Secondly, Internet field trips can be used for the pre-field-trip activity. This type of Internet field trip is designed to help students prepare an upcoming actual field trip. Thirdly, Internet field trips can be made by others. This type of Internet field trip is adopted to help students gain information about areas they are unable
Characteristics of Effective Internet Field Trips

As with an actual field trip, students taking an Internet field trip will explore the virtual spaces, make observations, test ideas, collaborate with peers, collect things, learn prerequisite concepts, and deal with the questions at hand, and so forth. (Woerner, 1999). To avoid aimless and chaotic attempts, an Internet field trip must have effective features to support students’ learning. There are a growing number of studies on identifying features of effective Internet field trips. Woerner (1999) compiled these features as indicated in Table 1.

Design and Development of Internet Field Trips

A valuable and effective Internet field trip is not simply a fun game or a change-of-pace event for learners who have been pushed through homework assignments, lectures, and tests. It is imperative that the Internet field trip project is accountable and it incorporates high standards, rigorous challenges, and valid assessment methods. A review of the literature supports the following model of TIED (target, implementation, evaluation, and development) for classroom teachers to design and develop their Internet field trips (see Figure 1).

The model of TIED serves two ends. The first end is to provide a guide for in-service teachers to outline the major issues they face in designing the educational Internet field trips on their own, to shape the process and constrain some specific choices, and to prevent the situation that in-service teachers are simply busy

Table 1. Features of effective Internet field trips (Source: Woerner, J. J., 1999)

<table>
<thead>
<tr>
<th>The Internet field trip should have:</th>
</tr>
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<tbody>
<tr>
<td>• a specific focus or objective(s) that is clearly stated</td>
</tr>
<tr>
<td>• an integral part in the classroom learning</td>
</tr>
<tr>
<td>• a pre-trip orientation with concrete activities</td>
</tr>
<tr>
<td>• a navigator to guide students easily around the field trip site</td>
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<tr>
<td>• a post-field-trip follow-up with activities and debriefing</td>
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<table>
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<tr>
<th>The students should be able to:</th>
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<tbody>
<tr>
<td>• move around at their own speed and select what is meaningful to them to see and experience</td>
</tr>
<tr>
<td>• interact with the field trip environment and use multiple sensory modalities</td>
</tr>
<tr>
<td>• have access to content experts who understand the events, processes, and concepts illustrated at the site</td>
</tr>
<tr>
<td>• make observations, collect and analyze data, and construct their own explanations</td>
</tr>
<tr>
<td>• compare their observations and explanations to those made by other students and field “experts”</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>The online features should:</th>
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<tbody>
<tr>
<td>• be rich in context and aesthetically pleasing</td>
</tr>
<tr>
<td>• have a navigator to guide students easily around the field trip site</td>
</tr>
<tr>
<td>• have online resources that provide easy access to the content</td>
</tr>
<tr>
<td>• relate the focus or objectives to the curriculum content of the site</td>
</tr>
<tr>
<td>• use the unique features of the Web</td>
</tr>
<tr>
<td>• accommodate multiple modalities and learning styles</td>
</tr>
<tr>
<td>• facilitate independent investigation and cooperative group work</td>
</tr>
<tr>
<td>• contain suggested off-line student activities</td>
</tr>
<tr>
<td>• contain appropriate links to related sites</td>
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“doing without understanding” on Internet field trips. The second end is to secure an opportunity for students to develop a greater technological competency while reflecting on their own learning processes, to develop a deeper understanding of the Internet field trips they are engaged in, and to enhance a broader skills needed to solve real-world problems, than a formal didactic transmission approach.

**The components of TIED.** TIED consists of the following four interrelated, graduated and cyclic stages.

**Target.** This stage includes identifying learning goals and disciplinary objectives; assessing potential online and off-line resources; scaffolding main concepts and activities; and planning timeline, and so forth. This stage can be conducted by using concept mapping. Previous studies have shown that concept mapping could help teachers generate ideas, design a complex structure, communicate complex ideas, aid learning by explicitly integrating new and old knowledge, and assess understanding or diagnose misunderstanding, and so forth. (Lanzing, 1997; Novak, 1998; Novak & Canas, 2006; Novak & Gowin, 1984).

**Implementation.** This stage contains investigating and selecting available and feasible hardware and software; locating and evaluating online and off-line resources; assembling and testing elements of an Internet field trip (text, sound, graphics, layout, internal and external links); and preparing and writing descriptions and instructions for students, such as the narrative of the Internet field trip site, guidance for students visiting the Web, the worksheet for students working the objectives and goals.

**Evaluation.** At this stage, teachers should carefully analyze the findings from students’ learning experiences and products to identify the strengths and weaknesses of the Internet field trip, and make a plan to enhance the Internet field trip for the future usage.

**Development.** An effective Internet field trip is continuously updated based on learners’ comments and teachers’ insights. Teachers may need to keep revising what they have done and putting latest contexts that they think are going to enhance their Web projects. In addition, online resources are extremely dynamic. What is true today is often outdated tomorrow. Therefore, it is important for teachers to periodically check online resources in order to delete outdated or unavailable ones and to add new relevant ones.

**Marching through the stages.** Figure 1 illustrates how the TIED components are interrelated. The model of TIED is essentially a cyclic process, but the *target* stage is the most reasonable initial stage of developing and implementing an Internet field trip. The *target* stage defines project goals, identifies necessary tasks, and designs a working plan. These goals, plans, and so forth are fed into the *implementation* stage. At the implementation stage, the conceptual outputs from the previous stage are realized. There are two types of outputs produced at the implementation stage. The *extrinsic* outputs include the Internet field trip site and any auxiliary documents, such as activity handouts and evaluation sheets. While the *intrinsic* outputs can include the lessons learnt by the teachers, the educating moments experienced by the students and the learning outcomes resulted from the Internet field trip. These outputs are then evaluated at the stage followed (that is, the *evaluation* stage). Any findings resulted from this stage will be reflected at the Internet field trip project, which are actualized by the Web site updates.
and project refinement at the development stage. Therefore, the development stage contributes to both the target stage and the implementation stage, at which the Internet field trip project goals, objectives, tasks, and project plan are refined, as well as the project Web site is modified.

REFERENCES


KEY TERMS

Active Learning: It refers to a process whereby learners are actively engaged in the learning process, rather than “passively” absorbing lecture. During the active learning process, learners must read, write, discuss, and engage in solving problems, analysis, synthesis, and evaluation.

Concept Mapping: It refers to a type of structured conceptualization by representing knowledge in graphs that was developed by Joseph D. Novak in the 1960s. Knowledge graphs are networks of concepts. Networks consist of nodes (points/vertices) and links (arcs/edges). Nodes represent concepts and links represent the relations between concepts.

Information Literacy: It refers to a constellation of skills revolving around information research and use. According to the Final Report of the American Library Association Presidential Committee on Information Literacy (1989), the information literate person is, “able to recognize when information is needed and have the ability to locate, evaluate, and use it effectively.” (Retrieved April 3, 2007, from http://www.ala.org/ala/acr/acrlpubs/whitepapers/presidential.htm)

Inquiry-Based Learning: It refers to a student-centered, active learning approach focusing on questioning, critical thinking, and problem solving.

Technology Integration: It refers to describe effective uses of technology by teachers and students for teaching and learning in content areas.

Virtual Reality: It refers to a simulated multidimensional environment by computer technology that feeds the user’s senses with stimuli that model real-world conditions and thereby, give the impression of moving within a virtual world.
**INTRODUCTION**

Forensics is the application of sciences that help to seek out, examine, and answer questions about certain characteristics. For example, forensic toxicology helps us understand certain drug interactions, whereas forensics evidence helps us understand evidence that is uncovered at a crime scene. Since computers are now often used in criminal activity, a forensic branch of science has been created termed computer forensics. Unfortunately, unlike other forensics sciences, the complexity, legality, and even the nature of computer forensics may make it more vulnerable to errors.

Computer forensics is defined by Nelson, Phillips, Enfinger, and Steuart (2006) as “obtaining and analyzing digital information for the use as evidence in civil, criminal, or administrative cases” (p. 2). It is also defined by Noblett, Pollitt, and Presley (2000) as “the science of acquiring, preserving, retrieving, and presenting data that been processed electronically and stored on computer media”, but rather than simply examining a computer system, computer forensics investigations need to produce “direct information and data that may have significance in a case” (p. 1).

Computer forensics as now grown into a sub-field of learning within information technology (IT), and according to Berghel (2003):

“while not a profession, computer forensics satisfies the definition of a discipline. It is a well-defined field of study and practice. Like IT itself, it satisfies both the durability condition and the body of principles. It also has a codified body of practices that have evolved over the years through courtroom experience, and standards for competence, ethics and practice (p. 15).”

These definitions of computer forensics imply that this science is more than uncovering data; it is the uncovering of data that will have some potential usefulness, such as the applicability in a court of law.

The reverse is also true; the complexity introduces the very real danger of the opposite, that is, bad investigations, faulty record keeping, maintaining the integrity and custody of data, and that if an investigator is not careful, the data he or she collects will not be admissible in a court of law.

Computer forensics investigations also differ from other forensics sciences, like DNA forensics evidence testing where a conclusion is reached. Forensic science “makes no interpretive statement as to the accuracy, reliability, or discriminating power of the actual data or information” (Noblett et al., 2000, p. 1). Since computer forensics science investigations do not reach a conclusion, to withstand court challenges, the methodology used must be rigid, detailed, and logically conducted in steps that adhere to widely-accepted practices and procedures.

**BACKGROUND**

Born out of necessity, computer forensics was created to combat the increase in computer crimes. The discipline was modeled after basic law enforcement principles, and followed with well-defined processes and procedures (Berghel, 2003). It was created by the blending of two unique needs: first, the increasing dependence of law enforcement on computing; and second, the ubiquity of computer systems in our everyday life. Because of this ubiquitous nature, the general public still does not understand how a computer could be used for a crime, and often fails to understand even after a crime has occurred (Armstrong & Jayaratna, 2004).

Brungs and Jamieson (2005) report that computer crime continues to grow, and according to a financial fraud survey, 80% of respondent companies admitted to some type of financial fraud with losses averaging $1.4 million. Busing, Null, and Forcht (2005) reported that in 2004, 384 companies reported losses of $377 million due to computer crime. According to Icove, Seger, and VonStorch (1995), they report:
"Criminals are using computers to store records regarding drug deals, money laundering, embezzlement, mail fraud, telemarketing fraud, prostitution, pornography, gambling matters, extortion, and a myriad of other criminal activities (p. 1)."

Computer crimes are basically electronic crimes that are facilitated with the use of a computer, and the terms “computer crime, high-tech crime, digital crime, e-crime, and cyber crime” are considered interchangeable (Brungs & Jamieson, 2005, p. 59). Computer forensics is used to investigate these computer crimes, and a host of other possible criminal activities. Mercuri (2005) illustrates some of these examples as:

- Investigation of a law firm’s accounting information by a state Office of Attorney Ethics to determine whether escrowed funds had been misused;
- Reconstruction of thousands of deleted text and image files in a murder case, in order to gather information about the activities of the victim and various suspects;
- Examination of source code used in the construction of an MPEG decoder chip set, to see if patents had been violated;
- Evaluation of the contents of a database to determine the cost of its production, as mitigating evidence in a large financial disagreement between business partners;
- Consideration of possible foul play by a former company employee, in the damage of computer records;
- Mathematical analysis of photographs to see if they have been digitally altered; and
- Preparation of explanations for an abnormally high missed vote rate exhibited by certain self-auditing electronic election equipment (p. 18).

Just this small set of different criminal activities where computer forensics investigations can be used to examine questionable activity, show the potential reach of the discipline—and its complexity. Even while forensics investigation has been used to identify criminal activity for the last 30 years, electronic evidence continues to be challenged on authentication and admissibility grounds (Giordano, 2004).

### Legality of Computer Forensics

There are differences in the way forensics investigations are conducted between the private enterprise and law enforcement agencies. Private organizations usually have their own internal staff of legal and security experts that have to deal with a myriad of issues such as embezzlement, stealing trade secrets, and also human resource issues, like sexual harassment. Corporations will also have to tackle the problem of preservation of data. Unfortunately, most organizations are ill-equipped to deal with forensics investigations, and must work quickly to collect and preserve data in a sound and secure manner so that the evidence is complete and the authenticity can be accurately determined for future use (Casey, 2006). Corporations normally do not want to prosecute an individual, just stop the actions from occurring (Brungs & Jamieson, 2005). This may have to do with the potential of bad publicity if the situation becomes known in the media.

The use of computer forensics evidence in a court of law had not normally been accepted, and has not achieved the level of status as other forensics investigations, for example, fingerprinting and DNA evidence. One reason is that this field is still somewhat new and courts are hesitant to apply existing laws to a new area. Giordano (2004) has noted that in order for computer forensics to be accepted like other forensics’s fields, computer evidence has to be built around core legal requirements of evidence handling, which include:

- **Admissible:** It must conform to certain rules before it can be put before a jury.
- **Authentic:** It must be possible to positively tie evidentiary material to the incident.
- **Complete:** It must tell the whole story and not just a particular perspective.
- **Reliable:** There must be nothing about how the evidence was collected and subsequently handled which causes doubt about is authenticity and veracity.
- **Believable:** It must be readily believable and understandable to members of a jury (p. 162).

In order to reduce inaccuracies when presenting evidence, the Federal Rules of Evidence requires the application of the best evidence rule. This is usually
meant to mean the original work, so that no errors or fraud can occur. With respect to electronic evidence, for any data that is stored on a computer or similar media, only a printout is needed and thus deemed original. While this introduces the problem of authenticity, it would seem to aid the plaintiff. In addition, beginning in the 1990s, and after 2001, laws were rewritten to expand on the use of computer data, its applicability in criminal proceedings, and changes were made to make it easier for law enforcement to obtain digital data. It is now more commonplace for courts to order forensic reviews of computer systems, not only for the purpose of recovering information, but also determining if potential information was deleted before or during an investigation, and whether or not there was a legal obligation to preserve such data (Benson, 2004).

The Patriot Act of 2001 modified several existing laws that made it easier for law enforcement to gather digital evidence. It amended the Computer Fraud and Abuse Act, the Electronic Communicates Privacy Act, and the Cable Act, and so forth, to remove distinctions between voice and data, and whether stored on a hard drive or in real time. These amendments made it easier for law enforcement to obtain one warrant for an investigation, rather than individual ones for the different media and data they were trying to capture, while still staying within the boundaries of the United States Constitution’s Fourth Amendment Unlawful Search and Seizure.

Admissibility of Digital Data

Law enforcement investigations are governed by laws of the United States, individual states where a crime may have been conducted, and international treaties if the crime is on an international level. These types of investigations can be conducted by individual police officers, but can also be conducted by higher level personal and/or technical specialists in the law enforcement agency.

An interesting aspect on computer forensics is that “finding, securing, and maintaining credible evidence in computer forensics is the key to solving or losing a case or investigation” (Busing, Null, & Forcht, 2005, p. 1). However, the majority of cases involving computers never get to court, they are dealt with administratively, and even those that develop into something more of a case never go to trial, but are settled. This may make this practice more prone to mistakes and errors. If an investigator knows that the probability of going to court is very remote, is there a possibility that a slack attitude may occur? Is it possible that prosecutors recognize that there is a slim chance of successful prosecution, so is there a rush to settle? Even Bhaskar (2006) argues that none of the key elements of computer forensics “identification, preservation, analysis, and presentation—are done uniformly by law enforcement” (p. 82). This can have a detrimental impact on the quality and admissibility of evidence in a court of law.

Busing, Null, and Forcht (2005) have listed a number of reasons where mistake occur, these include:

- Failure to notify or provide accurate information to decision makers;
- Failure to control access to digital evidence;
- Failure to report the incident in a timely manner; and
- Underestimation of scope of the incident and having no incident plan in place (p. 117).

These mistakes may reveal the nature of the science, and possibly of successful convictions. Further, at its very core, electronic data has to be determined to be authentic, which means that an item or bit of data is what a proponent states. However, given the nature of electronic data and its flux state does present some very unique challenges as suggested by Giordano (2004):

- Computer evidence can be readily altered or deleted.
- Computer evidence can be invisibly and undetectable altered.
- Computer evidence can appear to be copied while in fact is it undergoing alteration.
- While in transit, computer evidence can share the same transport pipeline as other data.
- Computer evidence is stored in a different format to that when it is printed or displayed.
- Computer evidence is generally difficult for the layman to understand (p. 163).

Even with the need for forensics experts at the state level, Bhaskar (2006) reports only a handful of personnel in various states even have a basic understanding of computer forensics. These conditions show the problem and the task to introduce electronic data in a court of law. Compounding these problems is that due to the shortages of forensic experts in areas of law enforce-
ment, there is a backlog of anywhere from six to 12 months in most major cities, and with the limited legal support given to training of law enforcement in computer forensics law, it is often difficult to prove chain of custody, and if the digital data have been tampered with (Bhaskar, 2006).

There is also the problem of jurisdictional laws, as different states’ legislations differ with respect to presentation and admissibly of computer evidence. This brings up a serious issue with the collection of data in that digital data may be accepted in one court, but not in a different state’s court, so then the location of the court comes into play as an issue in bringing charges and the admissibly of collected evidence (Brungs & Jamieson, 2005).

Additionally, as computer forensics investigations take on scale, and investigations that now spans multiple systems, how much data can be collected and analyzed? If not enough data, then a case is opened to legal challenge, and it will be impossible to expect an investigator to collect every bit of data (Richard & Roussev, 2006). There are those who argue that collection of every bit of data is not necessary, and that by using careful acquisition and extraction techniques would stand up to legal inspection and might actually lower the risk (Kenneally & Brown, 2005). Further compounding the problem, Casey (2006) warns that when examining distributed systems, or what he terms hacking back, may actually be worse, since it could “miss or alter evidence, alter the intruders, and break the law” (p. 53). Tracing back and examining remote systems without proper authorization and access from the owner may have no legal standing since it is against U.S. law to intentionally access a system without proper authorization, and given the need for speed in tracking back a suspect, does law enforcement take the time to get a warrant?

**Global Scale**

Typically, computer forensics tools were designed to run on one computer. As criminal activity grows, so does the complexity of the attacks and now forensics investigators find themselves examining multiple systems (Richard & Roussev, 2006). Since criminal activity is not the sole responsibility of one country, neither should be computer forensics investigations. Criminal activity, hacking, viruses, fraud, and so forth, are all conducted throughout the world, and organizations are growing over the world to combat these activities and help countries share in the expertise to track down criminals. With the need and necessity of countries to catch criminals, the G8 of major industrialized nations proposed a set of guidelines in handling digital evidence. Busing, Null, and Forcht (2005) note that:

- When dealing with digital evidence, the standard forensics and procedural principles must be applied.
- Upon seizing digital evidence, actions taken should not change the evidence.
- People who access original digital evidence should be trained for that purpose.
- All activity relating to the seizure, access, storage, or transfer of digital evidence must be fully documented, preserved, and available for review.
- Individuals are responsible for all actions taken with respect to digital evidence while such evidence is in their possession.
- Any agency that is responsible for seizing, accessing, storing, or transferring digital evidence is responsible for complying with these principles (p. 117).

Internet forensics investigations and cooperation among governments is needed. According to Graham (2005), “Well-funded groups in China are breaking are gathering sensitive information by breaking into U.S. government networks” (p. 1). While these attacks have successfully reached hundreds of unclassified systems, Department of Defense officials are worried that even though no classified systems have been breached, each piece of information that an attacker learns could help their overall knowledge to possibly compromising a classified system.

It is no longer a simple attacker that has law enforcement worried; it is as according to Casey (2006) “the increase in organized criminals, foreign governments, and non-state actors breaking into computer systems is raising the stakes of computer crime” (p. 48).

**CONCLUSION**

Computer forensics, either from an organizational perspective or a law enforcement perspective, will continue to help combat criminal activity. However,
in order for computer forensics to become a staple in prosecuting criminals it must become a more robust science with more rigorous research, standards, testing, and acceptability. Computer forensics is going to continue to play an important role in court settings.

Criminals are getting smarter, and as they learn more about forensics and how data can be hidden on computer systems, they will continue to find and explore new ways to make data more inaccessible. As fast as investigators can locate and preserve data, criminals are even more adamant on hiding and destroying evidence, and sophisticated intruders take careful steps to hide their tracks by deleting logs, modifying access times, altering dates, and so forth, and installing their own utilities to modify and counter legitimate tools to capture and collect data (Casey, 2006).

Computer forensics investigations need to become smarter. Faster data acquisition and analysis is not enough—keyword searches and classifications need to morph into prediction processes where files that have been tampered with are easily identified as being suspicious. Tools, processes, training, analysis, and distributed analysis all need to expand and grow in order for computer forensics to be viable in the 21st century (Richard & Roussev, 2006). Forensics has to move from its static nature of collecting, storing, and analyzing all data to taking a snapshot of the system at some point in time, that is, live forensics. Adelstein (2006) suggests that even though system and log files are constantly updating and new data is arriving, a snapshot could be taken at some point in time, coupled with a time stamp that would ensure its identity and authentication.

Computer forensics investigations are also growing due to the size and complexity of the attacks, which now measure in the gigabytes and terabytes of data, and often with the use of more than one computer (Richard & Roussev, 2006). Forensics investigation requires the acquisition and duplication of data, but on a network forensics investigation, acquisition can become a real problem. Smarter acquisition techniques are required, and simple data capture will be of no use since they will overwhelm the investigator with useless data sets. Triefenbach and Erbacher (2006) argue that due to these large data acquisition sizes, “a great deal of time is wasted by analysts trying to interpret massive amounts of data that isn’t correlated or meaningful” (p. 71). The details of this area of forensics needs to be examined for its relevance in a court of law, but may assist the forensic investigator learn and analyze bigger and more complex distributed systems and investigations.

Computer forensics need to grow into a more multi-dimensional discipline, covering behavioral and technical characteristics, and as Casey (2006) suggests that in the future an “ideal investigative team has expertise in information security, digital forensics, penetration testing, reverse engineering, programming, and behavioral profiling” (p. 50). Computer forensics investigations will move into a much more dynamic and fluid process where each investigation will be discussed as the best approach.

REFERENCES


**KEY TERMS**

**Computer Crime**: Computer crime is crime committed with the use of a computer. It can be used for money laundering, mail fraud, pornography, blackmail, and so forth. Its primary aspect is that it is done with a computer system. Computer crime is uncovered with the use of computer forensics technology.

**Computer Forensics**: Computer forensics is a discipline that is the field of computer technology. It is a well-defined field of study and code of practices, with researchers and practitioners. It is the process of acquisition, analyzing, preserving, and present electronic data in a format that the authenticity cannot be denied.

**Computer Forensics Investigator**: A computer forensic investigator is trained in the field of handling and applying specialized tools to uncover sensitive computer data in computer systems and other electronic equipment. An investigator tries to determine the extent of a security breach, figuring out how the system was compromised and allowed an intruder in, identifying the damage, and potentially identifying the subject. The computer forensic investigator attempts to use a wide variety of tools and process to uncover electronic data from a computer system, whether the data is deleted, hidden, encrypted, or even if the computer system is damaged.

**Evidence Handling**: Evidence handling is the process of how electronic evidence was handled from the moment of seizure to the presentation in a court of law. It covers admissibility, authenticity, complete, reliable, and believable. It is this set of components that covers the necessary and core legal requirements that digital data can be used and accepted into a court of law.

**Federal Rules of Evidence**: Federal rules of evidences are rules allowed by Congress and enforced by the U.S. Supreme Court, which govern the admissibility of evidence in Federal court rooms in the United States. These rules govern how evidence can be submitted, and are meant to ensure the fairness of evidence without delay or prejudice. They are also meant to ensure the uniformity of legally admissible evidence and reduce the variability that often varied from court to court before they were enacted.

**Forensics**: Forensics, often called forensics science, is the application of a wide range of sciences that help to seek out, examine, and answer questions about certain activity characteristics. Forensics is the uncovering of information from investigations of incidents, in order to identify some evidence that may point to the circumstances that caused that event under investigation.

**Internet Forensics**: Internet forensics is an expansion of computer forensics, in that Internet forensics relies more on search and seizure investigations. While computer forensics investigations rely on finding data on computer systems, malicious e-mails, Trojans, denial of service attacks all have other originating sources, and have to be identified by: (1) the actual data hidden inside the code, that is, its signature, and (2) the source of that hostility. Internet forensics examines the data to attempt to find the source of the attack.
INTRODUCTION

The phenomenon of distance-based learning has dramatically changed the direction and delivery of education in the past decade. Course Web sites, whether used as supplemental resources for face-to-face courses or as essential materials in an online course, have exploded since the mid-1990s. By the end of the millennium, higher education institution world-wide were racing to establish dominance on the distance education bandwagon.

Pastore (2001) estimated that 1,500 colleges and universities were offering Web courses by 1999, and this was expected to double to 3,300 by 2004. The U. S. Department of Education found some 26,000 online courses with an estimated 100 new college courses going online every month (James & Voigt, 2001).

Technology has become an integral part of the educational process, particularly as it has broadened the realm of distance learning. According to the National Education Association (NEA), currently one in 10 higher education members teaches a distance learning course. Furthermore, 90% of its members who teach traditional courses indicated that distance learning courses are already offered or are being considered for immediate implementation at their respective institutions (NEA, 2000).

TEACHERS AS LEARNERS, EXPERTS, AND SCHOLARS

The International Society for Technology in Education (ISTE) recognizes three distinct levels of professional technology development. At the outset, technology foundations are suitable for all teachers-as-learners as they prepare to assume the instructional duties of the classroom teacher. At mid-level, skilled educator competencies address the teacher-as-expert; specifically, those who serve as computer teachers and building/campus-level technology facilitators. At the third level is IT professional leadership with advanced programs for preparing the teacher-as-scholar and those who serve as technology directors, coordinators, and IT specialists.

To meet the increasing demands for technology at all three levels, dedicated technology-based programs have been implemented for pre-service (undergraduate), in-service (classroom teachers and graduate students), and post-graduate (i.e., doctoral candidates) learners. Technology courses inherent at all three levels often beg questions in the minds of teachers and technologists as they move through their formal education agendas. What will I learn differently about technology as a freshman than I will as a graduate student or even a doctoral candidate? What is different at each of these levels? If I take undergraduate technology courses as a teacher-as-learner, am I sufficiently prepared to use technology throughout my career?

THE K-A-RPE MODEL

Since 1996, the K-A-RPE Model has served to differentiate teaching and learning of technology. It is offered here as an archetype for other institutions seeking to develop their own comprehensive technology program.
Knowledge, application, and research, practice and evaluation (K-A-RPE) offer the necessary dichotomy among instructional technology programs for undergraduates, graduates, and doctoral candidates. Similar to other more well-known taxonomies, the K-A-RPE model is progressive and assumes mastery and competency at previous levels.

At the knowledge level of the model, candidates are introduced to technologies as personal learning tools. For example, in an undergraduate technology course, participants are encouraged to “create a 10 cell x 10 cell worksheet to capture semester quiz grades and correctly compute an average (mean) score given only a lecture/demonstration on the basic features of electronic spreadsheets.” At the knowledge level, the teacher-as-learner acquires the technology skills that will serve to enhance their own learning needs beginning with a formal pre-service education and lasting throughout a lifelong career as an educator.

Graduate candidates, on the other hand, seek to master technology to advance the learning process as instructional technology is infused into the classroom curriculum. At the application level, candidates master technology-based skills for immediate inclusion into everyday instruction. For example, “using principles of instructional system design, teachers will develop and implement an eight-page, text-based, student workbook containing all the essential elements appropriate for a selected classroom lesson.” At the application level, the teacher-as-expert acquires technology skills that benefit their students. Success is measured as an observable increase in student achievement and classroom learning outcomes.

At the highest level of the K-A-RPE model lie research, practice and evaluation. Doctoral candidates, too, must learn new technologies. They must also be able to apply technology in a very practical sense. But they do so with a rich knowledge base (research) and a comprehensive review of the literature to support their implementations of technology as teaching and learning tools. The teacher-as-scholar is charged with changing the way technology is experienced (practiced) in the classroom and they do so with an ever-watchful eye on verifiable learner achievement (evaluation).

With a focus on research, the doctoral candidate investigates the number of computers located in a particular school and how the technology impacts student achievement scores as evidenced in standardized tests. For example, by “using Internet-based data, candidates correlate student achievement scores and the ratio of students-to-computers.” Instructional technology improves the practice of teaching and learning when “candidates develop a visual presentation suitable for school directors and technology coordinators that provides an overview of instructional technology and its potential impact on district decision-making to include: administration (planning and budgets); faculty (professional development, curriculum, and teaching load); and staffing.” Finally, evaluation implies assessment of student achievement and how technology succeeds (or fails) as a tool for learning. In every respect, it presupposes a firm grasp of the pillars of instructional technology education and merits co-equal status in the K-A-RPE model. “Candidates assess at educational software packages in the core academic areas of mathematics, social studies, language arts, and science and appraise content coverage, effective use of technology, and impact on student learning outcomes.”

The K-A-RPE model distinguishes among instructional technology programs throughout higher education and seeks to answer the questions posed earlier.

What will I learn differently about technology as a freshman than I will as a graduate student or even a doctoral candidate? Simply put, a well-designed formal education program in technology considers all three roles of the educator over the course of their career. Technology demands for the teacher-as-learner focus on technical knowledge and the skills needed to effectively use technology for your own learning. The teacher-as-expert, comparatively, exhibits the broader range of technical competencies necessary to effectively apply technology as an alternative teaching strategy in the classroom. Ultimately, educators are expected to give back to the discipline the qualities of best practice accumulated throughout a lifetime of personal achievement; for the teacher-as-scholar, technology takes on the role of research, practice, and evaluation.

What is different at each of these levels? Here are some excellent examples of how technology skills and competencies differ at each level of the model.

**UNDERGRADUATE PROGRAMS**

At the bachelor’s level, knowledge plays the most pronounced role. Examples of typical knowledge outcomes at this level include:
1. Proficient in programming in at least two programming languages;
2. Mastery level knowledge in each of the following core computer science subjects:
   a. Principles and practices for problem/solution analysis and design;
   b. Data structures and algorithms;
   c. Computer architecture and organization;
   d. Programming languages;
   e. Operating systems;
   f. Theory of computing;
   g. Software engineering;
3. Possess an understanding of the practices and dynamics required to develop software whether it be a single program or a major software product developed in a team environment;
4. Proficient in the use of mathematical tools including discrete mathematics, calculus, elementary statistics, and probability;
5. Understand the basics of information and database systems and their implementation;
6. Understand basic business, accounting, and economic practices;
7. Understand the basics of team and organizational leadership principles;
8. Understand the basics of science, and specifically the scientific method;
9. Have an understanding and appreciation for the arts, humanities, and social sciences, and their importance in today’s society;
10. Possess sufficient fundamental knowledge of computer science to be a life-long learner;
11. Understand the social and ethical issues which face computer scientists, and thus be able to contribute to society in a positive and productive manner; and
12. Able to communicate information effectively both in writing and orally.

Here are two examples of knowledge-based behavioral learning objectives:

- Undergraduate students will correctly define terminology related to computers and technology in their written and oral communication.
- Undergraduate students will operate a multimedia computer system with related peripheral devices to successfully install and use office productivity software.

**GRADUATE PROGRAMS**

Surprisingly, for many graduate programs, knowledge objectives remain a prevalent aspect of the learning experience with application objectives coming in a distant second. Typical application outcomes follow:

1. Effectively manage IT/IS projects, processes, and professionals;
2. Evaluate and analyze the organizational, political, legal, ethical and global ramifications of managing information, technology and IT professionals;
3. Explain complex IT/IS concepts to non-IT/IS persons through effective communication in written, presentation, and conversational formats;
4. Evaluate how technology contributes to the “big picture”;
5. Assess and apply sound IT security management principles to safeguard organizational assets;
6. Contribute to and collaborate effectively in international team settings;
7. Evaluate business requirements and formulate technology solutions into efficient business processes;
8. Building a school home page that will go up this year on the Web;
9. Creating animations in 3-D to run on the hall monitors displaying school/community events;
10. Participating in the planning, configuring, and installation of a LAN at the nearby elementary school;
11. Developing a hypercard stack on peer counselors to guide students;
12. Implementing a FirstClass Server as the school’s e-mail system and bulletin board; Assembling a demonstration computer in a clear plastic case;
13. Implementing a Web server to create and maintain Web pages for non-profit groups in the community;
14. Planning a Web radio station for the broadcasting class to run; and
15. Establishing a production center for desktop publishing and multimedia presentations in the school.

Again, here are a couple of application-based examples of graduate-level behavioral learning objectives:
Using the principles of instructional system design, Master’s candidates will develop and implement an eight-page, text-based, student workbook containing essential elements appropriate for their selected classroom lesson.

Given a portfolio exercise and diskette file, Master’s candidates will prepare an intelligent portfolio for use throughout the program in instructional technology. This portfolio will be exhibited and assessed during the course of the student’s program of study to evidence the understanding of the concepts and principles presented in this course.

POST-GRADUATE PROGRAMS

Most doctoral learning objectives are found at the R-P-E level. Example research, practice, and evaluation objectives at this level include:

Research-Based:

1. Reasonable criteria for course delivery using distance learning technologies, with emphasis on the articulation of general principles and identifying examples.
2. Reasonable criteria, principles, and standards governing distance learning collaborations.
3. The impact of this distance learning program on existing graduate programs supported by the participating faculty, including the effects of this program on faculty workloads.
4. Classification (regular, adjunct, etc.) of faculty involved in the design and delivery of the program.

Practice-Based:

1. Ongoing educational and administrative policy review to ensure that acceptable standards of educational quality are met, that administrative and bureaucratic barriers to utilization of distance and technology enhanced learning are minimized, and that student, faculty, and institutional needs are considered in policy and program development.
2. Advising the Policy and Review Councils and Executive Committees on matters pertaining to distance and technology-enhanced learning. This committee should also be consulted on the development and implementation of support services and internal consultative networks in this area.

3. Helping to disseminate information on course development and program structuring to faculty members and programs exploring their options in this arena, and serving a mentoring role for such faculty and programs in the development and implementation of their initiatives in distance and technology enhanced learning.
4. Level of student-faculty and student-student interaction appropriate to the program and necessary for the establishment of a community of scholars, including a discussion of how and by what means this level of interaction will be maintained in the distance learning environment.
5. Mechanisms to be utilized in facilitating the supervision and mentoring of graduate degree students at a distance.
6. Procedures to be implemented for overseeing and monitoring distance learning program quality consistent with resident programs.

Evaluation-Based:

1. Need for the program, especially with regard to its delivery by distance learning.
2. Objectives of the program, including a discussion of how this program is consistent with the goals of the originating program(s), appropriate for delivery by distance learning, and qualitatively equivalent to resident programs.
3. Relationship of the program to existing resident programs and to other distance learning initiatives.
4. Anticipated program audience/participants, especially with regard to size, demographics, academic preparation, course prerequisites, and so forth.
5. Inclusion of significant faculty-student and student-student interaction, as appropriate to programs, and a discussion of how this interaction will be fulfilled in the distance learning environment.

A research, practice, and evaluation-based example learning objective follows:
CONCLUSIONS

The KAR-P-E model for differentiating teaching and learning with technology appears worthy of consideration in the practice of post-secondary teaching and learning with technology. The connections between knowledge-based learning objectives and undergraduate IT programs; graduate and application objectives; and, post-graduate doctoral program objectives with research, practice, and evaluation are worthy of consideration. The potential of the KAR-P-E model to provide differentiated instruction for professional programs is important.

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KEY TERMS


K-A-RPE Model (Application Level): Candidates master technology-based skills for immediate inclusion into everyday instruction. The use of previously learned information in new and concrete situations to solve problems that have single or best answers.

K-A-RPE Model (Evaluation Level): Judging the value of material based on personal values/opinions, resulting in an end product, with a given purpose, without real right or wrong answers.

K-A-RPE Model (Knowledge Level): Mastery of terminology; specific facts; ways and means of dealing with specifics (conventions, trends and sequences, classifications and categories, criteria, methodology); universals and abstractions in a field (principles and generalizations, theories and structures). Knowledge is defined as the remembering/recalling of appropriate, previously learned information.

K-A-RPE Model (Practice Level): Candidates examine the tradition of teaching and learning that includes instruction, administration (hiring, staffing, management, etc.), and curriculum.

K-A-RPE Model (Research Level): Candidates investigate aspects of their chosen discipline in terms of attention from the literature and how the discipline impacts teaching and learning.

Teacher-As-Expert: Classroom teachers and building/campus-level technology facilitators.

Teacher-As-Learner: Candidates preparing to assume the instructional duties of the classroom teacher.

Teacher-As-Scholar: Professional leaders and those who serve as technology directors, coordinators, and IT specialists.
Keyboarding and When to Teach It!

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**INTRODUCTION**

Over the past two decades typewriting has transformed into keyboarding. Twenty years ago students were taking typewriting classes in high school. No one ever thought to teach a first or second grade student how to type. Times have changed and the need to know how to type has steadily increased. This has also put increased pressure on educators to teach students how to use this new technology properly. Many schools have focused energy on teaching students how to use computers to obtain and produce information; they have paid little attention to teaching them how to type on the keyboard quickly and accurately, and with correct technique. But who decides at what age should we teach keyboarding? Who should be teaching these classes (Starr, 2005)?

**BACKGROUND**

The introduction of the personal computer has changed business education and the method in which typewriting instruction is delivered. The ability to interact with computers is an essential skill for the Information Age, in which our schools will need to address to prepare our students to meet the challenges of this new era. The educational reform act of the 1980s has recognized the importance of computers in education. For example, *A Nation at Risk* (1983) calls for the high school students to:

a. Understand the computer as an information, computation, and communication device;

b. Use the computer in the study of the other basics and for personal and work-related purposes

c. Understand the world of computers, electronics, and related technologies

Presently, people interact with computers via typing words on typewriter, such as a keyboard. Even though it may be possible someday for computers to understand handwriting and human, speech it will take many years for these technologies to filter into the educational systems. It is for these reasons and many more that schools integrate computers, especially keyboarding, into curriculum at all levels (Shuller, 1989).

Keyboarding can be exciting and rewarding when approached through the content areas as a skill necessary to use the computer to its fullest potential (Lindroth, 2002). Computers allow students to become more efficient as they key letters, memos, reports, and so forth. English teachers require that papers be in a typed format, and so do many other disciplines. How can students type papers if they have not learned to type yet? This is the dilemma of many school districts, deciding what grade levels to teach keyboarding. On the other hand, many critics say “how young is too young?”

Many pre-K students are now expected to be familiar with the keys on a computer, that is, knowing where the various letters are located (Lindroth, 2002). However, children in the early years of pre-K through second grade are developing larger muscle groups. Later when they begin to develop smaller muscle groups, they learn to print and write in cursive, cut with scissors, and so forth (Starr, 2005). All children do not have the eye-hand motor coordination to learn keyboarding skills any (Hopkins, 1998).

**What Age is Appropriate to Teach Keyboarding?**

Some say the proper use of the keyboard should be introduced as soon as a child shows interest in using the alphabet to create or communicate on a computer (Keyboarding Readiness, n.d.). Everyone who uses a computer needs to develop “touch” keyboarding skills. The emphasis is on the skill of entering alphanumeric data for the primary purposes of obtaining, processing, or communicating information.

Although the National Educational Technology Standards (NETS) require that students be able to apply “basic keyboarding techniques” by the end of the fifth grade, these student guidelines have only been adopted in 30 of the states and are subject to differing...
interpretation. Curriculums for schools are set at the state and local levels; therefore, each district has the discretion to determine the appropriateness for early keyboarding education within that school districts policy (Minkel, 2003).

Various groups have suggested that keyboarding be taught prior to using a computer, especially since students need formal instruction to acquire keyboarding skills using the touch system. Benefits of acquiring keyboarding skills include the enhanced use of time and effective use of computers. Research shows that children with keying skills are able to compose faster, and they are more proud of their work. These students typically produce documents with neater appearance and have better motivation and demonstration of superior language arts skills (Erthal, 2003).

Some educational technologists are adamant about teaching keyboarding at the lower grades. These specialists say that, “If you combine keyboarding with letter-recognition and hand-eye coordination activities in grades K-3, then you provide a developmentally appropriate skill that helps reinforce classroom learning and develop fine motor skills. To wait is to deprive the student of a fundamental skill (Hopkins, 1998).

Students below third grade, however, do not possess the dexterity and hand size to manipulate the keys effectively. The suggested age for effective keyboard instruction is 10 to 12 years. Children in grades four to six gradually exhibit greater smoothness and command of small-muscle expression, which is reflected in better coordination in activities (Erthal, 2003). This does not mean that children in earlier grades should not be introduced to a computer keyboard. Students should be encouraged to pretend that there is a middle line down the keyboard and to keep the right hand to the right of the line and the left hand to the left of the line. Encouraging students to use more than one finger to type is important beginning step to keyboarding that can be learned prior to the fourth grade. This helps build into more complex keyboarding in the later grades (Hopkins, 1998).

Who Should Teach Keyboarding?

Most teachers with knowledge of correct keyboarding skills and the will power to enforce appropriate hand placement for keying can teach keyboarding. When first learning to touch type, students need about 30 hours of keyboarding instruction to acquire the ability to use the correct fingers. In many schools, keyboarding instruction is limited to approximately 10 or fewer hours of instruction due to time constraints. The result is poor keying skills, which will follow the students to the next grade.

Keyboarding instruction can be supplied by elementary teachers who have taken a keyboarding methods class, a business education teacher with elementary learning methods, or a combination of business education and elementary education teachers (Erthal, 2003).

Software can enhance keyboarding skills. However, software cannot take the place of a qualified teacher. Many popular keyboarding software packages violate psychomotor skill development. The complexity of teaching keyboarding requires an extensive and extremely well-written software program. No software program has been shown to be superior to a skilled and experienced teacher. Software programs serve well for drill, remediation, enrichment practice, as well as adding variety to keyboarding instruction. Software cannot be programmed to see, hear, or to feel the keyboarding instructional needs of students (Erthal, 2003).

How to Teach Keyboarding

Once you have decided when to teach keyboarding, the decision about how to initiate the process arises. The danger that many schools curriculum have regarding keyboarding instruction is that it is taught at a singular grade level. Keyboarding is like any other skill, the more you work at it, the better you become. If you do not use the skill on a regular basis you can begin to forget what you have learned and loose some of the skills. That is why some experts suggest the continued education of keyboarding beginning in elementary school throughout junior high/middle school. Of course as students progress to higher grades they should be required to complete more complex tasks with keyboarding, that is, more words per minute typed.

Teachers should not discourage the use of the keyboard if no formal education has occurred. However, there are some elementary instructional ways to help a child become familiar with the appropriate ways to use a computer. Therefore, when a teacher has a group of students with no computer experience the use of preparation and explanation are of key importance. For example, to prepare students for keyboarding they must learn the names of the fingers. As you point your
pointer finger or index fingers to the students, have them point at you. Visual descriptions and practicing are useful at a young age to keep the students interested (Keyboarding Readiness, n.d).

For younger keyboarders in grades K-2, students are familiar with letters in alphabetical order. One strategy that works well is to teach the keyboard positions alphabetically. This method helps to reinforce letter recognition as the children learn where the letters are positioned on the keyboard. For example, think about where the keys are located on the keyboard. The letters A through G can all be typed with the left hand. Letters H-P is all typed with the right hand. Younger students can make it more than half way through the alphabet before they have to alternate hands. It is not until U, then V, and X, Y, Z that students have to begin moving their hands from one hand to the other. This pattern of learning the keyboard placement seems to work very well with all students (Lindroth, 2002).

After the letters have been taught, students can type the alphabet over and over to help reinforce the location of the keys while using the proper fingering. Students can also practice with sentences such as, “The quick brown fox jumped over the lazy dog,” which uses all 26 letters of the alphabet. These types of sentences are known as pangrams. Older students can be challenged by asking them to come up with their own pangrams (Lindroth, 2002).

Vocabulary building can also be practiced as students are learning the letters. When you are finished with the letters A through G, have students brainstorm words that can be made by using these letters. A keyboarding word wall can then be created for later reference and practice skills (Lindroth, 2002).

One of the most difficult aspects of computer keyboarding for students is to look mainly at the screen rather than the fingers while typing. Several experienced teachers have offered the following suggestions to help with this problem. First, put a cloth over a student’s hands that completely cover the keyboard. Have the student’s type while the cloth is in place. Another technique is to secure a piece of construction paper to the keyboard so it covers the student’s hands while keyboarding (Hopkins, 1998).

Another aspect of teaching keyboarding that can be problematic is actually grading a student’s performance. Some teachers test their students based on posture, hand placement, and eye focus. While others also include timed skills, participation, as well as technique for grading purposes (Hopkins, 1998).

Research shows that students improve faster when they use keyboarding for meaningful tasks. For example, have students practice their daily journal entries as a weekly newsletter to parents. This can be done by typing a class journal entry at the end of each day and then asking students to write their own thoughts and discoveries from the day. Once a week, have a selected student’s type their journal entries for inclusion in a parent newsletter. Another way to provide meaningful keyboarding lessons is to schedule a classroom computer for your students to use in practicing spelling words. Roll dice to determine how many times each vocabulary word or spelling word should be typed. Classroom typing practice may also be expanded to include topics being studied: classmates names, parts of speech, the names of presidents, states, characters in a book, and so forth.

Future Trends in Keyboarding

Keyboarding is a way to input information into a computer so that it can be manipulated. Thus, initial accuracy is less important than speed, ability to manipulate text is more important than formatting skills for specific types of documents, and composing is more important than transcribing. These distinctions recognize important changes in the purposes for which people type on computer keyboards. Therefore it is more important to focus keyboarding instruction on learning proper hand placement and memorization of the keypad to increase speed. The modernization of computers has led to programs such as spell check to correct mechanical errors. This is not to say that students should not learn to spell, however new technology should be used to focus on the future (Shuller, 1989).

Some experts in the field of education propose that schools should eliminate the teaching of cursive writing and substitute keyboarding. These experts point out the cursive writing is not taught in European schools; students learn manuscript, and then develop their own handwriting style though shortcuts. By teaching cursive writing instead of keyboarding the students are training for the last century instead of the next (Shuller, 1989).

The issue of touch typing vs. two-finger typing is a similar problem as stated above. Copying is important for Industrial Age clerks and typists to transcribe business documents, but it is irrelevant to writers using word processing to compose and edit. By insisting on
touch type some experts say we are training for the last century instead of the next (Shuller, 1989).

According to some people in the computer field, voice recognition systems will some day replace the need for keyboards. So, are keyboarding skills essential? Others argue that such systems are a long way off and that schools, which tend to lag technologically behind business, will not have computers equipped with voice recognition for a long time (Hopkins, 1998).

As we move further into the Information Age, fundamental changes in school curricula will follow in order to meet the changing needs of society. Envisioning these changes we can imagine a time when keyboarding will replace cursive writing as an essential skill for elementary school children, complementing a language arts curriculum using computers for activities such as writing with word processors. Developing an Information Age language arts curriculum with keyboarding as a fundamental skill should be central focus of our long-range curriculum planning (Shuller, 1989).

CONCLUSION

There is a huge need for elementary schools to adopt the process of teaching keyboarding at various levels. Beginning with the names of the fingers and progressing to speed type as the students develop increased dexterity and are more familiar with the keypad. Touch typing instruction is only effective if students receive a substantial period of instruction and practice throughout elementary school years. Keyboarding can be easily implemented into many different classes from English to Math. Keyboarding can be taught in any class where computing is essential. In today’s society that means most of them, if not all of the classes. The problems with learning to keyboard properly are recognized by decreased dexterity found in younger children, despite increased demands for younger children to be able to compete in this technologic world. The age of the computer had required children to begin using computers at much younger ages than was the norm 10-15 years ago. In addition, more homes than ever have computers available for children to practice on. With this in mind, the parent/guardian also has a responsibility in allowing the child to have supervised practice time on the computer. The time spent in school today is focused on so many different topics, including standardized testing, that time limitations can prohibit a child from reaching full potential for keyboarding. Schools need to use the time we have wisely and incorporate keyboarding with all disciplines in order to achieve the time needed for successful keyboarding.

REFERENCES


KEY TERMS

Keyboarding: The act of placing information into various types of equipment through the use of a typewriter-like keyboard. Typewriting and keyboarding are not synonymous. The focus of keyboarding is on input rather than output (Shuller, 1989).

Pangram: Also known as a holoalphabetic sentence; it is a sentence which uses every letter of the alphabet at least once. Pangrams are used to display typefaces and test typewriters. The best-known pangram in English is “The quick brown fox jumps over the lazy dog.”

Touch Typing: Typing using the sense of touch rather than sight to find the keys. Touch typing places the eight nonthumb fingers in a horizontal row along the middle of the keyboard and has them reach for other keys.
Learning Activities Model

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INTRODUCTION

The design of learning is probably more accurately described as the design of learning activities as it is the activities that are designable compared to learning which is the desired outcome of the activities. While the term “instruction” may be out of favor with some commentators, as it implies a teacher-directed approach, “instructional design” has been used for some years to describe the design of the things learners and teachers or trainers do to facilitate learning.

Instruction is a set of events that affect learners in such a way that learning is facilitated. Normally we think of events as external to the learner—events embodied in the display of printed pages or the talk of a teacher. However, we also must recognize that the events that make up instruction may be partly internal when they constitute the learner activity called self-instruction. (Gagné, Briggs, & Wager, 1992, p. 3)

Courses of study, subjects, or training programs are generally too large to be matched to a particular technology or technological element of a learning management system. Distance education courses are generally characterized by a “package” of several technologies (Bates, 1995) or a “combination of media” (Rowntree, 1994), indicating clearly that more than one technology is generally used. In online learning or e-learning where a learning management system (LMS) is used for a course, subject, or program, the question remains of how to undertake the matching of each technological element of the LMS to subsections of the course, subject, or program.

The learning activities model (LAM) is based on an investigation of approaches to the categorization and classification of learning activities and reconceptualizes them in such a way as to facilitate the matching of them to learning technologies.

With a small number of notable exceptions (Gagné et al., 1992; Laurillard, 2002) there is little reference in the literature to explicit methods of classification and categorization of learning activities for the purpose of matching them to learning technologies. However, several commentators provide tacit classification as a by-product of discussions for other purposes.

BACKGROUND

The approaches to the theorization of learning activities can be grouped into four categories:

- Some commentators classify learning activities for purposes other than the selection of learning technologies.
- Others do not overtly categorize or classify, yet provide tacit conceptualizations while achieving other ends.
- Yet others simply list methods or examples of learning activities in the absence of a more detailed conceptual framework.
- A fourth approach is to provide categories of learning activities that may ultimately assist in the selection of learning technologies in a way that is appropriate for the learners, the material, the context, and the budget.

By investigating other aspects of distance education, Bates (1995), Taylor (2002), and Rowntree (1994) imply a classification of learning activities. Bates’ descriptions of learning technologies as one-way or two-way implies that there are one-way and two-way learning activities and it follows that learning activities that utilize technologies in these ways can be classified as:

- Interactions with the material using the one-way technologies, and
- Interactions between people using the two-way technologies.

Taylor (2001) provides corroboration of this tacit conceptualization in the description of the generations of distance education, where technologies are
categorized as providing “highly refined materials” and/or having “advanced interactive delivery.” Further, Rowntree (1994) implies a similar tacit categorization of learning activities by categorizing “media” as those for human interaction and those for interaction with materials. It is not surprising that learning activities can be categorized as interactions with materials and interactions between people as this is reflected in many learning experiences.

THE LEARNING ACTIVITIES MODEL

The learning activities model is a theoretical framework that can be used as an analytical tool and to assist designers of learning events. It is premised on the argument that categories of activities that are subdivisions of the learning process can be matched to techniques, technologies, and methods as part of the design process.

Provision of Material

Traditionally, the predominant approach to undergraduate university teaching consisted of a presentational style. Most lectures were primarily concerned with the provision of material, as learning seemed to be equated with the acquisition of knowledge as opposed to the development or construction of it by students. A similar approach occurred in human resource development and many programs have been conducted in venues where a trainer presents material to a group of trainees. The material was provided by the words the professor or trainer spoke and the words written on the board, overhead projector, screen, or handout. The material provided in traditional presentations like this resulted in notes and memories that learners took away from the training room or lecture theatre.

The first category of the learning activities model (LAM) consists of activities concerned with the provision of material and is referred to as “provision of materials.” Materials may be provided in the classroom, training room, or lecture theatre where they are part of the learning process. Alternatively, in distance education, flexible learning, e-learning, or online learning materials may be provided away from designated learning venues. Materials can be provided in a number of ways, including:

- The voice of the presenter or facilitator in a training program, lecture, tutorial, seminar, laboratory, study group, or residential school
- Visual aids to the above
- Printed materials, for example, prescribed texts, references, and manuals
- Other printed materials such as training notes, study guides, lecture notes, and handouts
- Other media, for example, radio and television programs, audio and video, Internet resources, Web pages, multimedia, streams, podcasts, and Web casts.

Interactions

The provision of material alone is generally not considered sufficient to produce the desired outcomes of a learning event. For learning from materials to occur, learners have to interact with it and, clearly, in many learning events other types of interactions occur. These other interactions can be identified through a brief analysis of the history of distance learning and flexible learning as practiced in higher education and human resource development.

Correspondence courses represent one of the earliest forms of distance learning. In correspondence courses, learners interact with printed materials that are sent to them through the mail. Sometimes there are opportunities for limited interaction with the facilitator in the form of comments and corrections on assignments and assessments. Usually there are few, if any, opportunities for interaction between learners. When technology was added to correspondence courses, and the term “distance learning” (or “distance education”) was applied to it, there was greater opportunity for interaction between learners. However, in many cases this was limited due to the high cost of conferencing technology or other communication technology.

Distance learning presents a clear comparison to face-to-face learning where there usually are many opportunities for learners to interact with facilitators and with other learners. Three discrete categories of interaction can be identified. They are:

- Interaction with materials,
- Interaction with the facilitator, and
- Interaction between learners.
The term “interaction” has been used in preference to “interactive” or interactivity. Apart from the grammatical constraints, this is done to avoid confusion that can occur with the term “interactive.” “Interaction” in several dictionaries is defined as action on each party or reciprocal action. There are usually two definitions of “interactive,” one that describes things that interact and another that describes computers that react immediately to the input or commands of the operator. So that there is no confusion between what is meant here by interactive and the computer definition of interactive, the use of interaction is retained, and defined as reciprocal action. This is broader than, but includes, the interactivity of computer programs. For example, a conversation in which each party tries to change the attitude of the other can be described as interaction. Interaction is essentially a two-way process allowing information to flow back and forth between learners, facilitators, and other people or things. For example, when a learner (or for that matter any viewer) watches a broadcast of a television program, material is provided to them. If they make a video recording of the program and replay it, pause, rewind, and replay parts of it, the process gains an aspect of the two-way, and to a limited degree they interact with it.

The three categories of interaction are clearly identifiable in learning although not all categories are present in all learning events. The first category of interaction, and the second category in the learning activities model (LAM), is interaction with materials.

**Interaction with Materials**

As well as the different categories of interaction that can be identified in learning events there are different levels of interaction that can be present within each category. Obviously there are many levels and styles of interaction and although the interaction of the learner or viewer in the example of the videotape (above) is rather basic, it serves to help achieve the desired learning outcomes through the removal of the ephemeral nature of the broadcast once the program is encapsulated in a video recording. “Interaction with materials” is the second category in the learning activities model (LAM) and some examples of activities in this category include:

- Looking up a definition in a reference book,
- Pausing and replaying sections of a video or audio recording,
- Searching the Internet or World Wide Web, and
- Interacting with computer aided learning packages (e.g. multimedia).

In face-to-face learning, the boundary between the provision of material and interaction with it can be difficult to distinguish. In a presentation, material is provided by the voice of the presenter and by any visual aids used. By definition interaction with the material only happens when a learner does something with it. In flexible learning, the boundary between provided material and interaction with it is usually clearer than in traditional face-to-face learning. Often the material is recorded and provided by a technology and in such cases the boundary is defined by the boundary of the technology.

**Interaction with the Facilitator**

Interaction with the teacher or trainer plays an important role in many learning events and for simplicity’s sake this person is referred to as the “facilitator.” The role of the facilitator in traditional face-to-face learning will be different to their role in flexible learning. In flexible learning the role can include some or all of the following:

- Design of materials,
- Consultation with learners,
- Assessment of learners’ work,
- Answering learners’ questions, and
- Provision of materials.

In some contexts, for example, in-house training in a small company, these activities might be undertaken by one person. In traditional face-to-face learning at a university it could be a team consisting of the presenter, a coordinator, and one or more tutors. In flexible learning, learning events can be the result of single or team efforts. The teams can consist of academics who provide the content material, tutorial staff who answer learners’ questions and assess their work, as well as instructional designers, administration, and other infrastructural staff.

In a face-to-face learning environment, learners interact with facilitators by ways like interjecting in a presentation or asking questions during a consultation with the facilitator in the facilitator’s office or elsewhere. An example of interaction with the facilitator in higher
education can be a discussion taking place between a teacher and student in a tutorial or seminar. An example of interaction with the facilitator in training could be the discussion between a participant and the trainer in an in-service workshop. Tutorials, consultations, and workshops traditionally have been face-to-face meetings; however, interaction with the facilitator can happen in flexible learning through the use of technologies like electronic mail, audio conferencing, videoconferencing and online discussion. While face-to-face interaction is obviously synchronous, the technologies used for interaction may be either synchronous or asynchronous. Some examples of the techniques and technologies that can be used in interactions with the facilitator are:

- Questions and answers in lectures (synchronous)
- Questions and answers in workshops (synchronous)
- Tutorial discussion (synchronous)
- Phone calls (synchronous)
- E-mail (asynchronous)
- Letters (asynchronous)
- Facilitator/learner consultation (face-to-face) (synchronous)
- Audio or videoconference discussions (synchronous)
- Feedback on assessments (asynchronous)
- Chance meeting and social events (synchronous)

Generally, interaction is a valued quality of learning. The author was a member of the Education Committee of the National Tertiary Education Union (NTEU), the peak academic industrial union in Australia, which developed a policy statement that echoes this sentiment:

*NTEU recognises the increase of flexible teaching and learning in tertiary education and while the benefits of flexible teaching and learning are also recognised it must be remembered that education is an interactive process, at the heart of which lies the relationship between student and teacher.* (National Tertiary Education Union, 1997, p. 12)

In many Australian universities, it is part of teachers’ duty statements to be available for a number of hours per week for student consultation. Also many teachers cultivate an attitude of questioning in their students, hence engendering a learning style that is highly interactive. In human resource development interaction is also valued and considered vital to learning:

*All collaborative learning theory contends that human interaction is a vital ingredient of human learning.* (Kruse & Keil, 2000, p. 22)

Interacting with the teacher or trainer is the third category of the learning activities model (LAM) and is referred to as “interaction with facilitator.”

**Interaction Between Learners**

Interaction between learners can be formal or informal. The most formal would be in events such as student presentations in tutorials or participant interaction in workshops. Other examples of formal interaction between learners occur where they work as a group or team on a project for assessment. Less formal interaction between learners can occur at any time or place where they talk about their learning.

The third type of interaction and the fourth category of the learning activities model (LAM) is interaction between students, trainees, or participants and is referred to as “interaction between learners.”

These last two categories (that is interaction with the facilitator and interaction between learners) are both dialogic. Dialog can have different attributes depending on the technology it is mediated by. For example, e-mail is generally limited to text while a videoconference can include body language and vocal attributes. Dialog here is defined as a conversation and is not limited to a duolog.

**The Fifth Category of Learning Activities**

The first four categories of the learning activities model describe the learning process as consisting of provided materials, interactions with materials, interactions with the facilitator, and interactions between learners. This is not a complete description of all learning activities, rather it is a description of the activities that can be planned and undertaken in order to facilitate learning. There are a number of things that learners do in order to learn or as part of the learning process that the designer of the learning event can facilitate but generally
Learning Activities Model

cannot control. These activities do not fit into the first four categories of the learning activities model and include activities such as:

- Learners’ informal reflection on what they have heard or read,
- Formal or structured reflective practice,
- Critical thinking,
- Refining ideas, opinions, and attitudes,
- Comparing new to existing knowledge and experiences, and
- “The penny dropping” or sudden realizations that are apparently not stimulated.

As these activities are outside of the categories mentioned so far, and so that the model can represent all learning activities; a category for these activities is added to the learning activities model. This is the fifth category and is referred to as “intra-action,” a term coined by the author to describe action within. The opportunities for intra-action can be maximized through thorough and appropriate design of the learning activities, and environment. However, as learners bring their own psychological baggage to their learning and as it is ultimately dependent on them, the activities in the intra-action category cannot be prescribed or guaranteed.

The Learning Activities Model

The five categories described are brought together to form the learning activities model (LAM). This model is a theoretical framework of learning activities has theoretical and practical applications and is represented graphically in Figure 1.

In Figure 1 the space enclosed by the circle represents the total of all activities that happen during the process of learning and can be applied to complete programs of structured learning in a range of granularity. At a coarse granular level the model can be used to analyze and describe the approach taken to learning by an institution or organization and the listing of activities for each category of the model would reflect the approach. At a finer level of granularity the model can be applied to courses or programs or to subjects. At the finest level of granularity the model can be applied to short discrete learning events such as using a set of instructions to perform a task. The five categories of the model, provision of materials, interaction with materials, interaction with the facilitator, interaction between learners, and intra-action are indicated by the segments or “piece of pie” shapes.

It is not suggested that all categories of the model need to be present for learning to occur or that there is a relationship that always correlates the presence of more elements with increases in the effectiveness and efficiency of learning. Some successful learning events may use all five categories, and others may use only one or two. There are many factors to be considered in the design of the number of categories of the model to include in learning events. For example, while interaction between learners is generally considered desirable in learning events it may be reduced or not occur where the number of learners is small; the duration of the learning event is short and flexibility of time is desired. In such cases it would be conceivable for no interaction between learners to occur during the process of learning.

The model provides a framework within which the activities of learning events can be mapped and can be used as a tool for the design of learning events. The following examples are provided to illustrate the model in general terms and to demonstrate the applicability of the model to commonplace learning environments.

Figure 1. The learning activities model
THE MODEL EXEMPLIFIED

This group of examples concerns a simple, everyday learning event: preparing and cooking food from a recipe for the first time. The desired learning outcome can be easily, although subjectively, measured as the successful production of the food. The first example is the simplest, containing only two categories of learning activities. In subsequent examples further categories of the model are added expanding and developing the activities of learning. In the simplest case of the example, the learner is the person preparing the food and they interact with the learning materials. The learning materials are the recipe and other relevant information, for example, a conversion chart for weights and measures. We all know that food can be prepared this way and that the results can be anywhere in the spectrum of taste. So it would be reasonable to suggest that effective learning can happen this way.

Example 1

The materials are already on hand and not provided as part of the learning event. The facilitator (assuming the facilitator is the person who prepared the recipe and instructions) is not present and the learner works alone. The activities include interaction with the materials (the materials being the recipe book, not the ingredients) and an intra-action (where the intra-action is the comparing and critical evaluation of the process with recipes prepared earlier and other experiences). This is represented graphically in Figure 2.

Example 2

In the second example the learner prepares the food in much the same way but this time the materials include a videotape of a television program, and through the recorded program activities in the category of provision of material are introduced. As well as interacting with the recipe some limited interaction with the videotape (i.e., replaying, pausing, etc.) is possible as well. The graphical representation (Figure 3) is the same as in the earlier example with the addition of the provision of material category.

Example 3

In the third example the learner prepares the food in much the same way interacting with the materials including the television program. However, the learner is not alone. The learner works and interacts with another learner, discussing aspects of the food preparation, sharing information, experiences, knowledge, and reactions. Hence the category of interaction between learners is added and the graphical representation is presented in Figure 4.

Example 4

In the fourth example, the learner is a member of a face-to-face cooking class. The learner still interacts with the materials and the other learners, and material is provided by the words spoken by the facilitator. The category of interaction with the facilitator is introduced as opportunities exist for learners to question and interact with the facilitator. In this example, all five categories of learning activities are present.

The examples of the cooking class show how the model can be used to analyze existing learning events in a general everyday learning environment. The category intra-action has been included in each example and as mentioned earlier this category is one that the learner controls rather than the facilitator or designer.
Learning Activities Model

and is included here as an indication that it is possible for activities in this category to take place in these examples.

CONCLUSIONS

The learning activities model (LAM) has been developed for two purposes. First, it provides a theoretical framework for analysis of learning activities, and second, it assists facilitators and designers of learning events in the design process by subdividing learning events or programs into categories of activities. It can be used in a formative way to analyze a proposed learning event or program or in a summative way to assist in the revision of an existing learning event or program. The learning activities model (LAM) can also be used to compare different methods and modes of achieving learning goals.

There are some things that the learning activities model (LAM) cannot, and is not intended to, do. It will not prescribe the best mixture of activities to use for a particular learning event or content area. It is not sensitive to the cultural and demographic make-up of learners. The facilitator is usually the expert on the content and the facilitator or designer should have created a profile of the learners and hence they are best placed to match the activities of the model with the content and the learners.

REFERENCES


KEY TERMS

Categorization: Grouping according to according to the role played.

Classification: Grouping according to similar or like characteristics.
**Distance Learning (aka Distance Education):**
Education in which learners are separated from facilitators.

**Education:** A structured program of intentional learning from an institution.

**Facilitator (aka facilitator of learning):** The person who has prime responsibility for the facilitation of the learning; rather than terms such as “teacher,” “trainer,” or “developer.”

**Flexible Learning:** An approach to learning in which the time, place, and pace of learning may be determined by learners. In this chapter this term is used to include the approaches taken by distance learning and open learning.

**Higher Education:** Intentional learning in universities and colleges.

**Human Resource Development:** Intentional learning in organizations. Can include training and development.

**Instructional Design:** The process of is concerned with the planning, design, development, implementation, and evaluation of instructional activities or events and the purpose of the discipline is to build knowledge about the steps for the development of instruction.

**Interaction:** Reciprocal between humans and between a human and an object including a computer or other electronic device that allows a two-way flow of information between it and a user responding immediately to the latter’s input.

**Learner:** A generic term to describe the person learning, rather than terms such as “trainee” and “student.”

**Learning:** An umbrella term to include training, development, and education, where training is learning that pertains to the job, development is learning for the growth of the individual that is not related to a specific job, and education is learning to prepare the individual but not related to a specific job.

**Learning Activities:** The things learners and facilitators do, within learning events, that are intended to bring about the desired learning outcomes.

**Learning Event:** A session of structured learning such as classes, subjects, courses, and training programs.

**Learning Management System (aka Virtual Learning Environment, Course Management System and Managed learning Environment):** A Web-based system for the implementation, assessment, and tracking of learners through learning events.

**Learning Technologies:** Technologies that are used in the process of learning to provide material to learners, to allow learners to interact with it, and/or to host collaborations between learners and between learners and facilitators.

**Online Learning:** Flexible or distance learning containing a component that is accessed via the World Wide Web.

**Representational Technology:** A one-way technology that supports interaction with the material.
Learning Community and Networked Learning Community

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INTRODUCTION

A community is socially organized around relationships as a result of seeking a common ground that builds upon “community by kinship, of mind, of place, and of memory” (Sergiovanni, 1994, p. xvi). Participating in the activities of others and contributing to cooperative doings may reveal identity construction in the social process of forging a community. Such a community-building process is further reinforced by its members’ increased belonging and shared identity, values, norms, communication, and supporting behavior.

However, along with the rapid postmodern technological developments, the notion of community has changed as current community involves “virtual as well as actual, global as well as local” (Palloff & Pratt, 1999, p. 25). As a result, a relationship-focused rather than place-based community has expanded the parameters of community concept, as is the case with networked-learning community. Seen in this light, this article examines the notions of community, of learning community, and of networked-learning community that is related to technological developments. A discussion of trends, issues, and strategies that can be used to foresee, solve, and maximize learning outcomes in the networked online learning environments will also be addressed.

COMMUNITY

The notion of community conveys multiple meanings, including those of locality, social activity, social structure, and sentiment (Clark, 1973). According to Clark, (1) locality suggests space, place, or the geographical location of the community; (2) social activity implies agency and relationship with a purpose of engaging in a shared social movement or response; (3) social structure indicates social cohesion, social participation, social control, or mutual support; and (4) sentiment conveys a sense of solidarity and a sense of significance, or signifies identity, understanding, friendship, and togetherness. Of all these meanings, the essential role of the individual within the group in the community-building process cannot be ignored because the community is often seen as “a social enterprise in which all individuals have an opportunity to contribute and to which all feel a responsibility” (Dewey, 1959, p. 61).

In view of that, community may turn into a dynamic whole that emerges when a group of people become involved in common practices, grow to be mutually dependent, make shared decisions, feel for synergy, and make an enduring commitment to the well-being of their own, one another, and the entire group (Shaffer & Anundsen, 1993). Evolving toward wholeness, the community engages in the sharing of goals, values, expectations, and mutual needs, and involves the nurturing of group identity, belonging, connectedness, support, trust, mutual interactions, and shared engagement. In such an evolving process, “an organic body of personal relations and responses, a living and evolving community of creativity and compassion” (Palmer, 1993, p. 14) is forged.

Applying the notion of community into school settings, the fundamental educational beliefs, structures, practices, and behaviors may require rethinking, thus reorganizing them into actions that are both pedagogical and educative. Highlighting the need for a recovery of community, Palmer (1993) claimed that the community as “a foundation stone of the educational enterprise” (p. xviii) is vital to the understanding of “the nature of reality (ontology), how we know reality (epistemology), how we teach and learn (pedagogy), and how education forms or deforms our lives in the world.
LEARNING COMMUNITY

Origin and Concept

From a historical perspective, traces of learning community are evident in the works of John Dewey (1915) and Alexander Meiklejohn (1932). To minimize the effect of enormous specialization, isolation, or fragmentation of the curriculum structure across disciplines on America’s colleges and universities during the 1920s and 1930s, Dewey advocated learning as an active, student-centered, and shared inquiry that focused more upon the teaching and learning processes and anticipated to “make each one of our schools an embryonic community life, active with types of occupations that reflect the life of the larger society and permeated throughout with the spirit of art, history, and science” (1915, p. 27). Such an idealized pursuit was concretized in the pioneering Experimental College at the University of Wisconsin—Madison in 1927 with intent to form “a closely-knit intellectual community” (Meiklejohn, 1932, p. 215) between advisers and students. Hence, “education becomes what it ought to be—not a set of imposed, demanded, external tasks, but a form of human living and association, the natural and inevitable growth of a healthy organization in a congenial environment” (Meiklejohn, 1932, pp. 227-228). As a result, the learning community or “a generic term for a variety of curricular interventions” (Gabelnick, MacGregor, Matthews, & Smith, 1990, p. 1), came into being to “counteract the isolating tendencies of education and the curricular dis-integration that results when knowledge is compartmentalized into competing disciplines and isolated courses” (Gabelnick et al., 1990, p. 90).

A review of literature finds that learning communities have been formed with diverse foci such as student/faculty learning communities (Cox, 2004), e-learning communities, blended learning communities (Kaplan, 2002), and online collaborative learning communities (Alavi, 1994). Although different terms are used to indicate the concepts of learning community, one thing is definite in that the learning community may “form the hearts and minds of learners, shaping their sense of self and their relation to the world” (Palmer, 1993, p. 20) and “stand on the common ground of learning as development, the value of building connections, and the power of shared inquiry” (Gabelnick et al., 1990, p. 17).

In reality, the shaping of such an empowering learning community takes time. The participatory, collaborative, active, and interdisciplinary nature of learning community can be seen as an approach to curriculum design that requires instructors and students to make joint efforts to coordinate proper courses into different programs of instruction, to implement the coordinated courses, and to evaluate the designed course content and learning objectives. Stated in a specific way, learning community is the purposeful restructuring of the curriculum that links together courses or course work in a way that learners may find greater coherence in their learning process as well as increased intellectual interaction with instructors and peers (Gabelnick et al., 1990). Moreover, in an effort to “reverse the alienating effect of traditional authoritarian education” (Fox, 2002, p. 80), the learning community may also “enable faculty to find different ways of thinking about what promotes effective educational reform, excellence in teaching and learning, and collegiality” (Gabelnick et al., 1990, pp. 85-86). Taken as a whole, learning community is an educational philosophy and/or practice that “requires a sharing of responsibility for learning methods, the curriculum followed, and assessment procedures adopted” (Fox, 2002, p. 80).

Learning Community Curricular Models

Significant variations exist in different institutional settings. Gabelnick et al. (1990) summarized five major types of learning community curricular models to “represent attempts to reorganize and redirect students’ academic experience for greater intellectual and social coherence and involvement” (1990, p. 19). These models include:

1. **Linked Courses Model:** Students register for two courses which are linked together. The instructors of the two courses coordinate syllabi but teach individually.

2. **Learning Clusters Model:** This model links three or four courses in a given quarter, semester, or year. The courses are scheduled and listed so
that students registered for this model may be grouped into the whole cluster. Instructors teach the clustered courses individually, but students take the clustered courses as a substantial portion of their course load or their entire load.

3. **Freshman Interest Groups (FIG) Model:** This model also links three courses together according to premajor topics and has a peer advising component. Each FIG cohort registers for all three courses and travels as a subset of about 25 students to larger classes.

4. **Federated Learning Communities (FLC) Model:** This model not only builds coherence and community for students but also provides considerable faculty development. The approach involves diverse courses around an overarching theme, and holds up to 40 students to coregister and travel as a small group within those larger courses.

5. **Coordinated Studies Model:** Three to five instructors team-teach in a coordinated studies program, which includes sixteen credits per quarter. Both instructors and students are engaged full time in interdisciplinary and active learning around themes. Instructors generally teach only in one coordinated study program, and students register for only one coordinated study program as their entire course load for one or more quarters.

**Implementation Strategies**

Implementing learning community “can open up new dialogue and build new ties among disciplines and departments” (Gabelnick et al., 1990, p. 39), “contextualize the disciplines and push both students and faculty to develop a personal point of view about the material and issues being studied” (Gabelnick et al., 1990, p. 55), and “enact the social construction of knowledge as it emerges through dialogue and dialectic” (Gabelnick et al., 1990, p. 56). However, challenges are evident since establishing learning community “requires leadership, energy, patience, a willingness to experiment, and … a commitment to collaborate across traditional organizational and disciplinary boundaries” (Gabelnick et al., 1990, p. 31). As such, a three-step strategy for initiating learning community based on Rasmussen and Skinner (2001) is described as follows:

1. **Pre-implementation** as the initial process involves identifying a need for a learning community, trying small-scale linked course activities; determining the feasibility of linked courses, and preplanning a linked-course program.
2. **Implementation** as the actual process concerns observing linked courses, keeping a daily log, conducting classroom research, inviting guest observers, and assessing student outcomes.
3. **Continuing development** as the reinforcing process focuses on evaluating program and revising frameworks to improve the created learning community.

In a similar vein, Gabelnick et al. (1990) also discussed the strategies for implementing learning community. Their strategies include: (1) taking the first step—initiate the learning community; (2) identifying an administrative home; (3) choosing an appropriate design and theme; (4) choosing faculty; (5) considering enrollment expectations and faculty load; (6) devoting every effort to recruitment, marketing, and registration; (7) securing funding, space, and teaching resources; (8) institutionalizing learning communities; and (9) assuring considerations for the long run.

**Perceptions, Issues, and Solutions**

According to Gabelnick et al. (1990), students in a learning community (a) often perceive themselves as being mature, (b) value friendship and a sense of belonging, (c) enjoy collaborative learning, (d) develop intellectual energy and confidence, (e) reexamine appreciation of other students’ perspectives, (f) improve the role and power of texts in learning, (g) build intellectual connections, (h) embrace complexity, and (i) enrich new perspectives on their own learning process. However, issues also exist. For instance, students drop the learning community program because of the heavy work load and their misunderstanding of the program’s nature. Some inexperienced students come to the program with divergent or opposing viewpoints. They find diversity or controversy perplexing or frustrating and become resentful to tolerance. Students often experience anxiety and fear of being exposed to the public when discussions and seminars are extensively used. The collaborative learning environment may be new or inappropriate to the students from traditional learning environments.
Meanwhile, faculty responses to learning communities are largely positive (Gabelnick et al., 1990). They appreciate the greater coherence as a result of rethinking the curriculum and engaging in intellectual coherence making process. They enjoy a new meeting place for the new intellectual dialogue and new levels of self-awareness. They benefit from interaction across departmental boundaries and obtain satisfaction from investing deeply in their students. However, faculty members are still influenced by their preference for the autonomy of their individual classrooms. Other issues also exist, such as the effects of personal teaching style, the need for control, confidence as a teacher, maturity on team teaching, and more time devoted to teaching-oriented activities but less to research. In addition, disappointment as a result of different expectations about coverage and evaluation, and unrealistic expectations about students and personal needs being unfulfilled also contribute to teachers’ reluctance in adopting learning communities.

To minimize these negative effects on the building-process of learning community, Gabelnick et al. (1990) suggested that, as learners, a sense of responsible citizenship, a community obligation to share with others, and conscious group process skills should be purposefully cultivated in the learning community. In addition, group norms for tolerance, inclusion, support, risk-taking, and ownership are important factors for a successful learning community. As faculty, a degree of “fit” among their expectations begins with clear guideposts. In addition, faculty should be clear about the educational rationale and objectives of the learning community and provide students with detailed syllabi, program covenants, and explicit skill-building work for seminars, peer group writing, and group dynamics. All these efforts may help make the collaborative learning community a success.

**NETWORKED LEARNING COMMUNITY**

Technology in education has been applied to the representation and transmission of knowledge. Integrated into teaching and learning, technology provides rich and dynamic interaction among learners, between learners and instructors, and with nonhuman resources. Over time, a learning community that is “networked electronically through the Internet” (Fox, 2002, p. 78) emerges to create knowledge and meaning communally, collaborate on projects, share resources, and evaluate learning tasks and outcomes. Such an emerged learning community is referred to a networked learning community.

From a collaborative learning perspective, Kaplan (2002) presented three approaches to designing networked learning community. They are the people, process, and technology approaches. Specifically, people approaches involve clearly defining different roles in the community, creating space for group learning activities and group project collaboration, and supporting individuality that allows learners to create personal profiles and salient information to the topic. Process approaches concern the establishment of operating norms (e.g., guidelines for online and off-line etiquette); fostering trust (e.g., learners’ expectations around shared objectives, values, and behaviors); and creating a buddy system (e.g., pairs or groups of learners responsible for joint participation and contribution). Technology approaches provide an easy-to-use collaborative learning environment realized through the integration of instructional media. For example, synchronous media involve audio-conferencing, Web conferencing, videoconferencing, chat, instant messaging, and whiteboards. Asynchronous media involve discussion boards, calendar, links, group announcements, e-mail, and surveys and polls. Content integration uses courseware, streaming media, narrated slideshows, and e-books. Document management adopts resource library, version tracking and control, and permission-based access.

Transitioning from face-to-face toward online classroom instruction, teaching, and learning can be viewed as an open, shared, coconstructive, collaborative process among networked learning participants. Such a process may well suggest that both roles of the instructor and learners shift. For example, online instructors as “coaches and facilitators who construct partnerships with learners” (Schrum & Berenfeld, 1997, p. 44) may require reexamining the conditions that are compatible with the shifted instructor roles in the networked teaching environment. Goodyear (2002) suggested that educational design for networked learning may involve “design of tasks, design of supportive organizational forms/structures and design of supportive tools/physical environments” (p. 66). In other words, a commitment to active online learning begins with an emphasis on the design of appropriate learning tasks that aligns with the learning goals and of supportive
Learning Community and Networked Learning Community

learning environments. This environment involves increased levels of socially co-constructed meanings, engagement, mutual support, and encouragement. According to Palloff and Pratt (2001), the emergence of networked learning communities result from ensuring access to and familiarity with technology, establishing guidelines and procedures, achieving maximum participation, and promoting collaboration and reflection. In terms of online learners, they are also expected to shift from being passive knowledge recipients toward active knowledge constructors in networked learning environments. For example, online learners are responsible for actively seeking solutions to problems and view these problems from a variety of perspectives. Collaborative learning facilitates the opportunities to cooperate with others through the processes of negotiation, discussion, and dialogue between and/or among learning communities. More importantly, online learners are responsible for managing their own learning and for establishing networked learning community through joint efforts.

A search on Google has identified various networked learning communities. For example, education with new technologies (ENT) is designed to help educators empower their students with learning experiences through technology integration (see ENT, http://learnweb.harvard.edu/ent/welcome/index.cfm). The networked learning communities (NLCs) enables groups of schools, local authorities, and higher education institutions to work collaboratively to raise standards, improve opportunities for students, and provide opportunities for school leaders to exchange good practices (see NLCs, http://www.standards.dfes.gov.uk/sie/si/eips/existingmodels/nlc/). A good summary of the functionality of establishing a networked learning community is presented by ENT as follows:

Computers, the Internet, and other tools offer the promise of significant improvements in teaching and learning, but fulfilling that promise can be difficult. … The site will help you navigate the expanding territory of new educational technologies with guidance from established principles for teaching and learning … through processes for integrating new technologies. (ENT, http://learnweb.harvard.edu/ent/welcome/index.cfm)

FUTURE TRENDS

The educational opportunities created for the students in this century should be able to prepare them ready for the world in which they work and live. However, current educational models, structures, and approaches are inadequate (Palloff & Pratt, 1999) to meet that need as a result of conceptualizing the school or the teacher in a classroom as an island, standing alone with no interconnectedness with society or other educational institutions, and with no generated competence in a knowledge society (Harasim, Hiltz, Teles, & Turnoff, 1996). Accordingly, students need new and different information resources, skills, roles, and relationships to survive in a challenging yet interweaved society.

Palloff and Pratt (1999) pointed out that the creation of a learning community supports and encourages knowledge acquisition. Learning together and renewing the passion for exploring the unknown creates a sense of excitement. The collaboration among students truly creates an atmosphere of passion for learning and working together. The total outcome of knowledge acquired and shared is far greater than what would be generated through independent, individual engagement in the learning materials. Stated in a different way, “The power of a learning community is even greater, as it supports the intellectual as well as personal growth and development of its members” (ibid., p. 163). However, creating and sustaining a learning community requires that students, teachers, administrators, and support staff work together.

Networked learning communities will become a trend in education because it prepares students for not only obtaining the knowledge, but also the skills in using them in the globalization for a rapid exchange of information. More and more networked learning communities will be established for different purposes. The development of the networked learning communities involves developing new instructional approaches to education and new skills in its delivery. As a result, educators will face new challenges in this innovation. Within the networked learning communities, students may achieve the flexibility in gaining knowledge and skills when they step outside the tradition of isolated courses and adopt more interdisciplinary approaches via applying technologies. However, the networked learning community operates differently due to the particular context of each group, the people involved, their different purposes and expectations, their personal
and professional backgrounds and concerns, and their familiarity with technologies. Hence, there is a need for conducting further studies on these aspects.

CONCLUSION

As discussed in this article, learning community facilitates a coherent and meaningful educational experience, fosters collaborative spirit among learners, promotes retention and achievement for students, and revitalizes the teaching experience for instructors as well. According to Rasmussen and Skinner (2001), learning is raised to a higher level as students see the commonalities in thinking across several subject areas. Furthermore, critical thinking is strengthened as students are exposed to multiple, and sometimes conflicting, perspectives on identical issues. Accordingly, when an individual discipline is seen in a broad context that encompasses various aspects of social activities, more ethical decisions are possible.

As a result, community-based learning and knowing is gaining more attention in educational settings. However, as technology-mediated communication helps shrink the globe, parameters of communities extend from the actual into virtual, and from local into global. Further, the emergence of a virtual, interdependent community that is both technology-dependent and relationship-focused may challenge the long-established educational structures, norms, practices, and procedures. Hence, more research is needed to explore the concept of a networked learning community such as its theoretical underpinnings, the roles that instructors and learners have within that community, and the convergence of courses with corresponding technologies.

REFERENCES


Learning Community and Networked Learning Community


**KEY TERMS**

**Blended Learning Communities** are groups of people gathered together for certain educational purposes through online learning and face-to-face meetings. Engaged learners communicate, share thoughts, and collaborate learning via online discussions, Web conferences, or other methods before and/or after a face-to-face learning event.

**Collaborative Learning** is a term used for various educational approaches that involve intellectual efforts by groups/pairs of students working mutually to understand content, solve problems, and create projects.

**E-Learning Communities** are groups of people connected solely via technology for certain purposes. All interactions begin and occur over the Internet through conference calls, videoconferencing, and so forth. These communities promote virtual collaboration that focuses upon addressing a specific topic and are thus supported by one or more online learning and media tools (Kaplan, 2002).

**Faculty Learning Communities** (FLCs) are formed by teachers to address teaching, learning, and developmental needs so as to reduce the isolation, fragmentation, stress, and neglect in the academy. Teachers can propose topics to the FLC program director to address special teaching and learning needs, or issues.

**Learning Community** is a purposeful restructuring of the curriculum that links together courses or course work so that learners may find greater coherence in what they are learning and have access to increased intellectual interaction with faculty and peers (Gabelnick, et al., 1990).

**Student Learning Communities** are formed by students from different grades or classes to achieve better learning outcomes through collaborative and active approaches to learning. Student learning communities link together courses or course work so that students may find greater coherence in what they are learning as well as gain greater intellectual interaction with faculty and peers.
INTRODUCTION

Imagine a vast repository of digital materials that includes an unlimited supply of instructional videos, interactive multimedia exercises, links to Web sites, reading exercises, recorded interviews with experts, interactive graphs, charts, diagrams, photographs and maps—and nearly any other form of digital instruction—all organized according to academic standards, instructional objectives, and specific topics addressed. Teachers could log in to the repository via the Internet, type a simple search string and instantly access hundreds of pertinent instructional sequences that they could use to enhance their teaching practices in both the classroom and in the virtual learning environment. This vision has been the driving force behind a form of instructional technology called learning objects (LOs), and it is becoming an increasingly relevant topic within the field of instructional technology today.

The idea that instructional content can be systematically encapsulated, retrieved, transmitted to others, and then reused is the driving force behind the LO movement. In the face of such enormous potential, the field of instructional technology has made little progress since 2002 when it comes to defining a practical method for populating LOs with meaningful instructional content and research that addresses the pedagogical effectiveness of using LOs in the K-12 learning environment is scarce. As yet, no practicable model for implementing this technology in a “real world” setting exists.

BACKGROUND

Perhaps the most widely accepted definition of the term learning object comes from David Wiley (2002). Wiley (2002) states that a learning object is any digital resource that can be reused to support learning (p.7). While Wiley’s definition and other attempts to define the true nature and function of learning objects are important efforts, varying views regarding the true nature and function of learning objects have caused a great deal of confusion within the field of instructional technology concerning this technology (Sosteric, 2002; Welsch, 2000). In any event, the fundamental theme that ties every perspective together is the basic idea that digital instructional content can be encapsulated, stored, and reused in the appropriate context. To put it more succinctly, learning objects are reusable and interoperable. These core attributes make learning objects both appealing and controversial.

The term “learning object” appears in the vernacular sometime around 1994 and is often attributed to the work of Wayne Hodgins (Wiley, 2002, p. 4), but the basic concept of reusing digital resources to streamline computing practices for programmers and to introduce uniformity of experience for end-users can be traced back to the work of Ole-Johan Dahl and Kristen Nygaard from the Norwegian Computing Center, Oslo, Norway, in the mid 1960s with their work on a programming language called SIMULA. This work led to a form of computing called object oriented programming that has had a profound impact upon the field of computer science and information technology. Object oriented programming gained momentum in the 1970s with the work of Alan Kay and became increasingly popular as a result of the work conducted in the 1970s and in the early 1980s by Bjorn Stroustrup with his efforts to apply the basic concepts of object oriented programming to the C computer language to create the commercially successful and widely accepted C++ computer language. Soon after that, a group at Sun led by James Gosling introduced a derivative of C++ called Java that has gained increasing popularity with the expansion of the Internet.

While the effective implementation of learning objects (LOs) will undoubtedly continue to require formative input from the field of computer science, the fields of instructional technology and education will need to add more formative input to the conversation if LOs and learning object based instruction (LOBI) are to reach their full potential. To date, the majority of work concerning LOs has been focused upon establishing metadata referencing and retrieval schemes that can be used to quickly access LOs. In the 1980s and early
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1990s, several metadata referencing initiatives began to address the need to categorize and quickly retrieve digital content and various tagging schemes began to emerge. In the fall of 1997, the U.S. Department of Defense, the White House Office of Science and Technology, the Department of Labor, and others, kicked off the Advanced Distributed Learning (ADL) initiative that established the metadata referencing standard called the Sharable Content Object Referencing Model (SCORM). Since it was introduced, SCORM has come to be the most prominent metadata referencing standard in the United States, but other metadata standardization efforts—like the IEEE’s LOM project—also address the same need.

The introduction of, and further refinements to metadata referencing standards like SCORM and LOM are a critical step that must be taken to allow different content publishers to create learning objects that can interoperate within different learning management systems (LMS), but these efforts have little or nothing to do with pedagogical effectiveness of the LOs themselves. These efforts were an important first step because they addressed the need to ensure that LOs are retrievable and interoperable, but they do not address exactly what instructional materials a LO should contain to be instructionally effective (Welsh, 2002, p.2).

The first attempts to address the need for LO content standards are typically attributed to the work of M. David Merrill from Utah State University in his work in the 1990s. Other early pioneers in the effort to devise a content model for LOs include L’Allier (1997) and his efforts with the NETg Learning Object Model and Barritt (1999) and others from CISCO who introduced the RLO/RIO content models. Verbert and Duval (2004) present a thorough overview of such efforts.

In 2002, Macromedia released a white paper that clearly identifies SCORM as a referencing standard only and acknowledges the fact that

the intent of SCORM is not to promote uniform content, but to enable conformant content to work better in a technical level. What content goes into the Learning Object (LO) is determined by the learning designer and not governed by SCORM. (p. 4)

Other efforts at around the same time, like The Masie Center’s white paper (Masie, 2002), the Learnativity content model (Duval & Hodgins, 2003), and the SCORM content aggregation model (Dodds, 2001) all attempted to meet the demand for a content model that addresses the actual instructional media contained within an LO. Despite these early efforts, the confusion between the function of SCORM and how it does (or more appropriately, does NOT) affect the content of a LO remained—and it is still present today. Soon after this flurry of activity, the collective attention of the field of instructional technology moved toward the formation of LO repositories and the issue of how best to populate LOs with instructional content still needs to be addressed in a practicable way.

Much of the recent activity in the LO community has been devoted to building LO repositories like MERLOT,

Table 1. Partial list of existing LO repositories

<table>
<thead>
<tr>
<th>Organization</th>
<th>LO Repository Name</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>California State University</td>
<td>Merlot</td>
<td><a href="http://www.merlot.org/Home.po">http://www.merlot.org/Home.po</a></td>
</tr>
<tr>
<td>Discovery Education</td>
<td>Cosmeo</td>
<td><a href="http://www.cosmeo.com">http://www.cosmeo.com</a></td>
</tr>
<tr>
<td>EduSource Canada</td>
<td>Canadian Network of LO Repositories</td>
<td><a href="http://www.edusource.ca/">http://www.edusource.ca/</a></td>
</tr>
<tr>
<td>European SchoolNet</td>
<td>Celebrate</td>
<td><a href="http://www.eun.org/eun.org2/eun/fr/Celebrate">http://www.eun.org/eun.org2/eun/fr/Celebrate</a> LearningObjects/entry_page.cfm?id_area=1008</td>
</tr>
<tr>
<td>The Remediation Training Institute, Inc.</td>
<td>ExtraLearning</td>
<td><a href="http://www.extralearning.net">http://www.extralearning.net</a></td>
</tr>
<tr>
<td>The Monterey Institute for Technology and Education</td>
<td>The National Repository of Online Courses</td>
<td><a href="http://www.montereyinstitute.org/nroc/nrocworking.html">http://www.montereyinstitute.org/nroc/nrocworking.html</a></td>
</tr>
<tr>
<td></td>
<td>Hippo Campus</td>
<td><a href="http://hippocampus.org/">http://hippocampus.org/</a></td>
</tr>
<tr>
<td>Utah State University</td>
<td>Instructional Architect</td>
<td><a href="http://ia.usu.edu/">http://ia.usu.edu/</a></td>
</tr>
<tr>
<td>Wisconsin Technical College System</td>
<td>Wisconsin-Online</td>
<td><a href="http://www.wisc-online.com/">http://www.wisc-online.com/</a></td>
</tr>
</tbody>
</table>

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Wisc-Online, EduSource in Canada, CELIBRATE in Europe, and the newly introduced commercial product from Discovery Learning, Inc. called Cosmeo; but, there has been surprisingly little research and discussion surrounding the use of learning objects within the learning environment (Haughey, 2005). While these repositories represent a great deal of progress and they are, indeed, a critical accomplishment; they are only a first step toward widespread implementation of LOBI in the K-12 environment, and ultimately into every day learning and teaching practices in public schools across America. Table 1 includes some of the more prominent learning object repositories that are available today.

Each of these projects has made significant contributions to the advancement of LOBI. They are, however, only a first step toward implementing LOs into the mainstream of the field of instructional technology and, ultimately, into every day teaching practices.

The Need for a Widely Accepted Content Model

SCORM imposes few restrictions upon the content to which it refers and the position that SCORM is a referencing model only (Brown, 2002) is an important one because it underlines a need to somehow define the parameters of the instructional content contained within the learning objects to which it refers. Just like the Dewey Decimal System refers to all kinds of different media in your local library ranging from microfiche, to encyclopedias, magazines, and classic novels, and so forth, the SCORM metadata referencing model is concerned with brief descriptions and access—it has little-to-nothing to do with the quality and/or the quantity of media to which it refers. Friesen (2001, p. 2) acknowledges the dichotomy between function (metadata) and form (content) by noting that metadata standardization efforts are a start, but there remains a need to answer the basic question “What is the relation between learning object metadata and content?”

The responsibility to practically answer this question and provide some guidelines for populating LOs with meaningful instructional content falls upon the shoulders of the field of instructional technology. The questions remain, however, exactly how that content model will be formulated and how it will be embraced by the educational community as a whole.

A Suggestion for Meeting the Need for a Content Model

Hodgins and Connor (2000, p. 1) claim that revolutionary changes do not take place without widespread adoption of common standards, but, ultimately, those standardization efforts have to address a common need in a delivery environment. The fact that resources currently exist (LO repositories) and that there is a growing demand within the K-12 learning environment for a practicable model for teaching K-12 online learners underlines the need for such an environment that accommodates the natural evolution of this LOBI.

Consider how various forms of recorded media are interwoven into our daily lives. It can be argued that stored digital media like movies, songs, and television shows adhere to at least three types of guidelines that make them meaningful for us. First, they meet the technical requirements of the delivery mechanism—they must be recorded in a way that can be broadcast so we can experience them. Second, they fit within the publishing norms for their respective medium, and third, they must meet an intrinsic need in the target audience. First, there is typically an elaborate process that ultimately results in the creation of a physical artifact that is compatible with projectors, CD players, and/or TV broadcast equipment. Second, the content of that particular production adheres to established standards for publishing content in that particular medium (it is rare to come across a 12 hour movie, a song that is so high-pitched that only your dog could hear it, or a TV production without characters or a plot line), and finally, each of these forms of recorded media meets an intrinsic need within the target audience. They fit into our lives in such a way that they have value for us—they are used.

In each of these examples, guidelines, or standards, have emerged that drive distribution, content production, and adoption. Ultimately, it is the iterative interplay between content production and adoption within a target delivery environment that refines the adoption of the particular form of recorded media—and the content publishing standards themselves. To date, the field of instructional technology has (perhaps necessarily) focused its attention upon the interplay between distribution (or retrieval) standards and content production standards. But like any other form of recorded media, it will be the interplay between content production efforts and adoption in the delivery environment that
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will have the greatest impact upon the development of standards that will guide the widespread implementation and acceptance of LOs. To facilitate this formative process, a theoretical framework that accommodates the interplay between published artifacts (LOs) and the intrinsic needs of learners in the target delivery environment must emerge.

Rather than continuing to rely upon rigid and abstract theoretical perspectives to guide the development of learning objects and the implementation of LOBI, the field of instructional technology has evolved to the point where more pragmatic approaches to instructional design (Vischer-Voerman, 2004) can be employed. Shank (2002, p. 4) suggests that a good opportunity for semiotic research in education will be to create an a-priori set of meaningful concepts that can serve as the basis for a new model for educating in a particular setting. Rather than a “one size fits all” approach to creating a content model for LOs, several types of native interactions will be identified and then specific types of LOs that accommodate those interactions will be developed. The specific methodology that will be employed to transform and translate these different types of native interactions into LOs that are woven into the proposed theoretical framework is what C.S. Peirce calls abduction, or the creative process of reasoning to a satisfactory explanation, of creating a structure in which our observation makes sense (Buchler, 1955).

Curriculum Directors—The Missing Link

Every lesson that uses learning objects needs to be assembled. Just like any other well designed lesson, someone has to analyze instructional goals and learning objectives and then create a strategy for conveying information to the learners that will help them meet those objectives. The fact that LOs are self-contained, meaning that the instructional message is already inherently part of each learning object greatly streamlines the process of creating a lesson and, as search techniques become more and more refined and repositories become more and more standardized, it may be possible for classroom teachers piece learning objects together to make online lessons, but this is not presently a practical reality.

In the meantime, LOBI will be implemented by a select few curriculum directors who work with classroom teachers to “hunt and gather” pertinent learning objects from existing repositories and deliver them online in a learning management system. This development process is an extension upon Wiley’s (2002) manual assembly techniques and has come to be known

Figure 1. Using the collaborative model for distance education to refine a content model for LOs in the K-12 online learning environment
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as the collaborative model for distance education. This process effectively enables classroom teachers to “broadcast” lessons online that mirror the instruction that they present in their classrooms. Ultimately, this simple assembly process opens the door to many exciting possibilities for students who are absent from the classroom for any number of reasons because it effectively blends virtual instruction with traditional classroom instruction in such a way that effectively accommodates the existing infrastructure of public schools and utilizes stored media as a performance support tool for classroom instructors.

By analyzing native instructional design documents like lesson plans as a guide, curriculum directors can employ rapid prototyping techniques (Tripp & Bichelmeyer, 1990) and situated instructional design methods (Wilson, 1995) to quickly assemble online learning object based lessons that mirror the instruction presented in the traditional classroom environment. More recent advocates of this approach include Suhonen and Sutinen (2005) with their work on formative methods in sparse learning environments. Other instructional technology visionaries like Hodgins (2000, p. 14) agree that the best way to arrive at a future that embraces LOBI, it is most practical to adopt a backward approach, and more mainstream instructional designers like Wiggins and McTighe (2005) advocate this approach as a practicable way to achieve results in a learning space.

FUTURE TRENDS

The apparent benefits of decoupling stored, reusable, and self-contained digital instructional content and retrieval and delivery mechanisms is a fundamental aspect of LOBI and computer mediated instruction that opens the door to many exciting opportunities for educating K-12 students, but also poses fundamental challenges to paradigms that guide existing classroom practices. More specifically, if facilitators in a computer mediated learning space that accommodates LOBI can rely upon stored and reusable instructional content to convey the instructional message to their students, it becomes possible for them to devote their energies to other critical aspects of the teaching and learning process (like behavior support and more individualized instruction). This interplay between stored media and facilitated learning is one of the great strengths of LOBI that makes it more suitable for the K-12 audience than other forms of distance education because children often need more guidance in learning activities than adults.

Haughley and Muirhead (2005, p. 2) suggest that “learning objects do not have value or utility outside of instructional contexts and that their value is in their application to classroom settings and to online learning environments where teachers may or may not be present.” Currently, teachers in the traditional classroom setting follow a model for presenting information that simply does not accommodate the use of LOBI. The very nature of how information is presented in the ideal delivery environment differs so dramatically from traditional classroom practices (lecture-based instruction vs. inquiry-based facilitated learning), that introducing LOBI into a traditional classroom setting requires a complete rethinking of the role of the teacher and the way that information should be presented in the target delivery environment.

In a sense, learning objects are an anachronism—they are artifacts that are available in an environment that does not yet know how to use them. While LOs themselves will undoubtedly be transformed and refined as the educational community develops learning environments and practical pedagogical principles that accommodate LOBI, the majority of the evolutionary change will happen within the learning environments themselves. As may be expected, sociocultural approaches to learning and teaching that view LOs as semiotic tools and/or social resources that can mediate the link between the social and the individual construction of meaning (Hung, 2002, p. 175) will play a formative role in the adoption and development of LOBI. Ultimately, LOBI will be defined by the environment in which it is delivered and, like any other form of instruction, its efficacy must be determined by the effect it has upon learners themselves.

CONCLUSION

Since the introduction of learning objects in the 1990s, the field of instructional technology has struggled to develop implementation models that fully take advantage of the vast potential that this form of instructional technology affords. While nearly all instructional designers and technologists currently acknowledge the nearly endless possibilities associated with LOs, several obstacles remain that make practical implementation of
LOBI difficult. At this point in the evolution of computer assisted instruction, LOs and LOBI are being under utilized and only when these barriers are isolated and addressed (and/or eliminated), will learners and teacher reap the benefits that LOs can provide.

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**KEY TERMS**

**Collaborative Model For Distance Education:** The term used to describe the process formative and iterative of using native resources to guide the translation of classroom instruction into learning object based instruction so it can be delivered online.

**Content Model:** A commonly accepted set of specifications that developers can use to guide their efforts when they create media. Commonly used interchangeably with the term *publishing standard*.

**Curriculum Director:** In the collaborative model for distance education, the curriculum director is the person who is responsible for analyzing classroom instruction, searching through a repository to collect learning objects that address the same topics, and then delivering those learning object to end users in a learning management system.

**Learning Object:** Any digital resource that can be reused to support learning.

**Learning Object Based Instruction (LOBI):** The process of utilizing assembled learning objects to teach in a learning environment. LOBI is a form of facilitated instruction, or performance support, as opposed to direct instruction and/or lecture based models for presenting information to learners.

**Metadata:** The standardized information that is used to describe learning objects. Typically metadata comes in the form of completed form fields that describe the formative characteristics of a learning object.

**Metadata Referencing Scheme:** A shared, syntactical approach to the use of metadata that programmers can use to ensure that learning objects are retrievable and interoperable.

**Publishing Standard:** A commonly accepted set of specifications that developers can use to guide their efforts when they create media. Commonly used interchangeably with the term *content model*.

**Pragmatic Paradigm:** An instructional design approach that emphasizes environmental factors like adoption and use in the test when evaluating the validity and efficacy of learning materials.

**Rapid Prototyping:** The process of quickly analyzing instructional needs in a learning environment and selecting relevant instructional materials that meet those needs.

**The Shareable Content Object Reference Model (SCORM):** A set of guidelines that The Learning Technology Standards Committee of the IEEE began their efforts to come up with one set of metadata guidelines that can be used to systematically categorize digital content. Currently, this effort is being refined by the U.S. Department of Defense’s Advanced Distributed Learning Division (ADL).

**Situated Instructional Design:** Brent Wilson’s theory for instructional design that posits that implementation and design are ultimately inseparable.

**ENDNOTE**

* www.vlnpartners.com
INTRODUCTION

Research into the learning styles and preferences of students is well established but is currently the subject of renewed interest driven by a number of factors. First, following policies to encourage and facilitate widening participation, the student population is being drawn from more varied backgrounds, and greater emphasis is being placed on helping students to learn (Smith, 2002).

Second, models of learning theory have largely been developed in isolation from the subsequent advances in the use of information communication technology (ICT) and its changing role in education (Sadler-Smith & Smith, 2004). The flexibility offered by online learning environments changes both the temporal and spatial dimensions of the learning context. Technology increases the physical distance between student and lecturer and imposes a technical aspect, which may be seen as a physical barrier to learning or may be perceived as a way of removing cultural and social barriers and therefore opening and creating new opportunities for dialogue. The impact of ICT on the learning context offers new opportunities and challenges to learners and instructors that need to be considered within the context of learning preferences.

Third, the renewed interest in learning styles is perhaps also fuelled by the ease with which multiple modes of learning can be accommodated and combined using ICT. Within online learning environments learning objects can be developed and reused more easily, for example, short videos can be created without the use of extensive production equipment. This provides the opportunity for lecturers to reconsider their pedagogic strategies to effectively integrate the use of technology into teaching (Fisher & Baird, 2005).

BACKGROUND

Research in learning styles recognises the need to understand how students learn (Smith, 2002). Most individuals have one or two preferred styles with the other styles being used to a lesser degree (Shaw & Marlow, 1999). When designing the learning context it is necessary to consider how to respond to and challenge the variety of learning styles and preferences of learners (Sadler-Smith & Smith, 2004), irrespective of whether the learning context is Web-based (Byrne, 2002).

Carl Jung introduced the concept of learning style in 1927. Jung noted major differences in the way people perceived (sensation vs. intuition), the way they made decisions (logical thinking vs. intuitive feelings), and how active or reflective they were while interacting (extroversion vs. introversion) (Silver, Strong, & Perini, 1997).

A number of different constructs are labeled as learning styles (Lum, 2006). Riding (1996) suggests that the way people learn is strongly influenced by in born strategies and styles. This is reflected in the way in which learning styles of students are identified. Most approaches that are used to identify an individual’s learning style, do so independently of context, and then assume that the learning styles identified are also present within the context of learning activities (Laurillard, 1993). The degree with which styles are considered to be dependent or independent of context is reflected in the following definitions of related learning theories and concepts.

Learning styles are:

- A distinctive and habitual manner of acquiring knowledge and skills (Sadler-Smith, 1996).
- ‘Stable and pervasive characteristics of an individual, expressed through the interaction of one’s behaviour and personality as one approaches a learning task’ (Garger & Guild, 1984, p. 11).
- A preferred way of acquiring and using information (Lawson & Johnson, 2002).
- A persistent use of a learning strategy in relation to multiple tasks and may be thought of as cognitive styles observed in learning contexts (Ford, 2004).
Learning styles focus on the learning process in terms of the way in which individuals differ in their interaction with the learning environment (Diseth, Pallesen, Hovland, & Larsen, 2006). A learning style reflects habitual patterns of behavior where as a learning strategy is a conscious plan of action adopted in the acquisition of knowledge and skills (Sadler-Smith, 1996).

Approaches to learning reflect the orientation of a student to the learning situation (Diseth et al., 2006). Marton and Booth (1997) introduce the phrase ‘approach to learning’ (Entwistle, 2001) and propose three types of approach: deep, surface, and strategic. A deep approach to learning describes a student’s active engagement and extensive development of the learning material. In contrast, a surface approach to learning describes a student’s limited engagement with the learning material as the student seeks only to memorise sufficient material to enable reproduction of those aspects on which the student is to be assessed.

Diseth et al. (2006) differentiate these approaches to learning in terms of student intentions. A deep approach to learning is adopted by students with an intention to understand the material presented to them, surface learning reflects an intention to reproduce the learning material for assessment purposes, and the strategic approach to learning is adopted by students with an intention to succeed.

These intentions can be considered to be both context and student dependent (Entwistle, 2001). They are partly determined by the learning context in terms of how the student responds to the specific learning context (Entwistle, 2001) but are also developed over time through the student’s prior experience of learning situations.

A learning preference is a disposition to a mode of learning which reflects the extent to which a particular learning activity provides learners with the opportunity to process information in a manner that is consistent with their cognitive style (Sadler-Smith, Allinson, & Hayes, 2000).

Cognitive styles are:

- In built dispositions linked to personality (Riding & Rayner, 1998) and therefore represent a consistent way of responding to and using stimuli in the context of learning.
- A plan of action adopted in the process of organising and processing information (Sadler-Smith, 1996).
- Characteristic modes of thinking, remembering, and problem solving (Messick, 1984).

Sadler-Smith et al. (2000) suggest that preferences for learning activities are a function of innate cognitive style, which can be seen as a consistent set of preferences in the manner in which information is organised and processed (Messick, 1984). For example, based on the cognitive style index (Allinson & Hayes, 1996) students with analytical cognitive styles prefer sequential approaches to learning, focusing on procedure building. In contrast, holistic intuitive learners prefer synthesis and description building.

Riding and Cheema (1991) define two dimensions of cognitive style: field dependence and field independence. Field dependency is the extent to which a person uses the context to understand and make sense of new information (Smith, 2002).

Ford (2004) reports studies that link:

- Field independence and lower use of information services and lower preferences for broad Internet exploration.
- Verbaliser/imager dimension of cognitive style and use of visual information sources, lower levels of unplanned Internet browsing and poor retrieval effectiveness in the Web society.
- Visuo-spatial ability and the acquisition of navigational knowledge.

Cognitive styles represent approaches to understanding material that are conceptually linked to theories of divergent and convergent thinking (Ford, 2004).

The human brain is split into two halves, each with its own unique abilities (Huston & Huston, 1995) processing different types of information. Learning styles vary based on the development of the left and right hemispheres. The left hemisphere specialises in verbal and numerical information processed sequentially and analytically, while the right hemisphere is the intuitive, creative, part of the brain and deals with three-dimensional forms and images. The left hemisphere adopts a systematic approach and predominantly left-brained people prefer a step-by-step build up of information. The right hemisphere seems to process information more ‘holistically,’ and can process clusters of stimuli at the same time; predominantly right-brained people need to see the big picture. Optimal learning requires learning activities that include the strengths of both hemispheres.
Lum (2006) suggests that issues of culture, communication, and learning are interdependent and that the role of culture in understanding a student’s learning preferences is underestimated. Cultural differences refer to patterns of thought, attitudes, and behaviours (Lum, 2006) and can therefore influence learning styles. While research explores specific cultural preferences (e.g., Chan, 1999), study of the interplay between a learner’s original cultural and the culture in which learning is taking place, is limited. Cultural issues are of particular concern in e-learning as online learning environments create a third culture where (at least) two different social and cultural experiences combine to create a third, unique (albeit temporary) cultural experience for the participants (Goodfellow, Lea, Gonzalez, & Mason, 2001).

In seeking to differentiate between all of these terms, Curry (1983) positions the definitions within an onion model with personality at the center, and then moving outwards with cognitive personality (field dependence/independent), information processing styles (e.g., Kolb, 1984), and then behavioural interaction (preferences for learning methods).

### Learning Styles and Learning Methods

There is considerable debate concerning the extent to which teaching methods should be matched with student learning styles. Lawson and Johnson (2002) suggest that the main aim of learning style research is to identify student learning styles and match them with instructional methods to optimise learning. Learning materials should therefore be presented in a manner consistent with a student’s learning style (Karuppan, 2001). Congruence between learning style and learning method has been shown to have a positive effect on the learning context (Smith & Renzulli, 1984). When student and teacher are matched for cognitive style they view one another positively and the goal of the interaction is more likely to be achieved (Tennant, 1997).

Conversely, it is argued that if learning preferences are ignored there is a risk that students will withdraw from engaging in the learning process (Smith, 2002) and reject the value of the information presented (Ford, 2004). This is particularly of concern if, for example, students perceive more value in personal contact with the tutor rather than online discussion with peers.

However, Diseth et al. (2006) suggest that although the relationship between students’ approaches to learning and achievement is well documented, there is limited evidence of a causal relationship between them. A study by Lawson and Johnson (2002) suggests that students do not perform better when the instructional method matches preferred learning styles, as learning styles do not interact with instructional methods in the manner expected.

Arguments are also posited that learning methods should deliberately not match learning styles as incongruence challenges students and strengthens areas of weakness, thereby improving the flexibility of the learner (Ford, 2004). There is a fine line between challenging learners to construct new understanding in new ways and asking them to engage with new information that is mismatched to their preferences, to the extent that the tasks becomes excessively difficult (Ford, 2004).

Similarly, in multicultural learning environments, sensitivity needs to be shown towards culturally inherent learning traditions while also enabling students to develop their ability to actively participate within the dominant learning culture and processes (Lum, 2006). Student approaches to learning are dependent on their perception of the content, context, and demand of the task (Diseth et al., 2006) and therefore learning styles should not be the primary determinant in the selection of learning methods.

Evans and Sadler-Smith (2006) report from the 10th Annual European Learning Styles Information Network Conference which recommends that instruction should be sensitive to the needs of the learner and aimed at developing and broadening learning styles and strategies, with an informed awareness of the benefits of matching and mismatching learning and learner.

The use of learning styles can result in the disadvantage of labeling students which has led to proposals that the use of learning styles should be discontinued (Reynolds, 1997). It is recognised that there are problems with classifications of learning styles. For example, students cannot and should not fit into one category and by using the constructs, they can become self-fulfilling prophecies (Smith, 2002), reinforcing approaches to learning rather than developing flexibility. Lecturers therefore need to be aware of the judgments implicit in learning style classifications (Smith, 2002).

Entwistle (2001) emphasises that learning styles are not intended to assert ability but seek to focus attention on the nature of the learning interactions between the student, the learning object, and the nature
of the learning task. It is also recognised that student learning styles may change over time and in response to the demands of the learning environment (Sadler-Smith et al., 2000). For example, Lum (2006) refers to a study that shows that the learning style of students changed between years 1 and 4 of an undergraduate medical course.

Approaches to help identify preferred learning styles (e.g., Honey & Mumford, 1992) can be used to help individuals develop their abilities to learn. Raising student awareness of their learning styles and preferences, and helping them reflect on how they have been developed, is important in helping students develop as flexible learners (Smith, 2002) and for enabling students to manage their own learning (Evans & Sadler-Smith, 2006). For example, self-reflection of learning styles using the Kolb (1984) learning style inventory is embedded in formal professional licensing mechanisms controlling the practice of health professional in North America (Lum, 2006). E-learning offers the potential to use technology to support this reflection as a means to take a student from being a passive recipient of knowledge to becoming an active learner (King, Cox, & Midgley, 2005). For example, Hollyhead and Cox (2006) used a commercial blogging tool to encourage students to develop reflective skills.

Learning Styles and ICT

Despite numerous studies examining the relationship between learning styles and the use of ICT, evidence remains contradictory. Some researchers found that there is a strong relationship between students’ learning styles and their attitude towards IT assisted learning, while others suggest that no such relationships exist (Shaw & Marlow, 1999).

The learning context affects a student’s approach to learning (Diseth et al., 2006) and online learning changes the context within which learning takes place. E-learning can empower the learner as they take control and responsibility for their learning (Cox, Perkins, & Botar, 2004). Karuppan (2001) suggests that in order to facilitate learning, students should be given more options in the way material is presented and this becomes feasible with online learning. E-learning offers flexibility and the advantage that courses can be adapted to the needs of individual students (Dalsgaard, 2005) by reconstructing learning environments around specific learning styles (Buch & Bartley, 2002). Application of learning technology that cannot adapt to learning styles risks rejection (Byrne, 2002).

It must however be recognised that, despite the flexibility offered in online learning environments, the technological context will not be suited to all learning styles. Cultural differences such as societal, personal, organisational, and disciplinary issues will also impact upon a student’s response to technology (Lum, 2006). For example, a study of learning preferences showed that business and management students preferred dependent methods of learning such as traditional lectures rather than autonomous methods of e-learning (Sadler-Smith & Riding, 1999).

Design features that are intended to support learning may become a barrier to learning due to interpretation within social and cultural values. For example, e-mail, chat, and peer dialogue impose an expectation to communicate which may pose burdens on participants, especially if the volume of postings is assigned a grade (Lum, 2006).

Individuals with specific learning styles have preferences for specific training delivery mode formats (Buch & Bartley, 2002). Approximately 35-40% of people are estimated to be right-brain dominated but most e-learning materials are presented in a linear sequence (Carnwell, 1999); ideal for the left-brain learners but right-brain dominated learners do not learn well using this approach. Traditional teaching methods emphasise verbal learning (Smith, 2002), however, more visual approaches can be encouraged in online environments. This helps visual learners but may create a barrier for auditory, kinaesthetic learners or those preferring face-to-face contact (Lum, 2006).

The Texas A&M University (2003) outlines an approach that considers eight main e-learning development components in the planning and development of an online course. These components include syllabus, course structure, course design, navigation, assessment, collaboration, glossary, and references. Cox et al. (2004) explore the design of an e-learning system that supports left and right brain dominance using these development components. Their study demonstrated that left- and right-brain dominant learners have different requirements in e-learning. These are summarised in Table 1.

Cox et al. (2004) identify a number of components within an online learning environment which they categorise as presentation elements that refer to the way the content is displayed (e.g., colour, music,
Learning Styles in Online Environments

Table 1. Critical success factors in online learning for left and right brain dominances

<table>
<thead>
<tr>
<th>Critical success factors identified for the left-brain dominant learners</th>
<th>Critical success factors for the right-brain learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The material needs to be laid out in clear sequential steps.</td>
<td>1. Present an overview of the material first.</td>
</tr>
<tr>
<td>2. Multiple-choice questions rather than open-ended questions.</td>
<td>2. Use open-ended questions.</td>
</tr>
<tr>
<td>3. Enable progress to be tracked throughout the course.</td>
<td>3. Use colour to highlight key points in the text.</td>
</tr>
<tr>
<td>4. Focus on one task at a time.</td>
<td>4. Incorporate opportunities to listen to music.</td>
</tr>
<tr>
<td>5. Ensure each section is mastered before proceeding to the next section.</td>
<td>5. Combine word and picture icons.</td>
</tr>
<tr>
<td>6. Understand all the parts before presenting the whole structure.</td>
<td>6. Present the material in clear stages.</td>
</tr>
<tr>
<td>7. Use bullets or other means to list key ideas.</td>
<td>7. Facilitate access to other online sources of information from other sources.</td>
</tr>
</tbody>
</table>

image) and functional elements that refer to what the user can do (e.g., search engines and quizzes). Botar (2003) first tested the left and right brain dominances of a group of students and asked their preferences for a range of presentation and functional components in e-learning systems. A learning system was then developed with two interfaces, which met the reported preferences for each group. The study identified some key issues to be considered in relation to navigation, assessment, collaboration, and the use of glossaries in online systems.

Navigation

As left-brain respondents prefer to process information in a sequential fashion, material needs to be presented sequentially. A preference to see the structure of the lesson at all times can be supported by displaying the route that has been taken to the current area at the top of each page. Separating different topics into paragraphs or bullet points helps left-brain learners understand the material better because it identifies key issues and the relationship to subordinate topics.

For right-brain learners colour coding the material can achieve the same result. The right brain respondents reported a preference to see a map of the overall material with key points highlighted. The inclusion of a mind map on the first page of the system enabled learners to see the main topics of the material and gain a quick overview of the subject. Hyperlinks can also be used to show the progress of the learner through the material.

Assessment

Left brain learners prefer multiple-choice questions to open-ended ones and enjoy completing a quiz as part of the lesson. A quiz is also a good approach for self-assessment and tracking progress through the course, which respondents considered to be important elements of an e-learning system.

Collaboration

Communication between learner and tutor is necessary to support the learning process. The results showed that one-to-one communication is particularly needed by right brain learners who generally have stronger communication needs and skills than left-brain learners. This supports the work of Holtham and Courtney (2001) in finding that synchronous communication was preferred over asynchronous. Both e-mail and a chat room are needed to facilitate the sharing of information and ideas simulating classroom discussion and to facilitate individual feedback between learner and tutor.

Glossary

Links to other online resources and a search engine were requested by right-brain learners who are holistic in their learning styles and like to combine information from other sources. The results suggest a glossary of terms (or Frequently Asked Questions area) is needed by both types of learners.

Using a range of methods with a group recognises the different preferences within the group (Smith, 2002)
and seeks to create a favourable learning environment for all types of learners (Lum, 2006).

LEARNING STYLE RECOGNITION IN CONTEXT SENSITIVE COMPUTING

A range of paper-based instruments are available to aid identification of learning styles (e.g., Honey & Mumford, 1992) and these can be made available online. However, this approach has a number of disadvantages: it is time consuming, assumes that learning styles do not change, tests learning styles out of context, and has to be repeated with each cohort using the course material.

Technological learner profiling is a promising avenue for enquiry (Evans & Sadler-Smith, 2006) to enable presentation and functional elements of online learning to be adapted to situated learning contexts that are comprised of multiple technological devices. Data mining is the process of exposing hidden patterns in data (Chang & Chen, 2006). This enables student activity to be monitored and analysed automatically to assert their learning preferences based on the learning objects that they have accessed. Based on this data, the presentation of learning objects and activities can be adapted to learning preferences demonstrated by the student. This does not mean continuously matching material with student preferences, but providing a balance of learning activities that match and challenge learning styles. The data mining can continue to identify patterns of engagement over time and adapt the presentation of material accordingly.

CONCLUSION

When designing learning experiences it is necessary to consider characteristics of the learner and respond to a variety of learning styles and preferences (Sadler-Smith & Smith, 2004). Online learning provides greater flexibility to adapt to the individual needs of students, making personalisation of the learning experience a practical possibility. However, issues of material retention and any effects of prolonged use of e-learning systems still require further study. Despite the advances in technology that make personalisation possible, the challenge for lecturers remains to develop a learning environment that encourages, confronts, and adapts to the personal preferences and needs of the individual student.

REFERENCES


**KEY TERMS**

**Asynchronous Communication:** Communication through a technology system (computer and communication network) which permits the sender and the receiver to be separated by time. This results in a delay between sending and responding to the communication. Examples of asynchronous communication systems include e-mail, online forums, and cell phone short message service (SMS) text messaging.

**Blog:** An online personal diary, which is usually hosted by a commercial service which provides a simple user interface to make and amend postings. A development of blogs and ‘blogging’ is the ability for other people to comment upon the postings of the ‘blogger.’

**Cognitive Style:** Characteristics related to personality that present a consistent set of preferences for the manner in which information is organised and processed.

**Context Sensitive Computing:** Access, delivery, and presentation of resources and content using communication technology adapted to situational and personalisation factors. The system tailors the selection of material to be presented to the student to meet the particular needs and preferences of the specific student and the device being used.

**Data Mining:** The process of discovering knowledge in databases by identifying patterns and trends in data collected using classification, association, and clustering rules.

**Learning Approaches:** A preference to approach a learning task in a particular way that is congruent with a person’s learning style.

**Learning Style:** Personal characteristics that relate to how someone prefers to approach a learning task. These are considered to be relatively stable patterns of behaviour.

**Synchronous Communication:** The sender and receiver are using the communication device at the same time, enabling an immediate ‘conversational’ response to be given, as if they were in the same room at the same time. A telephone call is an example of synchronous communication system.
Learning Through Projects: Commonalities Among the Project Method, Project Based Instruction and the Project Approach

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INTRODUCTION

Educating through purpose is the foundation of several methods that use projects to organize instruction. Although these methods are quite similar, there are some important conceptual differences that are currently at risk of being overlooked due to similarities in terminology. The project method, project based learning, and the project approach, are all valid approaches to instructional delivery. It is unfortunate that the confusion created by the terminology appears to be creating isolated discussions. The purpose of this article is to identify some of the similarities and differences among these methods in the hope of encouraging new developments in project-related instruction.

BACKGROUND

Philosophically, the modern project method had its genesis in the American school of pragmatism as espoused by John Dewey, Charles Sanders Peirce, and William James (James, 1899; Peirce, 1878). The concept that results are the defining qualities of the solution in preference to the processes needed to reach those results would free American educational thought to explore innovative instructional methods. Dewey proposed that learning required a purpose and that purpose was the driving force behind action (Dewey, 1896). He encouraged the development of educational systems that allowed students to explore academic subjects through the use of experiments and applied studies (Dewey, 1918). His idea of supporting learning through activity would greatly influence early developments in engineering education and industrial arts education in the United States.

At the turn of the 20th Century, several individuals were experimenting with variations of the project method. Rufus Stimson, working in agricultural education, introduced the home project method in 1908 (Moore, 1988). This system assigned extensive projects such as animal husbandry and agronomy projects for agricultural students and these projects were assessed by agricultural instructors who traveled to review these projects. Projects were often home-based and the project was integrated into the life of the family. William Kirkpatrick would popularize the project method in 1918 in his publication titled “The Project Method” in Teachers College Record and broaden the methods appeal to nonagricultural applications (Kirkpatrick, 1918).

An exhibit showcasing the Russian Method at the 1876 Centennial Exhibition in Philadelphia is widely credited as influencing the development of project centered instruction in the manual arts (Barlow, 1967; Bennett, 1926). Under the direction of Victor Della Vos, this system developed a series of progressive exercises to develop manual skills. Students created small objects that showcased their mastery of each set of skills. As students advanced through the course, the teacher became less involved with instruction so that by the end of the program, the student had assumed significant responsibility for their own learning (Bennett, 1937). John Runkle, president of the Massachusetts Institute of Technology, after viewing this exhibit, became a strong supporter of an applied approach to engineering education and was influential in promoting this type of education in the secondary school system (Runkle, 1876). In turn, Runkle influenced Calvin Woodward who promoted the importance of an applied element in education and reformed the St. Louis school system to put his ideas in to practice (Woodward, 1903, 1906). Students received instruction in various methods and processes using short exercises. The project was assigned at the conclusion of the instruction and allowed students to apply the skills that they had mastered in the project creation or solution. Charles R. Richards altered this method so that work on the project was fully
integrated into the course. The project was assigned at the beginning of the instruction and students worked on short exercises and parts of the project as they proceeded through the course (Knoll, 1997; Richards, 1900).

The concept that projects could be used both as formative and summative experiences developed from these systems. Both forms, Richard’s integrated approach and Woodward’s capstone project, are still in use today. Many features of project instruction began with these two approaches, including the concepts of student-directed work, exhibitions, the use of criteria sheets or rubrics as evaluative tools and cooperative group work.

The project method eventually became the primary method of instruction used in vocational education. It was not as widely accepted in other areas of education possibly due to questions about its usefulness in broad context areas (Waks, 1997) and a concern that it would be less effective at preparing students to meet specific academic goals and college entrance requirements (Tate, 1936; Tyack & Cuban, 1995). In the Soviet Union, the project method had been initially heavily promoted by the state and was championed by Lenin’s wife, Nadezhda Krupskaya (Knoll, 1997). It fell from favor as the political climate changed and did not regain its former popularity (Mchitarjan, 2000).

Ironically, although political tides virtually erased the project method in the Soviet Union, political pressure in the United States would revise it. In the past 20 years, interest in projects has increased due to an emphasis on authentic experiences in education. In contrast to its first incarnation, the project approach is considered an effective instructional method when used in tandem with other methods rather than as a single method to support the curriculum (Kratz & Chard, 1989). In the United States, the project method has been successfully integrated into a variety of areas such as literature (Miall, 1999), technology based learning environments (Page, 2006), and elementary education (Wolk, 1994). As the emphasis on authentic assessment increased, these methods were recommended as assessment methods. (Bickel, 1994; Ediger, 1999). In the field of engineering, capstone projects are commonly used as a summary assessment experience for engineering students and these projects integrate all engineering related subjects into the development of a prototype or feasibility study (Dutson, Todd, Magleby, & Sorensen, 1997).

Initially, Kilpatrick (1918, p. 320) defined the project method by the purpose that drove the activity. In his view any activity that the student committed to with a “whole-hearted purpose” could be considered a project. Projects were to be selected and completed by the student under teacher guidance rather than teacher direction. John Dewey objected to this emphasis on student directed instruction because he believed that the student lacked the maturity and experience to plan effective projects without the direction of the teacher (Knoll, 1997). This is still a concern of many instructors who are uncertain how to develop a student centered learning environment.

This view of the teacher and student relationship as a partnership encouraged the development of specific guidelines for project assignments to clarify the mechanics of the method. Kilpatrick described a project as the embodiment of a plan, a problem solution, the enjoyment of an aesthetic experience, or the obtaining of a skill (Sexton, 1990). This description was considered to be so broad that nearly every type of purposeful activity could be considered a project and this was a commonly recognized fault in Kilpatrick’s conception.

As the concept of student directed learning received serious examination, educators began developing specific criteria for project based instruction. Hosic (1918) outlined the basic elements: provide a problem or situation, develop a purpose to solve the problem with the end result in view, conceive and execute the plan of action, and judge the results. Roark (1925) described the project method as containing five subparts: a problem, the use of material objects, questioning techniques to help the project progress, a requirement for student research, and the final use of the teacher as a resource if the student encounters a difficulty that he is unable to solve independently.

It is noteworthy that at this early date, the project method already had elements of the problem based instructional methods that would develop in the late 20th Century. Project based instruction often has a problem embedded into the project design but it differs from problem based learning in that the end result of the project is known at the beginning of the project. A project based problem results in a specific artifact; a problem based experience may result in a variety of expected solutions. Consider the following examples:
Learning Through Projects

1. Design a gate latch that can be opened by a seeing-eye dog. Develop the drawings needed to manufacture this object.

2. It is difficult for limited vision individuals to open most gates. What are some possible solutions to this problem?

Both of these could be developed into effective projects but the second example is focused on the problem and the possibility of many solutions rather than the application of existing skills to solving a problem. When beginning the first assignment, the student already knows that his or her solution will be contained as a set of mechanical drawings and that the solution will involve the application of his or her design skills. The solution to the second example is more open and could result in a variety of solutions such as a report on community support services, or a proposal to eliminate the gate. The project is transitory; it is less important what the student creates than how the students applied their knowledge or skill to create it. In contrast, the result of a problem-based assignment is the heart of the exercise. Through the solution of the problem, the student gains the expected knowledge and skills; finding possible solutions teaches the content.

Lilian G. Katz (1994) listed four qualities of the project approach. Projects provide the opportunity (1) to apply skill, (2) to develop proficiencies, (3) to awaken intrinsic motivation, and (4) to develop self-assessment skills. In contrast, she describes systemic instruction as helping students learn skills, redress deficiencies, respond to extrinsic motivation, and receive direction from their teacher. Katz believes that both systemic instruction and project work are needed in the curriculum (Katz, 1994). In an extensive examination of both problem and project based learning, Barron et al. (1998) found four principles of project design that help students focus on the knowledge and skill that the project is intended to develop rather than on the activity. These principles were:

- Learning goals clarify the relationship between the project activities and the knowledge that the project is intending to teach.
- Scaffolds must support learning for the instructor as well as the student. Problem based learning and contrasting case studies are effective scaffolds, helping students develop insights about the importance of the project. Scaffolding helps teachers by providing opportunities for formative assessment.
- Multiple opportunities for formative assessment and revision are created by the scaffolds.
- Students take ownership of their efforts and this sense of ownership is reinforced by presenting their efforts to outside groups (Barron et al., 1998).

PROJECT METHODOLOGIES

The Project Method

The project method is arguably one of the oldest instructional methods in existence. The concept that instruction should be organized around a specific purpose was probably in use in apprenticeships programs long before it became part of the formal educational system (Bennett, 1926). After enjoying considerable popularity in the beginning of the last century, the project method fell from favor in most academic disciplines except for career and technical education.

Within the last two decades, interest in this method has revived and variations have developed that reflect the strengths of the earlier work while incorporating new perspectives. From its formal origins during the industrial revolution, the project method and project based instruction has expanded into all educational levels and is widely used in academic and career/technical areas.

The project method centers instruction around the creation of an object or portfolio that requires the application of specific skills developed during the course of instruction. There are two major variations in the project method. In the oldest format, students master the required competencies though the use of exercises and the project is assigned at the end of instruction as a summary exercise. In the second version, the project is embedded throughout the course of the instruction and a portion of the project is completed at each stage of instruction. Although the project method was originally intended to produce actual objects, current definitions include a variety of tasks such as portfolios, research projects, exhibits, performances, and creative writing assignments. All project assignments share the central characteristic of focusing student efforts toward the application of newly developed skills. Many are structured as group experiences.
Project Based Instruction

Project based instruction is closely related to the project method and has many of the same foundational roots as the project method. Both methods were heavily influenced by the work of John Dewey and William Kilpatrick. Project based instruction initially emphasized real world applications; however, some present definitions omit this element (Green, 1998; Simkins, 2001). In both project based instruction and the project method, projects are expected to be long term experiences that require significant intellectual engagement. In a successful project, students develop ownership of a project and the project is guided by the instructor to ensure that the students master the subject area competencies through the experiences. Project based instruction differs from the project method by using a broader definition of project that includes elements such as reports and performances which were not traditionally part of the project method. In contrast to early project assignments, project based learning works to develop higher order thinking skills rather than fact retrieval and provides opportunities for teamwork (Fleming, 2000). A second difference is that project based learning often incorporates computer technology as an integral part of the project and the final project is often a multimedia product (Penuel, Korbak, Yarnall, & Pacpaco, 2001; Simkins, Cole, Tavalin, & Means, 2002). Since the project method developed in an earlier age and was used in laboratory-based subjects, traditional projects were actual objects rather than virtual products or reports.

The Project Approach

Project based instruction was modified by Katz and Chard (1989) who adapted the term “project approach” in order to break with the traditional expectation that the entire content of the course would be structured in a project format. The project approach encourages teachers to integrate classroom learning with authentic experiences such as field trips. Projects provide the structure that channels the interest of the students through inquiries into the subject. It is a spontaneous learning format; students may gather the information that they have learned in a variety of ways, including writing graphs, charting diagrams, murals, and other constructions (Chard, 2000). These connections are then organized using a concept map and the findings are shared with the rest of the group (Kratz, 1994).

Chard (2001) describes this process in stages. In Phase 1, the opening event engages student interest, and the ideas generated by this event are collected in a concept map. The students then collect and list questions that they have about this event. Phase 2 involves preparing for fieldwork, participating in an actual field experience, documenting and discussing the field experience and, if possible, including guest experts to discuss the students’ findings with them. The final phase, Phase 3, allows the students to share their work through the creation of an object, performance, or presentation. The final element is to allow time for a reflective exercise such as a journal or scrapbook.

Effectiveness

All types of project related instruction have long been held to be interesting and motivational activities for learners (Howell & Mordini, 2003; Yun 2000). Grégoire and Laferrière (1998) examined effective project based instruction for group Internet activities. Projects were found effective when topics were related to student interests, when a variety of educational uses for computer technology were incorporated, and when teacher guidance was provided only when needed.

Although project based instruction is gaining in popularity, critics point out several drawbacks to this method. Helle, Tynjala, Olkinuora, and Lonka (2006) noted that some students perceive projects as creating more work than is needed to learn the material. In projects that are technology based there is evidence that skills locating resources require more structure than might be expected. Land and Greene (1999) found in a study of preservice teachers that prior subject knowledge and the ability to assess the efficiency of search patterns were needed skills. Individuals who lack this skill were likely to mold the project to the found resources rather than adopt alternate search strategies. Fleming (2000) notes several additional areas of concern including the degree of student commitment to the task, the ability to cover required content in a student directed activity, student assessment issues, and issues related to project complexity.
Web Resources

Like many traditional instructional methods, project-based learning is developing a technology-based form. Numerous Web resources exist for the educator interested in exploring problem-based instruction. Tutorials are available at several sites including the Global Schoolhouse http://www.globalschoolnet.org/index.html, the Project Approach at http://www.project-approach.com/examples/previous/projects.htm, and an online certificate program at http://www.project-approach.com/certificate/default.htm. Additional resources include an annual student judged project based competition called Cyberfair offered through the Global Schoolhouse http://www.globalschoolnet.org/index.html. The George Lucas Educational Foundation maintains an extensive collection of problem-based resources including a collection of videos that illustrate applications for project based learning at http://www.edutopia.org/foundation/foundation.php#.

FUTURE ISSUES AND CONSIDERATIONS

The use of projects is particularly adaptable to interdisciplinary study. In teaching subjects such as multiculturalism that have multiple levels of understanding, Mendelssohn and Baker (2002) promote the project method as an effective way to scaffold student understanding. They describe multicultural education in terms of factors or levels: individual, domestic, systemic, and global. Related projects or a long term project can be developed that require the student to progress through all or some of these levels. (Mendelsshon & Baker, 2002). An example would be a series of projects that examine how good health habits can benefit the individual, the family unit, and the local community. This structure could be modified for projects that foster academic integrations and multiple levels of abstraction.

The importance of learning as play and recognizing the role of inquiry in both play and project learning is beginning to be recognized (Youngquist & Pataray-Ching, 2004). For young students, inquiry is an important part of play and well-structured project experiences are easily accepted by them. Hong and Trepanier-Street (2004) found that even 6-year-olds quickly adapt to technology when it is included in a project structured around play. Since it is well established that adults also pursue lifelong learning through the use of learning projects (Tough, 1971), the relationship of project learning to lifelong learning seems to be intertwined with the idea of learning for enjoyment.

CONCLUSION

Despite the very real differences between these methods, they are quite similar in purpose and intent. Students are actively involved in directing their education. Projects relate to real-world applications as well as subject area competencies. Problems are not neatly presented but demand intensive study and inquiry. Teachers are advisors and coaches rather than directors of the activity. The most important result is the satisfaction that a student gains from realizing that his success is his own, and he or she has the ability to learn through his own efforts.

Many of these applications blur the traditional distinction between the project method, project approach, and problem-based learning so that in some cases these terms are used interchangeably (Kraft, 2000). As these methods evolve, there is a serious need for the profession to adopt a common lexicon. This is an important issue. Nearly century ago, the project method failed to reach its full potential in part because Dewey, Kilpatrick, Prosser, and other leaders of that era could not agree on the purpose and form of project learning (Gordon, 2002; Knoll, 1997). This lack of definition made it difficult to defend the method to critics and to convince the profession that it was valuable. Except for vocational education, project learning became a passing fad of another century. It would be unfortunate if the full promise of project-enhanced education had to wait yet another generation before becoming widely accepted.

REFERENCES


Learning Through Projects


KEY TERMS

Authentic Assessment: A type of evaluation that closely mirrors the standards and conditions that will be encountered when competencies are applied outside of the formal educational system.

Formative Assessment: Evaluative measures collected during an instructional program that allow for changes to be made in that program prior to the end of instructional program.

Learning Project: Projects that are begun by adults in the pursuit of self improvement.

Project Approach: Instruction that is structured around activities that channels student interest through field experiences and inquiries into the subject. The resulting artifacts are collected into a summary product. The project is supplemental to the traditional curriculum.

Project Based Learning: Instruction based on broadly defined projects that include simulated experiences and scenarios in addition to or in place of laboratory and field experiences.

Project Method: Instruction centered on a project that reinforces previously developed subject area competencies and results in a tangible object. The project may be embedded into the curriculum or assigned as a summary experience.

Systemic: Affecting all parts of a system.


Learning With Laptops

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“There are two ways to break out of poverty. The first is by formal education, and the second is by the worker acquiring a greater skill at his work and thus higher wages.” (Mandela, 1964)

“Children are largely their own teachers, and in a right environment they will teach themselves more than all the schools can teach them.” (Mee, ca. 1953, p.2)

INTRODUCTION

Rogoff (1994) believes that technology can act as a catalyst influencing change from a traditional classroom to an environment of community of learners. One way to successfully integrate technology in schools is to use a constructivist approach. Here the environment provides facilities for students to learn by doing, to work with others, and to have authentic experiences, motivating learning and making it relevant. Technology provides cognitive tools for students as they make sense of the information gathered, allowing experts, teachers, and students to communicate their thoughts and interests in the subject matter and simulating real-life situations and problems. Laptops can hinder or help children. The software has to be well-designed for the purpose of “teaching the child to learn”.

The use of technology can enhance learning for children in developing countries. While desktop computers may be impractical for deployment in countries where many homes may not have electricity, laptops can be used to help children in the developing countries to learn. The reason for using laptops rather than desktops is that laptops are mobile. They can be taken home by children at night, and charged and reloaded at school. Laptops can be used by children to “learn learning”, through independent interaction and exploration. They give children access to a wealth of information which can be garnered by educationalists and teachers from the Web. Studies have shown that bringing laptops home engage the family (OLPC, 2006). There are many reasons why laptops for children are necessary for developing countries. These include:

- Lack of Internet access at home;
- Lack of textbook in schools or home;
- No public or school library;
- Many teachers are uneducated;
- Parents are uneducated; and
- Children are mostly poor.

Children must be encouraged to read as early as possible and to read as much as possible. Books are today’s repository of our accumulated wisdom, and a key to lifelong learning. Encyclopedic Electronic books are tomorrow’s investment for today’s children. Traditional encyclopedias have successfully launched many generations of children as lifelong learners. In the early 1900s, privileged children had to try to read their parent’s copies of Encyclopedia Britannica to find out about the world. Subsequent generations had their own encyclopedias: Arthur Mee’s Children’s Encyclopedia, Compton’s Encyclopedia, World Book Encyclopedia (1980), more recently the World Wide Web with Wikipedia, and now the One Encyclopedia per Child in Simple English.

A hyperlinked encyclopedia would provide a powerful tool for children in developing countries. Children in developing countries, who are keen to learn, can bring their newfound knowledge into the home. It is important that we encourage this attitude and motivation for learning to promote lifelong learners among these children. Lifelong learning skills are a must in today’s world as we are living in a very fast changing society. What has been learned today will be obsolete tomorrow. Today’s employers demand that prospective employees have problem solving, critical thinking, communication, and learning-to-learn skills. Children
must be encouraged and provided with the environment where they can develop these skills. The constructivist believes that learning is a social process where learners learn by construction of knowledge through interaction with their surroundings. We believe that by providing a child with a laptop generally referred to as One Laptop Per Child (OLPC) will enable the lifelong learning skills that each child needs to survive in a fast-changing, competitive world. Our theoretical underpinnings of the OLPC thus include constructivism, lifelong learning, and problem-based learning (PBL). The use of encyclopedias can invoke these techniques to stimulate the reader through doing projects, posing problems, puzzles, or asking questions. The integration of an encyclopedia with the curriculum can usefully be encouraged by employing these techniques.

The purpose of this article is to document the process of quick generation of good content for initially populating the One Laptop Per Child. This article shows the process of generating some best-practice content especially designed to engage the minds of poor children around the world. The product is a small corpus in Simple English, the One Encyclopedia Per Child (OEPC), suitable for ultimate downloading to the One Laptop Per Child. The OLPC can be made into the OEPC. *One Encyclopedia Per Child is arguably the most important content that can be pre-loaded on the One Laptop Per Child.*

The possibility of One Laptop Per Child (OLPC) have already analyzed (Kennedy, 2006a, 2006b; Kennedy & van Olst, 2006; Wikipedia, 2006d) as well as the side effects, the knock-on effects, the communities, the benefits and changes to the communities, the formation of new communities, the changing teaching patterns and rural life, creative teaching, lifelong learning, ad hoc network traffic, and even the implications to higher education. In these works, the authors envisage that fresh HTML, PNG, Audio, and even MPEG clips and associated driving computer programs will be downloaded daily via Wi-Fi from the One Laptop Per Teacher (OLPT).

*Figure 1. One Laptop Per Child*
Learning With Laptops

“Wikipedia is an example of a major source of content for the (OLPC) initiative” realizes the Wikipedia founder (Wales, 2006). “Jimmy Wales, one of the co-founders of Wikipedia, feels that Wikipedia is one of the ‘killer applications’ for this (OLPC)” (Wikipedia, 2006d). However, to fit Wikipedia onto the laptop—maybe 18GB for text only, over 100 GB for graphics too (Wales, 2006)—requires tremendous selection of what is appropriate and wanted by children, so it makes sense to only include that material which children will enjoy or benefit from.

Viewpoint

Figure 1 shows the OLPC from http://wiki.laptop.org. Although the World Wide Web provides vast amounts of information for readers to use, it is not a good place for children to begin reading. Children need guidance and structure. They need material that has been carefully collected, collated, catalogued, with content clarified. Material must be attractively formatted, with grammar and spelling fixed, and definitions included. Concepts must be linked to related ideas to entrap the children in the local Web. A bottom-up approach to content development helps to decide the appropriate entries (headings) and to find suitable articles for inclusion. A top-down approach would categorize all of the suitable and desirable knowledge into a tree of knowledge, Dewey or Library of Congress style. Initially the bottom-up approach is more pragmatic, and a top-down approach can follow. A proof-of-concept prototype has been built and it has shown that the OEPC can just fit on the OLPC.

Limitations of Other Encyclopedias

The content of Arthur Mee’s (ca 1953) Children’s Encyclopedia is out of date, as is his top-down classification of knowledge. Nevertheless, lasting entries in the indices can be identified and used to access modern content, and later augmented with new entries of relevancy to today’s children. In the last volumes of The Children’s Encyclopedia and The World Book Encyclopedia (1980) are indices to the full sets of encyclopedias. These entries contain the key ideas to encourage young minds.

A useful online encyclopedia of unlimited size is Wikipedia. Anyone online with a Web browser has free access to Wikipedia. Wikipedia is a multi-lingual, open content, Web-based, advertisement-free encyclopedia service. It is written collaboratively by volunteers, allowing almost any article to be changed by any reader (Wikipedia, 2006a). Because of its public nature and potentially broad base of contributors, Wikipedia is essentially free of bias (Wikipedia, 2006b). Its editorial policy is to adopt a neutral point of view (NPOV). “All Wikipedia articles must be written from a neutral point of view, representing views fairly and without bias” (Wikipedia, 2006c).

Some essential extract of Wikipedia may provide us with the sought-after content. Before we can use the materials, it is important to know how we should define the extract.

The question this article now addresses is: How is the best-practice content prepared for the OLPC?

Is an answer to distribute a Wikipedia CD for all schools? This means that the poor still need to purchase a CD-ROM reader. By not using CD-ROM and using flash memory instead, it is possible for the encyclopedia to be updated via regular downloads through Internet access at school.

The OLPC Project

The OLPC project seeks to provide a laptop with flash memory for each child, for a relatively low cost. The OLPC has the advantage over CDs that it has the ability to cheaply accept updates. There is an available source for material in the Simple English Wikipedia (Wikipedia, 2006f). This encyclopedia is intended for use by English “learners” and for teachers in English. Spanish, Portuguese, and other languages can certainly be developed in parallel. By using this principle, it is possible to cheaply update material at a school linked to the Web. The OEPC can also be flushed out of the flash memory when the memory is required for other purposes, and reloaded at a school connected to the Web. This article does not address the important issues of integrating the curriculum with the OEPC content. Obviously it is necessary to provide integration guides containing lessons to help children (and teachers!) learn how to navigate and search the OEPC.

Target Children

The OEPC project targets children in developing countries and rural or poor communities. In general, these children will not have dial-up or any other Web
access from home, but may be lucky to have the ability to download from the Web via the One Laptop Per Teacher at school. The OLPC has 1/2 gigabyte of flash memory and may sometimes be networked to the Web at school, from where downloads can be made. Not all of the 1/2 gigabyte of flash memory will be available for “user data”, because the startup program, operating and filing system, and “application programs” such as browser, compression software, and the ad hoc networking software all need part of the memory budget to make a functional computer. For example, the author’s full (Windows) Firefox program folder is 19.2 megabytes.

Contributions Made

Work has started for the OLPC Project on populating the flash and RAM with usable, user-friendly programs and content (the “Knowledge-Base-of-Material-to-be-Explored-and-Soaked-up”). The knowledge base must be educationally sound and in the appropriate language. By merging the entry headings from suitable printed encyclopedias, and omitting obsolete or non-neutral-point-of-view entries, the alphabetical index to the OEPC is quickly created. Then using these entry headings to pull in articles from the Simple English Wikipedia, the OEPC is rapidly built. When no suitable entry exists in the Simple English version, the article is retrieved instead from the Full English Wikipedia, and marked in bold to indicate that it is advanced material. We believe that there are three aspects that are important: top level organization, article titles, and content (Kennedy, 2006b).

Top-Level Organization

Wikipedia regularly gives prominence to “featured articles” (FAs). These are core subject articles which have reached a minimum level of quality (“featured quality”) for publication. Wikipedia has published a list of these pages (Wikipedia, 2006e), which serves as a reminder of the core article subject-areas which must be present in each language in which Wikipedia appears, or else that language’s Wikipedia is deficient.

Missing from this “list of articles”, but present in Mee’s Children’s Encyclopedia are the vital top-level topics “ourselves”, “things to do and make”, “power”, “wonder questions”, “ideas”, “poetry”, “numbers” (pre-algebra arithmetic), and “how to read”. Further deficits are found by inspecting other encyclopedias.

Article Titles

Included in the last volumes of Arthur Mee’s (ca 1953) Children’s Encyclopedia and the World Book Encyclopedia (1980) are indices to the full sets of encyclopedias. These entries contain the key ideas to encourage young minds. The content of Mee’s encyclopedia is badly out of date, as is his classification of knowledge. Nevertheless, lasting entries in the indexes can be identified and used to access modern content, and later augmented with new entries of relevancy to today’s children.

Content

Content can be retrieved from the Wikipedia in Simple English. Wikipedia has published a list of articles that all language editions should have, which forms a useful core of topics. It was found by Kennedy (2006b) that some of the core topic words (e.g., “agriculture”) are not known to the target population, and it is necessary to give an explanation (“farming”).

Kennedy (2006b) has prioritized these core topics by means of the simple expedient of inquiring from a child what his interests are. On the average, most topics tend to be rated as being very interesting. Only 5 of the 163 core topics were rated as being not interesting (algebra, philosophy, publication, sex, and society). Work on these five core topics can be given the lowest priority. It is also necessary to hint on keeping the English simple, the vocabulary basic, and the fonts big as well as having a complementary search engine to search for text.

THE OEPC PROTOTYPE

To test the advocated approach to constructing the OEPC in Simple English, a combined list was culled and collated by Kennedy (2006b) from the first column of entries in The Children’s Encyclopedia and the corresponding three and a third columns of entries in The World Book Encyclopedia (1980). His results follow, and these can be linked into the Simple English Wikipedia.
Table 1 gives a combined list culled and collated from the first column of entries in *The Children’s Encyclopedia* and the corresponding three and a third columns of entries in *The World Book Encyclopedia* (1980). Corresponding entries were sought in the Simple English Wikipedia, and failing that in the English Wikipedia (shown in bold). These bold articles are suitable for the older child. Only one desired entry could not be found in these two encyclopedias (“A-line style”).

An off-the-shelf reader (Firefox) can be used to allow any child to access any reading level in the OEPC. The convention used (bolding) warns the adventurous reader that the advanced material might be tough to read, but the rewards could be great.

### Results from the OEPC Prototype

There is a fundamental conflict in the design of the OLPC. On one hand, costs must be kept down, and therefore the OLPC has a small persistent storage (flash disk). On the other hand, the purpose of the OLPC is for learning, and learning requires the storage of information. What a child really needs to learn with is nothing more than an encyclopedia and a simple way to navigate it, but it is not feasible to store an entire encyclopedia in the available space. Nevertheless, through selective entries and appropriate content, a workable OEPC is possible. The prototype OEPC entries, ranging from A to Aborigines, took up 2.7 megabytes. This is about 1 megabyte when compressed. Since the prototype contains about 1/500th of the desirable entries, all of the desirable entries will take an estimated 500 megabyte when compressed, and will thus just fit without flushing. If other programs are present in the flash memory, then parts of the OEPC will have to be uncompressed or paged in and out as driven by the child’s browsing. If the operating system allows on-the-fly compression, then there will be no need for flushing.

The prototype showed that with few exceptions, material for the desired entries is available at one of the two levels, based entirely on current entries in the Simple English Wikipedia and “en.wiki.org”, here called EW.
Research with the prototype of the OEPC which covered entries from A-AB has also revealed that:

1. The practice of having many internal links in the OLPC is extremely useful in hooking the child’s curiosity and satisfying the craving for more knowledge.
2. Many of the desirable entries can be found in the Simple English Wikipedia (SEW).
3. The SEW also contains many entries which may not be thought of in an approach which simply merges and edits the entries from existing encyclopedias aimed at youth, for example, entries on ABBA, AIDS, AK-47.
4. A willing wiki community already exists which is maintaining the SEW.
5. The SEW community will benefit from a clearly specified target user of the SEW.
6. The simultaneous introduction of desirable articles from the English Wikipedia (EW), and the SEW is possible programmatically.
7. The introduction of articles from the SEW and EW results in a new and large number of internal links. These links are handled by the simple expedient of programmatically deleting them and then rebuilding all internal links from scratch by programmatically looking up the alphabetic index of actual contents.
8. Because of limited transmission distances, the number of OLPCs that can interconnect after school will in many cases be limited by the number of children in a cell island, especially on the periphery of villages.
9. The initial ad hoc routing software development may not initially be sufficiently advanced to allow children each to hold part of the OEPC and share it within the cell island. Thus each OEPC cannot house part of a “distributed textbase” until the distributed networking protocol is working.
10. Alphabetical lists of the entries in the SEW are available in the wiki and can easily be edited for the initial OEPC.
11. The main criticism of the SEW is that it has more stubs inviting contributions from readers than it has real links. These stubs must be programmatically unlinked. This will avoid frustrating the child. A prominent page can be included which advises readers that they can contribute to the next OEPC edition by adding entries at the online SEW.
12. To have a full text search “a la desktop.google.com” over the entire OEPC requires a reader. As there is no guarantee of this critical software component being available on time, the first edition of the OEPC should use Firefox as a browser.
13. The concept of the OEPC coming from two sources (Simple English and English) and providing for two audiences (beginners and advanced) is educationally sound and gives the OEPC appeal to a wider ranges of ages. Spanish, Portuguese, and other languages may not have this luxury.
14. When other subjects are being studied (numeracy, art, music, etc.), the OEPC can be flushed out of the flash memory for that day, and replenished on a later visit to school. In a way, the child can “book out” a full copy of the OEPC as needed. The OLPC becomes an OEPC for the day or the weekend.
15. On-the-fly compression and decompression of material on the flash disk is possible through the operating system.

FUTURE TRENDS

In the future there will indeed be One Encyclopedia Per Child. There will be benefits resulting from other types of courseware, not only for children, but also for adults. As the cost of memory continues its rapid drop, laptops will become universal and ubiquitous for learning and cause a renaissance in learning.

Much research remains to be done on validating the suitability of the vocabulary, language level, and of the appropriateness of the encyclopedia entries. Work needs to be done on editing the encyclopedia articles to ensure that they satisfy the children’s expectations. Educationalists need to augment the encyclopedia articles with educational exercises and examples. Field research must be done to establish the degree of usability and usefulness. Wireless and social networking problems must be sorted out. Longitudinal studies need to be performed to establish the effect of the intervention on uplifting the education of the community and ultimately in reducing poverty.

CONCLUSION

Included in the last volumes of Arthur Mee’s (ca 1953) *Children’s Encyclopedia* and the *World Book*
Learning With Laptops

Encyclopedias (1980) are indices to the full sets of encyclopedias. These entries contain the key ideas to encourage young minds. The content of Mee’s encyclopedia is badly out of date, as is his classification of knowledge. Nevertheless, lasting entries in the indices can be identified and used to access modern content, and later augmented with new entries of relevancy to today’s children.

Wikipedias, including the Simple English Encyclopedia are highly linked. This is fine if the child has continuous access to the World Wide Web, but this cannot be assumed in the poor communities being targeted by the OEPC. Programs are used to de-link those links to other articles that do not appear in the condensed corpus. The articles may be deliberately missing because they are not deemed to be of interest to the target population of children, not yet be written or be omitted for reasons of compression.

One Laptop Per Child is useless without courseware (content and program). After dedicating some of the flash memory to loading Firefox, there was a need to establish whether a didactically correct encyclopedia could be squeezed into the remaining flash memory. This was found to be possible. The OEPC is based on suitable open sources for the encyclopedia articles which were found to exist in two wikipedias: The Simple English Wikipedia and the English Wikipedia. Once a strategy for deciding on which encyclopedia entries to include has been chosen, a specification is outlined for the programmer to follow. Distribution takes place from the Web through the One Laptop Per Teacher to each One Laptop per Child. Version 2 of the OEPC should include ancillary projects, problems, questions, and puzzles to encourage an attitude of lifelong learning.

This article has shown the character of the best-practice content especially to engage the minds of poor children around the world. It has documented the production of a small corpus in Simple English, the One Encyclopedia Per Child (OEPC), suitable for ultimate downloading to the One Laptop Per Child. In the bigger picture, there is hope for children and adults to learn with laptops in all languages. The benefits of adopting this approach have far greater implications than the mere learning of content. By engaging children to take a social construction process to learning, we are also equipping them with the necessary skills of problem solving, critical thinking, and learn-to-learn skills through their active construction of knowledge. Finally we must not forget that there is a fine line between what a child can achieve independently and what a child can achieve when provided with adult assistance.

ACKNOWLEDGMENTS

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Learning With Laptops


KEY TERMS

**Child**: A young person, typically under the age of 13; older than this the person would be classified as a teenager. Various other Web references would have us believe that a child is under 6, 18, or 21.

**Courseware**: A computer programs and associated *courseware material* designed for educational or training purposes. Once the hardware, software, and operating system have been provided, courseware is the missing component to make the computer didactically useful.

**Courseware Material**: Educational content (text, pictures, etc.) and associated programs to deliver that content.

**Encyclopedia**: A reference source of brief, informative, authoritative *articles* on a variety of topics. The *encyclopedia entries* are usually arranged in alphabetical order. Encyclopedias can be general—covering all topics, or specialized— or focusing on a particular discipline such as information technology. Encyclopedias are useful in providing wide-based knowledge to children or background information for adults before they start out on research. The systematic approach adopted assists in the serendipitous or purposeful finding of information. A well-rounded education presumes access to and use of a good encyclopedia.

**Encyclopedia Article**: Academic or popular writing which summarizes and synthesizes available information from a variety of sources. It usually includes a selective bibliography of authoritative articles and books on the topic covered under the *encyclopedia entry*. Each encyclopedia article usually gives a broad overview and background information plus references.

**Encyclopedia Entry**: One item in an alphabetically arranged index which points to an encyclopedia article.

**Flash Memory**: A non-volatile, read-write chip. Its advantages are that it can continue to store data and software after the source of power has been turned off, and is robust as it has no moving parts. It is commonly used as “film” in digital cameras, and it demonstrates the ever-decreasing costs of digital storage.

**Laptop**: A small, portable computer with a flat screen. It is light enough and small enough to be operated on your lap. It can run on batteries for a short period of time. It is conveniently used by businessmen on business trips, teachers, and students in classrooms, and in other situations where traditional personal computers cannot be used.

**Lifelong Learning**: The continuous, (formal and informal) process of independent, personal self-development through acquiring knowledge and skills from diverse sources (and in diverse places), which goes far beyond the formal education of the individual child or adult.

**OEPC**: One Encyclopedia Per Child is an initiative to put useful content into the OLPC.

**OLPC**: One Laptop Per Child project (OLPC) will be deployed in rural, poor, developing countries where education is hampered by the difficult conditions, such as reliable power. It accomplishes this through the use of flash memory. The OLPC is a 24/7 free-standing opportunity for learning.

**Problem-Based Learning**: The main idea behind PBL is for the educationalist to introduce a topic through
the use of projects, problems, puzzles, or questions as a starting point for the children’s learning process. The problem is posed so that the children discover that they need to learn some new knowledge before they can solve the problem. PBL is thus a user-centric and self-directed method of learning which prepares children for lifelong learning.

**Simple English**: Material written with a small, basic vocabulary intended for use by people learning English and for teachers in English.

**Wikipedia**: A free online, multilingual, open content, Web-based, advertisement-free encyclopedia service. The service has succeeded in the aim of creating and distributing a free, online international encyclopedia in as many languages as possible. It is written and updated collaboratively by volunteers, allowing almost any article to be changed by any reader. Because of its public nature and potentially broad base of contributors, Wikipedia is essentially free of bias. Its editorial policy is to adopt a neutral point of view, representing views fairly and without bias (Wikipedia, 2006a, 2006b, 2006c).
Local Area Networks

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INTRODUCTION

Local area networks (LAN) are extremely popular in both the consumer and enterprise markets. The LAN has become ubiquitous throughout both of these markets as the Internet has grown in size and use, PCs have become readily available at an attractive price point, and high-speed broadband connections have become readily available. Yet, with all the usage of LANs for connecting computer equipment of all types, there is no standard, formal industry accepted definition for a local area network (Comer, 2006, 15). According to the Institute of Electrical and Electronics Engineers (IEEE), a local area network is describes as being “distinguished from other types of data networks in that they are optimized for a moderate-sized geographic area, such as a single office building, a warehouse, or a campus” (2001). Some definitions include a distinction concerning physical proximity (Palmer & Sinclair, 2003, 2), while others provide definitions based on topology, physical medium, or performance characteristics. Vendors, governing/standards bodies, and even network managers have yet their own definition of the exact meaning of what a local area network is and means. These definitions tend to use terminology loosely and allow the end user to determine actual meaning based on context and technologies used. The following discussion will give the reader the foundational information of LANs, including LAN addressing (both MAC and IP addressing), architecture, and protocols.

BACKGROUND

Many discussions of local area networks utilize the Open System Interconnection (OSI) Network Reference Model (Figure 1) to ensure accurate communications between all the parties involved. Discussions of network operations can center on a specific layer, or layers, of the OSI model while providing a common context for all parties involved.

The main benefit of the OSI model is that it provides data communications technology and standards developers a mechanism to discuss the interconnection of two networks or network nodes using a common set of terms and terminology (Goldman & Rawles, 2004, 25). The OSI model describes a layered approach to the necessary functionality required for network communications. Each layer of the OSI model is able to directly communicate with its adjacent layers, with the information passed between each layer being necessary for the successful transmission of data between the source and destination hosts. For example, in a LAN, data is passed down from an application to the Application Layer via the appropriate API. The Application Layer then passes the information to the Presentation Layer through a defined service access point (SAP) after any layer-specific processing has occurred. Each
Local Area Networks

Figure 2. OSI model vs. TCP/IP model

<table>
<thead>
<tr>
<th>OSI Model</th>
<th>TCP/IP Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Layer</td>
<td>Application Layer</td>
</tr>
<tr>
<td>Presentation Layer</td>
<td></td>
</tr>
<tr>
<td>Session Layer</td>
<td>Transport Layer</td>
</tr>
<tr>
<td>Transport Layer</td>
<td>Internetwork Layer</td>
</tr>
<tr>
<td>Network Layer</td>
<td>Network Access Layer</td>
</tr>
<tr>
<td>Data Link Layer</td>
<td></td>
</tr>
<tr>
<td>Physical Layer</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. LAN communication layers of the OSI model

LAN Communications Layers

layer has a set of defined SAPs for direct communication with directly adjacent layers. Data for network communication can only be passed between adjacent layers via these defined SAPs.

It should be mentioned that the OSI Network Reference Model is only one of many models that can be utilized to discuss network operations from a layered perspective. It is an extremely popular model, but it is not the only useful model for these discussions. Another highly popular model is the TCP/IP Network Model. Instead of the seven layered approach used by the OSI model, the TCP/IP model uses a four layer approach. A comparison between these two popular network reference models is shown in Figure 2 below.

Strictly speaking, only the physical and data link layers are required for communications between nodes on the LAN. These are the LAN communication layers of the OSI model, as shown in Figure 3 below. The data link layer provides unique addressing for every network node and the physical layer provides the mechanism to construct, maintain, and tear down the necessary communications channel (Goldman & Rawles, 2000, 38). The unique data link layer address is typically tied directly to the physical network interface card on that node. Therefore, the data link layer address is also called the physical address of the node.

In practice, nearly all applications require utilization of the network layer in order to provide network communications, regardless of the locale of the destination node on either a local network segment or remote network segment (Sportack, 1999, 12). In this instance, each network-enabled application requires the knowledge of the network layer address of a specific node, such as a server. The application then relies on the functionality of the LAN protocols to provide the necessary translation from network layer to data link layer addressing, and vice versa. The following discussion will further describe LAN addressing and the correlation between data link layer and network layer addresses.

LOCAL AREA NETWORK ARCHITECTURES

In order to provide node to node communications on a LAN, each node must be uniquely addressed. Without unique addressing for each node, it would be impossible to provide reliable, efficient communications between any two network nodes.

LAN Addressing: MAC and IP. This unique addressing begins at the data link layer of the OSI model, as the physical layer rarely is given a unique address (Comer, 21). By and large, the most popular data link layer addressing scheme is media access control (MAC) layer addressing. A MAC address is tied directly to a specific network interface card, making in the hardware address. This hardware address is used to uniquely identify that specific NIC to every other network connected device. MAC addresses are intended to be globally unique through the use of vendor codes, product line
codes, and unit codes. The vendor code and product code may be the same for many devices within the same specific product line, but the unit code will exclusively identify every physical hardware interface from all others. In this way, no two manufacturers can use the same address for a MAC address, and each device is globally unique. Additional data link layer addressing architectures exist, but utilization of MAC addressing is by far the most popular for LANs.

The most popular network layer addressing architecture is the Internet protocol (IP) (Murphy & Malone, 2005, 17). As previously mentioned IP is part of the TCP/IP suite and is used for addressing in LANs as well as the Internet. The current version of IP—IP Version 4—uses a 32-bit address space that is able to individually address network devices. Just as the data link layer addressing needs to be unique, so too does the network layer address. IP handles this requirement by allocating a portion of the 32-bit address to identifying the specific network & any necessary subnetwork, and the remaining bits identify the specific network host. The details of how this functions are beyond the scope of this paper, but suffice it to say that they have been reasonably effective for the better part of 15 years.

In 1998, the Internet Engineering Task Force determined a new version of IP was necessary. This was due to the proliferation of IPv4 addresses. IPv4 was designed for use on a much smaller internetwork than what the Internet had become at that time (Sportack, 151). IPv4 was inadequate due to its address size limitations, limited hierarchy, and sloppy allocation. Internet protocol version 6 (IPv6) was the subsequent version drafted by the IETF to resolve these shortcomings. IPv6 utilizes a 128-bit address space, providing $2^{128}$ potential uniquely addressed hosts. Also, IPv6 includes many improvements over IPv4 in the areas of security, functionality, and quality of service (Murphy & Malone, 58). Additional information on IP addressing and subnetworking can be found on the Internet using search terms such as “IP primer” or “IP tutorial”. Additional network layer addressing architectures exist and may still be in use. However, IP is by far the most popular and has the largest installation base.

In order for successful communication between the data link and network layers to occur, there must be a singular mapping between the addresses of each level for every host. That way, a data link layer address can be directly, and singularly, mapped to a specific network layer address. In a TCP/IP environment this is handled through the address resolution protocol (ARP). ARP operates using a request/response mechanism where a network device broadcasts a request for the data link layer (MAC) address of a specific network layer (IP) address. Any device on the LAN that has that IP address will then respond to that request, which provides the requesting network node the necessary mapping between the two layers (Wright, 1998, 22).

**Media Access and Broadcast Domains.** “A collision domain is a collection of devices that share media directly,” meaning only one device may send traffic onto the network at a time. A collision domain is also referred to as a media access domain. Historically, LANs have been shared media networks, meaning each network device gains access to the network through the use of shared communications media. Using this approach, only one host is able to transmit data traffic onto the network at any given time. So then, each network host is required to check the network medium to check if any other host was utilizing the network prior to any communications being initiated on the medium. More precisely, devices on the same media access domain (collision domain) must check the network medium prior to transmission in order to avoid packet collisions (Spurgeon, 2000). This network access mechanism is managed by carrier sense multiple access/collision detection (CSMA/CD). This provides an access methodology that allows multiple network clients to utilize the finite resources of the network in an ordered and structured way (Dean, 2003, 477). This “listen before talk” approach has been successful in the LAN environment. This can be likened to a telephone party line. Multiple parties are able to use the party line, as long as they aren’t all attempting to speak simultaneously. When these collision events occur, some agreement must be reached on how to deal with multiple parties wishing to speak at once. In this analogy, the party line is the equivalent of the network shared media domain, and the agreement to overcome multiple speakers is the CSMA/CD methodology (Barnes & Sakandar, 2005, 11).

“A broadcast domain is the collection of devices that will hear a broadcast message sent at the data link layer.” (Goldman & Rawles, 2004, 118) Simply stated, every device with a broadcast domain will receive any broadcast message sent by any other device within that same domain. In a hub/concentrator/repeater environment, all devices belong to the same broadcast and media access/collision domain. However, there is not
necessarily only a one to one correlation between broadcast and collision domains. One broadcast domain can contain multiple collision domains by dividing the LAN through a process called segmentation. Segmentation can be performed through the use of several different types of hardware (Olifer & Olifer, 2005, 93).

**LAN Segmentation.** The first LAN interconnect device that can be used to segment domains is a LAN bridge. This device operates at the physical and data link layers of the OSI model. Minimally, a bridge has two interfaces, or physical ports, used to pass network traffic. A bridge constructs a table of data link layer addresses for every device it is able to directly communicate, called a bridging table. Each port on the bridge monitors the traffic passed on the LAN, and then modifies its table when a new data link layer address is learned from this traffic. When a bridge receives a packet, it examines the destination MAC address. If the destination MAC address is present in the bridging table on the same port that the packet was received, then the bridge needs not forward traffic. However, if the destination MAC address is not in the bridging table for the interface on which it was received, the LAN bridge will forward the packet to the interface(s) that did not receive the original packet. In this way, a LAN bridge will segment the LAN by creating two distinct collision/media access domains while maintaining the original broadcast domain (Olifer & Olifer, 518).

The second LAN interconnect device that can be used to segment domains is a LAN switch. This device also operates at the physical and data link layers of the OSI model, which makes a switch similar to a bridge. In fact, a LAN switch is fundamentally a multi-port bridge. Instead of a bridging table, though, a switch maintains a port-based MAC address table. This table contains the MAC address of every device that has passed network traffic through the switch. This allows the switch to pass network traffic directly to the specific port that a destination MAC address is known to exist at. Like a LAN bridge, a switch will broadcast a packet for an unknown destination MAC address on every physical port of the device, with the exception of the originating port. So, just as a bridge, a LAN switch will segment the LAN into multiple media access domains (as many media access domains as physical ports) while maintaining one broadcast domain (Sportack, 88).

The third and final physical LAN interconnect device is a router. A router functions in an entirely different way than both a LAN bridge and switch. Whereas a bridge and switch processed network traffic based on the destination data link layer address, a router processes traffic based on the network layer address. Because of this, a router operates at the network layer and higher in the OSI model. A router utilizes a routing table to make its determinations on network traffic processing. Unlike the bridging table and MAC address table that were populated with individual destination nodes, a routing table is populated with addresses to entire network segments. A router will only pass traffic to another physical interface if the received packet has a destination data link layer address of the router’s LAN interface and a destination network layer address outside the scope of the local LAN. So then, a router will segment the LAN at both the media access domain and the broadcast domain. A router is able to perform many more functions that described here, but these functions are beyond the scope of this discussion.

One further point for discussion concerning LAN segmentation is the concept of microsegmentation. Microsegmentation is the process of segmenting every node on the LAN into its own media access domain. This is accomplished by connecting each LAN node directly to its own dedicated switch port. This creates an environment where each node no longer needs to contend for media access, which improves overall network performance by eliminating collisions between nodes and reducing the contention backoff times because no other traffic on the media is present except that which is either destined for that node or traffic that the node is originating.

Each of these previously mentioned approaches seeks to segment the LAN via physical means. However, it should be mentioned that there are other ways to segment a LAN. The best approach to logically segment a LAN is through the use of virtual local area networks (VLANs) (Barnes & Sakandar, 84). So then, a VLAN is “a group of network nodes whose traffic, including broadcasts, is isolated from other network nodes” in a logical way (Olifer & Olifer, 563). The IEEE standardized an open VLAN protocol in their 802.1Q–Virtual Bridged Local Area Networks revision approved which was ratified in 1998.

**Physical Architecture.** LAN nodes must be physically connected to each other according to some configuration and are linked by the shared media of the network. The actual physical layout of this configuration can have a significant impact on the LANs performance and reliability characteristics. This configuration of the
Local Area Networks

A bus topology is a linear layout of network nodes with terminators on both ends of the layout, with network nodes and other devices connected to the bus with connectors and/or transceivers. The purpose of the terminator is to end the endpoints of the bus, completing the electrical circuit in order to allow the data signals to flow (Dean, 466). In a ring topology, each host is connected to the continuous loop medium and is an active component of the ring by passing network traffic around the ring to its neighboring node. Each host examines every packet that passes its interface. Those packets that are destined for that node are accepted and passed up the node’s network protocol stack. Those packets that are not destined for that node are sent to the next node on the ring (Palmer & Sinclair, 62).

Although bus and ring physical topologies were common in the past, all modern LAN designs now use a star topology. In a star topology, a central device is used to interconnect all network nodes. Depending on the sophistication and processing capabilities of the device along with the underlying network architecture, the device could be a hub, a concentrator, a MAU (multiple access unit), a repeater, or a LAN switch. However, in today’s networks, nearly all LANs will use a switch as the central device of this topology (Goldman & Rawles, 2004, 156).

Since all network data in a star topology pass through one central location, it is an ideal location to add system management capabilities, such as monitoring, filtering, and security. However, the other side of the coin is that since all network data pass through one central location, it creates a situation known as a single point of failure. That is, if the single central device fails, the entire network will fail as well. However, any single network node can be lost and the network will continue to function properly (Goldman & Rawles, 2000, 48). Fortunately, vendors offer multiple reliability options such as redundant power supplies, dual buses, and “hot swappable” interface cards.

LOCAL AREA NETWORK STANDARDS

Multiple LAN data link and physical layer specifications have been defined. Historically, LANs have been implemented using a variety of these specifications, including Fiber Distributed Data Interface, Copper Distributed Data Interface, Token Ring, Ethernet, and Asynchronous Transfer Mode (Stallings, 2000, 212). However, the Ethernet family of LAN standards has become the clear leader with nearly 100% market share (Barnes & Sakandar, 32).

The Ethernet Family. The first Ethernet standard was developed through collaboration between DEC, Intel, and Xerox Corporation in 1981, after initial work at Xerox PARC in the mid 1970’s. The resulting standard was known as DIX 1.0, which is sometimes referred to as Ethernet I. This standard was superseded in 1982 by DIX 2.0, the current Ethernet standard, also known as Ethernet II (Spurgeon).

Ethernet Speeds. Although traditional Ethernet operates at 10 Mbps, the current base speed of traditional Ethernet is 1000 Mbps (1 Gbps), known as gigabit Ethernet. An interim step between Ethernet and gigabit Ethernet was Fast Ethernet, which represents a family of standards offering 100 Mbps performance while still adhering to the original CSMA/CD access methodology. The details of the operation of fast Ethernet are specified in the IEEE 802.3u standard. Most of the Ethernet family standards are implemented using category 5 or greater twisted pair cable. Many of the newer, higher speed Ethernets operate over a fiber optic cable to provide the necessary speeds. The fiber optic physical media typically provides greater distances for transmission, making it attractive for extending the LAN.

IEEE 802.3. In 1985, the IEEE ratified a standard Ethernet document known as IEEE 802.3 - Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications. Its frame layout is very similar to the Ethernet II frame layout, as Ethernet II was already widely implemented at that time. Fast Ethernet (802.3u) uses the same frame layout as its predecessors in order to allow backwards compatibility as well as dual-speed or tri-speed devices to communicate (Spurgeon).

Ethernet Nomenclature. Often Ethernet is referred to using an XbaseY format. Using this format, the X refers to the speed of the network in Mbps, the base refers to baseband transmission, which means the entire bandwidth of the media is devoted to one data channel, and the Y refers to the type of media being used. When coaxial cable was used in the past, the Y could also refer to the maximum transmission distance in hundreds of meters. For example, the Ethernet standard known as 10baseT runs at 10Mbps over twisted pair cable while
10base2 refers to 10Mbps over coaxial cable up to 200 meters. Faster Ethernet standards include 100baseT and 1000baseSX (Goldman & Rawles, 2004, 128).

FUTURE LOCAL AREA NETWORK CONSIDERATIONS

As mentioned, Ethernet has increased in speed beyond the wildest dreams of its creators. Originally designed to operate at 10 Mbps, Ethernet has since evolved to speeds of over 10 Gbps. Although these faster versions of Ethernet have little in common with traditional Ethernet in many areas, they maintain the standard Ethernet frame. This common frame structure enables a network engineer to use high-speed solutions in the core of the network while using slower, less expensive solutions for workstation connectivity.

Gigabit Ethernet. Ethernet continued to increase in speed. In 1998 the IEEE released another ten fold increase in Ethernet speed: Gigabit Ethernet. Gigabit Ethernet, also known as 1000BaseX, is an upgrade to fast Ethernet that was standardized by the IEEE in IEEE 802.3z (Olifer & Olifer, 448). The standard defined the following configurations using either twisted pair or fiber optic cable: 1000BaseSX: uses short wavelength (850 nanometers) laser multimode fiber optic media, primarily used for horizontal building cabling on a given floor.

- 1000BaseLX: uses long wavelength (1,300 nanometers) laser single mode fiber optic media, primarily for high-speed campus backbone applications.
- 1000BaseCX: uses copper twinaxial cable and transceivers for distances of only 25 meters. The subsequent release of 1000BaseTX has effectively eliminated the need for 1000BaseCX.
- 1000BaseTX: uses four pair of category 5 unshielded twisted pair with a maximum distance of 100 meters.

Specifics of the gigabit Ethernet standard are shown in Table 1.

Initially, most gigabit Ethernet switches and network interface cards only supported either the 1000BaseSX or 1000BaseLX fiber-optic-based standards. With the introduction of the 1000BaseTX standard in mid-1999, vendors have rapidly added support for the copper-based standard. Currently, most new PCs are available with a Gigabit Ethernet NIC included. It should be noted, from an infrastructure perspective, appropriately sized switches should have backplane capacity in the tens of gigabits per second, and tens of millions of packets per second to adequately support Gigabit Ethernet nodes.

Although the 1000BaseTX standard supports category 5 UTP, in order to achieve gigabit data rates into the limited bandwidth, the physical cable installation must adhere exactly to the standard. Unlike the 10BaseT and fast Ethernet standards that utilize only two pair in the category 5 cable, 1000BaseTX requires all four pairs for operation. Any business that chose to “split pairs” on their existing wired infrastructure in order to carry two Ethernets, or Ethernet and a telephone line on one cable (Comer, 16), must rewire their cable plants in order to support gigabit Ethernet speeds. A category 5 infrastructure that exhibits excellent performance under the fast Ethernet standard might not work at all with gigabit Ethernet as the requirements for operation are more stringent. Although most organizations will implement gigabit Ethernet in a switch-based configuration, the CSMA/CD MAC protocol still exists in the gigabit Ethernet standard for backward compatibility with 10BaseT and fast Ethernet implementations. As mentioned, the Ethernet frame size and format has not

<table>
<thead>
<tr>
<th>Standard</th>
<th>Media</th>
<th>Fiber Core Diameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000BaseTX</td>
<td>4 Pair category 5 UTP (unshielded twisted pair)</td>
<td>N/A</td>
<td>100 m</td>
</tr>
<tr>
<td>1000BaseSX</td>
<td>Multimode fiber</td>
<td>62.5 microns</td>
<td>2 m to 220 m</td>
</tr>
<tr>
<td>1000BaseSX</td>
<td>Multimode fiber</td>
<td>50.0 microns</td>
<td>2 m to 550 m</td>
</tr>
<tr>
<td>1000BaseLX</td>
<td>Multimode fiber</td>
<td>62.5 microns</td>
<td>2 m to 550 m</td>
</tr>
<tr>
<td>1000BaseLX</td>
<td>Single-mode fiber</td>
<td>9 microns</td>
<td>2 m to 5 km</td>
</tr>
</tbody>
</table>
changed, making gigabit Ethernet compatible with the previous Ethernet standards (Comer, 18).

Gigabit Ethernet offers two benefits over the previous Ethernet standards. This first is realized regardless of transmission medium: speed. The second, however, is only truly available when using single-mode fiber optic cable: greatly increased transmission distance. These two benefits can be directly mapped to popular uses for gigabit Ethernet (Goldman & Rawles, 2004, 132).

Single-mode fiber that can be used for LAN interconnections up to 5 km makes gigabit Ethernet an ideal option for large campus networks or metropolitan area networks (MAN). As streaming media technologies such as VoIP continue to evolve, the use of gigabit Ethernet in campus networks and MANs will increase to include converged data and voice networks.

The increase throughput of gigabit Ethernet creates additional capacity for bandwidth constrained servers and building backbones. Simply adding a gigabit Ethernet switch and NICs, most server bandwidth constraints can be alleviated. For most applications, both the LAN backbone and all the server connections to the network must be gigabit Ethernet to realistically solve bandwidth limitations.

10 Gigabit Ethernet. The next speed step in the Ethernet hierarchy is to 10 gigabit Ethernet. 10 gigabit Ethernet was approved as the IEEE 802.3ae in June 2002. Just as with the previous improvements in data rates, 10 gigabit Ethernet maintains the same format for backwards compatibility. However, the standard allows for data to be transmitted at 10 Gbps using only a fiber optic physical medium (Tomsu & Schmutzer, 2002, 54). Therefore, any existing category 5 cable installation will not be able to utilize 10 gigabit Ethernet. An item that differs from the previous standards is that CSMA/CD is no longer supported. This means that microsegmentation is required for LAN nodes to utilize this standard. Specifics of the 10 gigabit Ethernet standard are listed in Table 2.

The xW standards are intended to connect to SONET-based switching equipment. This means that they are constrained by the SONET-based OC carrier lines. An OC-192, which 10 gigabit Ethernet uses in these configurations, is limited to a payload capacity of 9.58464 Gbps. So then, 10 gigabit Ethernet is limited to this data rate when used with SONET (Tomsu & Schmutzer, 54).

100 Gigabit Ethernet. The IEEE currently has tasked a working group with the creation of yet another tenfold increase in speeds for Ethernet. This working group (IEEE 802.3 Higher Speed Study Group [HSSG]) is working towards the creation of a 100 Gbps Ethernet that will minimally span 100 meters using multimode fiber optic cable and 10km using singlemode fiber optic cables. The HSSG is currently expected to draft a standard by 2009, with equipment coming to market soon thereafter.

Advanced Network Services. The continuing trend in LANs is to implement advanced services and the underlying technologies to support those services. Voice over IP has become an important, business-driven service that is being implemented in many enterprise LANs. An additional and related service that has become en vogue is IP video. Together, these services have enabled and enhanced communications.

However, these services require strict network performance guarantees that most networks can not provide unaided. Quality of service (QoS) is that aid (Szigeti & Hattingh, 2005, 10-11, 29). The use of QoS on the LAN can also be expanded to the WAN. Many organizations have implemented multi protocol label switching (MPLS) on their WANs in order to classify and prioritize network traffic. The mapping of LAN QoS levels can be extended to the WAN via the use of the MPLS labels in order to allow complete, end-to-end QoS for all network traffic (Wang, 2001, 143)

<table>
<thead>
<tr>
<th>Standard</th>
<th>Media</th>
<th>Fiber Core Diameter</th>
<th>Bandwidth*</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10GBaseSR / SW</td>
<td>Multimode fiber</td>
<td>62.5 and 50.0 microns</td>
<td>10Gb</td>
<td>26 m to 100 m</td>
</tr>
<tr>
<td>10GBaseLR/LW</td>
<td>Single-mode fiber</td>
<td>5 to 8 microns</td>
<td>10Gb</td>
<td>Up to 10 km</td>
</tr>
<tr>
<td>10GBaseER/EW</td>
<td>Single-mode fiber</td>
<td>5 to 8 microns</td>
<td>10Gb</td>
<td>Up to 40 km</td>
</tr>
<tr>
<td>10GBaseLX4</td>
<td>Multimode and single-mode fiber</td>
<td>62.5 or 50.0 microns for MMF; 5 to 8 microns for SM</td>
<td>10Gb</td>
<td>Up to 300 m MMF Up to 10 km SMF</td>
</tr>
</tbody>
</table>

Table 2. 10 gigabit ethernet configurations
CONCLUSION

Local Area Networks have grown in use in both enterprises and homes, making them nearly ubiquitous. The operations of LANs require communications and addressing at both the data link layer and the network layer of the OSI model. These two layers are considered the data access layer in the TCP/IP Network Reference Model. A LAN can be composed of one or more media access domains and typically one broadcast domain. Segmenting the media access domain of the LAN can be accomplished using a LAN bridge, LAN switch, or a router. Each of these devices will most likely have a connection to the LAN via an Ethernet-based interface, which could be coaxial cable, twisted pair, or optical fiber. This interface could have a data rate between 10Mbps and 100Gbps, depending on the standard to which the interface adheres.

In addition to ever-increasing data rates, new services are being implemented into LANs with strict performance requirements. Quality of Service approaches are being used to attempt to provide the guarantees that each of these services require. In many networks, these differing QoS levels are mapped directly to a specific virtual local area network in order to provide logical segmentation of differing traffic types. One can expect to see the proliferation of both applications and network specifications to continue for many years to come.

REFERENCES


KEY TERMS

Collision Domain: See Media Access Domain

Ethernet: A family of LAN specifications that has become the de facto standard for local area networks.

LAN Segmentation: The process of dividing media access/collision domains via physical devices (bridges, switches, routers) and/or logical means (virtual local area networks)

Media Access Domain: The network components that share bandwidth on the local area network and contend for access to the local area network using CSMA.

OSI Network Reference Model: An open framework used for discussions of local area network operations and protocols in logical, layered approach developed by the ISO.

TCP/IP Network Reference Model: An open model used for discussions of networking using the TCP/IP suite of protocols.
Maslow in the Digital Age

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INTRODUCTION

The works of few individuals have impacted such a large variety of fields as the work of Abraham Maslow. His work describing human motivation in terms of needs and the priorities assigned to those needs has been cited by over 4,000 scholarly writers in a wide variety of disciplines including psychology, management, education, and theology. Although Maslow’s work is founded on the most basic of human interactions, the recognition and fulfillment of needs, digital realities are altering human interaction patterns. Social morality and norms are still being defined for a technology that has advanced more rapidly than cultural conventions have evolved. As technology expands the varieties of human experience, how does the Internet support the individual satisfaction of needs as defined by Maslow?

BACKGROUND

Maslow’s humanistic theory forms a third perspective in psychology that offers an alternative to the psychoanalysis of Sigmund Freud and the behaviorism of John Watson. Freud believed that human motivation was primarily directed by a need to reduce tension or strife (Ewen, 1988). Maslow saw individuals progressing into higher states of consciousness as their needs were fulfilled. Unlike Watson, he believed that human motivation was based more on desire than on reaction to physical stimuli. Maslow interpreted human behaviors in a positive and active sense. Individuals actively move toward a goal rather than away from a punishment and are engaged in creating their lives, rather than passively responding to events.

Maslow’s theory of human motivation, first published in July of 1943, described human motivation in terms of basic needs. He divided these needs into physiological needs, safety needs, love and belonging needs, esteem needs, and self-actualization needs (Maslow, 1943).

Although this is popularly perceived as a step-pyramid (Figure 1) where the needs at one level must be satisfied before progression to the next level, Maslow noted that there were exceptions to this hierarchy in which individuals seem to prefer one set of needs over others. He noted seven exceptions: (1) some individuals appear to value self-esteem more than love; (2) creative individuals appear to pursue creative endeavors even when their basic needs are not meet; (3) some individuals who have experienced continual disappointments in life may be satisfied at lower levels; (4)
some people are unable to form relationships due to psychological damage; (5) some needs that have been met for a long period of time become less valued, and because of this undervaluation, a basic need might be sacrificed temporarily in preference to a higher order need; (6) not every individual will actively pursue their wishes; and (7) in some cases individuals will sacrifice everything for a cause becoming martyrs to that ideal (Maslow, 1943).

Maslow (1970) separates his list of needs into two groupings: deficiency needs and growth needs. Most deficiency needs, according to Maslow, are involved in an effort to maintain physiological and/or psychological homeostasis, or balance. He proposes that just as the human body automatically tries to maintain a constant, normal state, so the human organism attempts to maintain a constant emotional state. Children, for example, may cling to their parents during frightening events in an effort to maintain a sense of security while adults may be willing to forego their usual freedoms during a time of social turmoil in an effort to maintain their sense of security. Deficiency needs include the four lower levels of his pyramid: the physiological, the safety, the love/belonging, and the esteem needs. These needs, with the exceptions noted above, are hierarchical: only after a lower level need is met will an individual be aware of the next level need. Once a need is consistently met, it will no longer exist as a need, but, should it emerge again later on, it will once again be the dominant need and motivator of the individual (Maslow, 1970).

Once deficiency needs are satisfied, they are forgotten. This is not so with the growth needs that emerge next. Growth needs, even as they are filled, remain the motivating forces in the life of the individual. Once the deficiency needs are filled, the individual feels the need for self-actualization. What this is differs from person to person, as, according to Maslow, each person “must be true to his own nature” and to “become actualized in what he is potentially” (Maslow, 1970, p. 46). Whatever the individual’s goals, this growth stage includes cognitive needs, the needs to learn and understand, and a craving for truth, justice, and beauty (Maslow, 1970).

**Criticisms**

Maslow’s work has been criticized for being optimistic about the basic nature of humanity and the need for individuals to move toward improvement. As described by Kohn (1999), Maslow’s perspective appears to be based on a belief in good as part of his definition of the fully realized individual. In Maslow’s perspective, good and moral choices are defined as healthy behaviors, a position that equates morality with mental health (Kohn, 1999).

**VIRTUAL EXPERIENCE VS. REALITY**

With the emergence of the Internet, individuals are given an entirely new stage on which to live their lives. This new environment is very different from that of the world observed by Maslow as he developed his hierarchy of needs. Virtual environments allow individuals to explore facets of their personality that they would be hesitant to reveal in less anonymous circumstances.

**Physiological Needs**

The lowest levels of Maslow’s needs are the physiological needs. These include the basic life needs such as air, food, drink, shelter, warmth, sex, and sleep. Maslow (1943) points out that it would be impossible to list all the basic physiological needs, but he states that they take precedent over all other needs. If these basic physiological needs are not met, all the other needs are not important, or may never even be experienced by the individual.

Most of the physiological needs are biological needs that cannot be directly supported in the virtual world. The notable exceptions to this are sexual needs. Internet pornography is one of the largest industries on the Internet generating billions of dollars in revenue (Perdue, 2002). Sexual materials are available in a wide variety of formats ranging from photography to interactive formats in which two or more participants share sexually explicit messages resulting in a virtual intimate sexual experience (Biever, 2006; Coopersmith, 2006). The effects of these experiences often create negative effects creating marital conflict and distorted perceptions about marriage (Manning, 2006). Many spouses view participation in pornography and sexual chat rooms as a form of infidelity (Featherstone, 2005; Hertlein & Piercy 2006).

Maslow believed that most individuals would work toward fulfillment by progressing toward good or moral choices. At the crossroads of the Internet and reality,
the process of meeting basic needs is often gritty and less noble. Workers in the cybersex industry are often drawn to the industry in an attempt to meet basic survival needs due to extreme poverty (Baldwin, 2004; Hughes, n.d.). Participation in the cybersex industry is extensive in poorer areas of the world with some countries developing a sexual tourist industry that ties into interests generated by the online sex trade. According to Brennan (2004), participation in the sexual tourist trade alters the role of men and women in marriage with men preferring not to work while expecting their wives to produce ever larger incomes.

Although the legal issues regarding conflicts between free speech rights and the rights of communities to restrict access to adult materials is still under review, some Internet portals have chosen to restrict access to these types of sites. In the United States, four major legislative acts have passed that would restrict access to Internet pornography but none of these acts has been fully supported by the courts due to concerns about freedom of speech (Krause, 2002). In the case of Internet sex, the conflicting needs of individuals is redefining what constitutes sexual relations and the needs of society for safety and security create a conflict with individual needs.

This conflict leads to concerns about security and safety which are part of Maslow’s second level of needs in his hierarchy.

**Safety Needs and Anonymity**

Maslow’s safety needs include security, stability, dependency, protection, freedom from fear, freedom from anxiety and chaos, need for structure, order, law, limit, and strength in the protector (Maslow, 1943). The Internet provides a social forum unlike any other in that it allows Internet users to interact in world wide community while remaining physically inaccessible. For many users this appears to be a safe method of interacting with strangers. Anonymity in a virtual world appears to be both empowering and liberating. It is known that individuals are more likely to act more intensely in an online environment than they normally would in reality. The reason for this behavior is unknown (Suler, 2004). Many persons appear to think of the Internet as one step removed from reality. They are willing to engage in activities and share information online that they would rarely or never share with others unless they had an intimate relationship with that individual. Topics generally considered socially taboo are discussed more freely on the Internet. In a study examining teenage sexual disclosure on the Internet, anonymity was found to be an important factor in willingness to participate in the discussion and in the type of information disclosed. Males were more likely to reveal personal information than females, possibly due to the fact that more females considered the Internet to be an unsafe environment (Wen-Bin, 2006).

This tendency to share personal information more readily with strangers in an online environment is especially dangerous for children and adolescents. Dombrowski, LeMasney, Ahia, and Dickson (2004) report that sexual predators find the Internet particularly effective for grooming potential victims by gaining their trust through the use of information gathered from personal Web sites. Although commercial products are being produced that monitor potentially unsafe Internet practices by adolescents (Babbitt, 2006), it is essential that parents and counselors educate adolescents to the potential danger of sharing personal information through sites such as Facebook and Live Journal. In the case of Internet communities, freedom from fear and easy interconnectedness of the virtual community may work against some participants by providing a false sense of security.

Although participation in virtual communities can create a false sense of security for some users, for others ready access to information provided by the Internet can be comforting. Internet use has been found to be effective method of coping with fear serving as an important source of information for cancer patients and is changing the way these individuals interact with their caregivers (Dickerson, Boehmke, Ogle & Brown, 2006). In an examination of the effectiveness of an online breast cancer support group, having quality information about the condition and the interaction through the discussion board improved patient satisfaction with their doctor (Shaw, Han, Hawkins, Stewart, McTavish, & Gustafson 2007). Physicians are often uncomfortable working with palliative patients and are uncertain how to deal with their requests for information since not everyone wants the same type or degree of information (Kaplowitz, Campo, & Chiu, 2002). The availability of accurate health information on the Internet can reduce the patient’s fear of the condition and provide an opening for discussion about these concerns with the physician.
Belonging, Love, and Virtual Communities

Maslow’s third needs level is that of belonging and love. There is a large portion of Internet users who employ the Internet to fulfill the need to belong by maintaining contact with the people they already know. Pew (2006) reports that 91% of Internet users send or receive e-mail, 39% send instant messages, and 27% share files from their computers with others. There is another segment of people who use the Internet to establish friendships that may be very brief or that may last for long periods of time. According to the Pew Reports (2006), 22% of Internet users chat in chat rooms or engage in online discussions and 39% read someone else’s online journal, Web log or blog, or use online social networking sites such as MySpace, Facebook, or Friendster (Pew, 2006).

Beyond virtual relationships, the Internet is a popular tool for developing romantic relationships. In August of 2003, 40 million Americans visited at least one online dating site (Cooper, 2004). Online dating is one of the most profitable businesses on the Internet; during the first half of 2003, Americans spent over $214 million on dating and personals sites such as match.com and eharmony.com (Cooper, 2004). Merle and Richardson (2000) have found that Internet dating differs from face-to-face relationships in several ways. Unlike face-to-face relationships, Internet romances begin without the element of physical attractiveness. Relationships develop based on common interests and only later result in a physical meeting after the couple has gotten to know each other online. Often these couples have shared more intimate details much more quickly than they would have in a traditional relationship. Just as the anonymity of the Internet has enabled some couples to openly share details of their lives, it has also enabled others to recreate their identities and these new self-concepts have a positive effect on their self-image and self-esteem (Yurchisin, Watchravesringkan, & Brown, 2005).

Self-Esteem

Maslow’s final deficiency needs are those involving esteem. Esteem needs are described on two levels: the external or lower level needs for attention, recognition, and respect from others; and the internal, or higher level needs for self-respect, confidence, achievement, and mastery (Boeree, 1998). Maslow describes the need for self-respect as a “higher” level need once it is achieved; it is much more difficult to lose than is the respect coming from other people (Boeree, 1998).

One social development that appears to be due to the rapid spread of information on the Internet is an obsession with fame. The Internet allows individuals to become microcelebrities who are recognized for reasons divorced from the importance of their actual achievements (Chaudhry, 2007; Martin, 2006). For the first time in history, any individual can gain world wide recognition by posting their private lives on the Web (Fleur & George, 2005). As the celebrity roles in the Internet have expanded, once obscure bloggers gain real world fame as their Internet presence gains popularity (Stone, 2005). Although Internet fame is fleeting, it is an individual creation and it does provide opportunities for those who crave recognition to a degree that Maslow could not have imagined.

For persons who are unhappy with the person they show to the real world, the virtual world may provide a setting to gain respect and esteem. The basic need to connect to others and to be part of the larger community group has led to the creation of virtual worlds on the Internet allowing individuals to adopt virtual personalities, or avatars, that are completely disassociated from their real lives. These avatars exist only within the virtual world, but they enable the individual to meet and to interact with others within that world on levels that might not be available to the individual in the real world. The disinhibition effect of the virtual world allows the individual to engage in behaviors without being responsible for that behavior (Suler, 2004). Some researchers have speculated that this allows participants in virtual communities to reveal truer aspects of their personalities than would normally be visible in an actual community. An alternate view is that personality is made of various segments or clusters and the use of multiple avatars in these communities allows individuals to explore these fragments of their identity. (Suler, 2002a, 2002b). The true identity of the individual is a mosaic of these various elements, different aspects of which come to the surface differently than they normally would in reality (Suler 2004). The importance placed on these virtual personas suggests that by living through an avatar, a person might fill the esteem needs for recognition and respect from others. It is unknown how much virtual recognition affects feelings of accomplishment and self-respect in the real world.
Maslow in the Digital Age

Self-Actualization

According to Maslow, only about 2% of the world’s population will ever reach the point of self-actualization. Those who do are characterized by the need to learn, to understand, to experience personal growth, to help others, and to experience beauty (Maslow, 1970). Self-actualization, according to Maslow, can come only with age (Maslow, 1943).

The Internet redefines how individuals value their lives by allowing them to create and explore different aspects of spirituality that have not been previously possible. Brasher (2006) describes how cyber-pilgrims are able to explore diverse religious traditions by participating in virtual events such as Cyber-Seder and visiting virtual places such as online monasteries. These types of experiences often preclude real world explorations into spiritual growth. Other types of online sites support spiritual reflection by providing an online version of a real world practice such as online rosaries (http://www.fatima.org/essentials/requests/onlinerosary.asp) and a virtual darsehen of Shree Siddhivinayak (http://www.siddhivinayak.org/home.asp).

The creation of artistic works is another path to self-actualization according to Maslow. Electronic art forms such as video art are created specifically for Internet presentation in virtual galleries such as the Histories of Internet Art: Fictions and Factions Web site http://art.colorado.edu/hiaff/index.php. Hypervideos create narratives that are defined by the user through the use of linked text and video, a form of storytelling that would not have been possible before the existence of hypertext (Sawhney, Balcom, & Smith, 1996).

One of the most popular sites on the Internet, Youtube (http://youtube.com), allows any user to upload and share short videos. The Internet is the most democratic of exhibition halls; anyone who is willing to learn the technology and to purchase the equipment can create and exhibit artistic work. The Internet has freed the artist from the restrictions of real world creation and provides an opportunity for new media to be developed. This may be the most innovative use of the Internet, to use the virtual world to showcase the real world in new ways and through these creative acts allow for individual growth.

FUTURE ISSUES AND CONSIDERATIONS

The digital age offers many opportunities for personal growth but it also offers new challenges. The difficulty of balancing individual needs with the needs of others and society will create conflicts based on the concepts of privacy, ownership, and personal need. As the virtual world expands, the impact of these experiences is likely to significantly affect real world relationships.

CONCLUSION

To meet Maslow in the digital age requires new conceptions of safety, personal relationships, community, and creativity. Although it is not possible for all individual needs as defined by Malsow to be met in the virtual world, the Internet offers new ways to support the fulfillment of these needs. The technology offers opportunities, but human beings are not defined by the technology. For the first time in history, humankind has the technology to support the individual self-actualization of all persons by providing a resource that is both universally available and individually defined. Not one person’s path through the Internet will mirror that of another, the uniqueness of each journey is the ultimate example of a tool for meeting the needs of every individual. The creativity and choices made by each individual will define each journey.

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**Avatar**: A computer generated figure used to represent a live participant in a virtual community. Avatars may be animated, modeled in two dimensions, or text-based objects. The characteristic of avatars often represent individual status, beliefs, or interests within the virtual community.

**Cyberpsychology**: The study of psychology that specializes in studying online personal interactions and experiences that happen to individuals participating in online relationships both as individuals and members of virtual communities.

**Disinhibition**: The freedom to act on impulses or drives unhindered by restraint systems provided by social and culture norms often due to the removal of a factor that would restrain that behavior pattern.

**Self-Actualization**: Self-actualization is the desire and drive of individuals to improve personal abilities to reach the highest level of understanding and achievement possible during their lifetimes. Maslow believed that self actualization allowed individuals to fully become the person they were destined to be and that moments of reaching this state were the most fulfilling moments of an individual’s life.

**Virtual Communities**: Social networks of individual that develop through interactions over the Internet due to a common interest are called virtual communities. The term may refer to communities that are only slightly cohesive such as members of a discussion list or it may refer to a group that has stronger social ties to the community group such a role playing communities.
INTRODUCTION

The use of PCs in the educational sector has changed the learning environment of higher learning institutions and learning styles (the way individuals grasp and process information) of students in general. When coursewares (software that are used by students in their learning) were first introduced, the information was often presented at a pre-determined tutoring level and followed a set of structure. These coursewares provided surface approaches to learning (for example, the information had to be memorized by the learners) and did not take the student’s basic knowledge or learning style into account and therefore lacked the ability to adapt intelligently to meet the student’s specific learning requirements. However, with the advent of new technologies such as artificial intelligence, multimedia, and virtual reality, it is now possible to develop coursewares that could be designed to engage learners in more motivating environments. These coursewares could be implemented by using the principles of computer-aided learning (CAL) (a terminology used for imparting educational experiences electronically).

The aforementioned revolution not only contributed in delivering better educational materials but also helped in engaging the learners in other learning environments such as deep learning (relating previous knowledge to new knowledge), discovery learning (where the learner discovers what the instructor decides he/she is to discover using a process/model prescribed by the instructor), active learning, and other learning environments.

BACKGROUND

In general although newer technologies such as multimedia and virtual reality have influenced (stimulated the learning process of individuals) the way learners learn, however there is growing evidence that these technologies are not being fully utilized (Cairncross & Mannion, 2001; Manjit & Ramesh, 2005). According to Cairncross and Mannion (2001), early designs were driven by technology (i.e., focusing mainly on physical interface) rather than pedagogy. Additionally, Cairncross (2002) reported that it could take 40 hours to develop one hour’s worth of quality interactive multimedia learning. This lengthy development time is extremely expensive because it is difficult and costly to find human experts to develop the interactive multimedia coursewares. As an option with most other teaching media, instructors wanting to use interactive multimedia courseware in their teaching can choose to develop simple unsophisticated materials locally or purchase more sophisticated, and thus more expensive, teaching materials from professional development units (commercial, software house, etc.). Schank (1994) argued that most multimedia programs are not suitable for learning because they merely add video and graphics to page-turning programs. Kinshuk and Patel (2003) added that the collection of multimedia objects, that is, pictures, graphics, sounds, and video, does not guarantee proper learning especially when the complexity of the task, skill, or learning increases. As such multimedia and virtual reality should be used where there is a potential for its use and necessity for such technologies to be employed in the learning environment. Some good examples where these technologies could be employed are physics, medical, and engineering education for teaching concepts that are difficult to learn and visualize from the textbooks. Additionally the coursewares employing such technologies should focus on discovery learning and problem solving techniques of the subject matter. The work reported in this paper described pertinent issues to the development of engineering mechanics dynamics prototype for a discovery-learning environment. For engineering and technology education, multimedia and virtual reality applications can include computer simulation, numerical analysis, computer-aided design (CAD), computer-aided manufacture (CAM), and electronic communications (Palmer, 2000).
DISCOVERY LEARNING

The concept of discovery learning has appeared numerous times throughout history as a part of the educational philosophy. Discovery learning has many definitions and is generally known as an inquiry-based learning method. However the most common method used for discovery learning is experimentation with some extrinsic (what is distinctly outside the thing in question) involvement for example clues, coaching, and a framework to help learners get to a reasonable conclusion. At the other end of the scope is the expository teaching model of discovery learning where the learner “discovers” what the instructor decides he/she is to discover using a process prescribed by the instructor. According to Sumeyra (2005), discovery learning could be used to accomplish three educational purposes by instructors as summarized in the following:

- Instructors want learners to know how to think and find things out for themselves. In other words, they want them to be less dependent on receiving knowledge from instructors and accepting the conclusions of others.
- Users of discovery learning want learners to see for themselves how knowledge is obtained. In other words, instructors want students to be able to learn by collecting, organizing, and analyzing information to reach their own conclusions.
- Instructors want learners to use their highest-order thinking skills (for example, to analyze, produce, and evaluate).

In a discovery learning environment, the role of the instructor may not be assumed as to impart knowledge but rather to create classroom experiences in which learners engage in order to discover knowledge. As the learner engages in the inquiry, the instructor encourages them to think deeply (where the learners draw on their own experience and prior knowledge to discover the truths that are to be learned). Most importantly learners accept the challenge of finding something out for themselves rather than having the instructor give them an answer.

In a discovery-learning environment, students become active learners as they participate to discover things on their own, for example, by encouraging them to ask questions, formulate their hypotheses, and carry out experiments on them. As such the learning is seen as a process of inquiry where learners play an important role, as opposed to a more didactic (tending to convey information in a linear fashion such as the instructor-centred style of teaching).

Discovery learning allows students to ascertain information and ideas on their own. In some ways, it is the most natural way to learn and often the student remembers the lesson learned more easily.

Sumeyra (2005) stated two main goals for discovery learning as listed in the following:

- Development of knowledge about the domain of discovery; and
- Development of skills that facilitate development of knowledge about the domain.

For discovery learning, it is therefore useful to employ modern technologies such as multimedia and virtual reality that could provide a virtual environment for students to explore, manipulate objects, perform experiments, and discover new concepts (for example, in representing actions in engineering such as object movement, links, pistons, and crankshaft in the form of dynamic illustrations (animated forms)). Since they are very important representative means in visualization experiments, the motions and actions of these objects maybe worthwhile to be shown in animated forms. On the other end, simulations are another area where new technologies can support students in discovery learning. For example, students may find it easier to investigate all possible loading conditions of a truss (a structure made from straight links connected at joints) to determine the most severe loading experienced by a truss member. In this situation, students could experiment safely by inputting different values for the load and investigate how such changes in the loading influence the internal reactions of the various truss members.

CASE STUDY

To address the previously mentioned issues, the present study discussed pertinent issues of a multimedia PC-based engineering courseware that has been developed to solve mechanics dynamics problems involving the motion of a projectile. Our past research has led to the implementation of structured two-dimensional (2-D) environment that enhanced visualization coupled with real-time motion by integrating 2-D animations with
multimedia technology. This problem-solving environment has been extended to 2-D virtual worlds where the user could freely explore and learn-by-discovery.

Experience through practice by doing is extremely important in the development of basic and advanced skills, particularly in engineering, where the user needs to practice solving a wide range of problems and handle different equations and theories. A highly interactive virtual environment encourages the user to explore complex relationships and increases the development of advanced skills through self-motivated discovery activities (Manjit, Ramesh, & Selvanathan, 2003).

Coach-Based Virtual Discovery Learning Environments

In general, most multimedia-based learning coursewares do not support learning-by-discovery but instead provide the basic capabilities for learning-by-doing. Adding interactivity by integrating multiple media elements such as audio, video, image, and motion could provide the dynamic assessment, coaching, and feedback capabilities that are essential for discovery learning. A useful learning-by-doing approach for a mechanical engineering problem solving module with a coach-based virtual (an environment that could guide a user by providing a step-by-step approach to solve a task) and discovery-learning environment is presented in Table 1.

Table 1. Learning-by-doing approach with a coach-based virtual and discovery-learning environment

<table>
<thead>
<tr>
<th>Learning-by-Doing Approach</th>
<th>User Activities</th>
<th>Coach-based Virtual and Discovery Learning Environment</th>
</tr>
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| Interaction                | The user interacts and observes meaningful tasks, e.g., the motion of a rider jumping of a platform. | • Animated video files are integrated with audio files and graphics.  
• User is narrated to explain the question during the motion. |
| Steps & Solutions          | A sequence of steps and solutions of the problem is presented to the user. The user moves forward to the next step or back to the previous step or solution. | • Animated page showing steps and solutions are created and integrated with the courseware.  
• The courseware guides the user to manage the sequence of steps the user should perform to solve the problem and control the 2-D animated mechanisms, i.e., play, stop, reset, and pause. |
| Simulations                | The user experiences a problem-solving environment in a virtual manner through the accumulation of his actions and the behavior of the animated mechanisms in a 2-D environment. | • The simulations are integrated with 2-D graphics that are embedded with audio files.  
• The courseware manages the state of the 2-D animated mechanisms and the user’s interactions.  
• The courseware further provides graph for users to view data and interpret in a pictorial form. |
$W = \text{mass, } m \times \text{acceleration due to gravity, } g \text{ which is normally taken as 9.81 m/s}^2$. Furthermore, their conception of motion prompts them to think that if an object is moving upwards, then there must be an upward force lifting the projectile or if an object is moving upwards and rightwards, there must be both an upwards and rightwards force acting on the projectile.

To explain further, let's consider the projectile problem given in Figure 1. The rider leaves the 30° platform with an initial velocity ($V_A$) and in the absence of gravity (i.e., supposing that the “gravity switch could be turned off”) the rider would then travel in a straight-line path in the direction of motion. The rider would continue in motion at a constant speed ($V_A$) in the same direction of motion provided there is no unbalanced force acting on the system. This is the case for an object moving through space in the absence of gravity. However, if now the “gravity switch could be turned on” then upon leaving the platform the rider is treated as a projectile and the rider would be under free-fall. Under this circumstance, gravity pull takes effect and the path of motion of the projectile would no longer be a straight-line motion. In fact, the projectile would travel with a parabolic trajectory as shown in Figure 2. As such, the downward force due to gravity effect, that is, $W$, will act upon the rider to cause a vertical motion having a downward acceleration of $a_y = -9.81 \text{ m/s}^2$ (the negative sign indicates that the motion is downward).

The presence of gravity, however does not affect the horizontal motion of the projectile. The projectile still moves the same horizontal distance in each second of

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**Figure 1. Typical projectile problem in mechanics dynamics tool**

(Description of Figure 1)

**Figure 2. Motion of a projectile**

(Description of Figure 2)
travel as it did when the “gravity switch was turned off.” Since, the force due to gravity ($W$) is a vertical force acting in the $y$-direction, it does not affect the horizontal motion in the $x$-direction. In accordance with mechanics theory, applying the Newton’s second law of motion on the projectile, this indicates that since there is no unbalance force acting on the projectile in the $x$-direction, then the projectile will not experience acceleration in the $x$-direction and the horizontal component of acceleration, that is, $a_x = 0$. As such, the projectile moves with a constant horizontal velocity in the $x$-direction (i.e., $V_x = \text{constant}$) throughout the flight.

In the problem shown in Figure 3, as the rider leaves the 30º platform, he undergoes an upward acceleration. However, as the rider strikes the ground, he undergoes a downward acceleration. A downwardly moving rider that is gaining speed is said to have a downward acceleration. In the animation, the downward acceleration is depicted by a change in the vertical component of velocity. This downward acceleration is attributed to the downward force of gravity that acts upon the rider. If the rider motion can be approximated as projectile motion (that is, if the influence of air resistance can be assumed negligible), then there will be no horizontal acceleration (i.e., $a_x = 0$ as shown in Figure 3). In the absence of horizontal forces, the horizontal component of velocity at any instant will remain constant, i.e., $V_x = (V_{x0})$. This is illustrated graphically in Figure 3 where the horizontal velocity component remains the same size throughout the entire motion of the rider.

Despite the aforementioned facts, many students would insist that there is horizontal force acting upon the rider since it is moving horizontally. However, this is simply not the case. The horizontal motion of the rider is the result of its own inertia. Inertia is the tendency of an object to resist changes in its state of motion. When jumped from the slope, the rider already possessed a horizontal motion, and thus will maintain this state of horizontal motion unless acted upon by a horizontal force. Therefore, the rider will continue in motion with the same horizontal velocity.

In the conventional method, these sorts of problems are usually presented to the student as a combination of schematic diagrams and text descriptions. The user/student must immediately apply learned knowledge in order to form an internal model of what the problem means. In addition, in mechanical engineering, the shapes and lines that make up the schematic diagram have very specific engineering meanings. Furthermore, the words accompanying the diagram normally provide additional hints to the problem in question and the user is expected to understand this before applying the appropriate theories in solving the question (Manjit et al., 2003).

On the contrary, with multimedia technology, such information and theories could be explained clearly through various media, which is not possible via a conventional method of classroom teaching.

The main benefits the user could gain by using this discovery learning method to study the motion of a projectile given in Figure 1 can be summarized as follows:

- The user can see the motion of the projectile at any instant or over a period of time.
• The velocity components (i.e., $V_x$ and $V_y$) at any instant could be analyzed. This is clearly illustrated in Figure 3. For example, when time $t=0$, the rider is at the start point $A$ on the slope of the platform. At this instant the rider is moving with a velocity of $V_A$, measured at an angle of 30º from the $x$-axis. In the analysis, the velocity $V_A$ can be represented by its components, that is, $(V_A)_y$, measured along the $y$-axis and $(V_A)_x$, measured along the $x$-axis. Since the motion of the projectile at $A$ is known, point $A$ is taken as the reference point and the origin of the $x$-$y$ axes is placed at $A$.

• Enhanced visualization and understanding of the problem. As the rider moves in a parabolic trajectory after leaving the platform, the velocity ($V$) of the rider changes with time, and this can be illustrated by the change in the length of the velocity components, that is, $(V)_x$ and $(V)_y$. However, since there is no acceleration in the $x$-direction (i.e., $a_x=0$), the horizontal component of velocity $(V_x)$ will always be the same as the initial $(V_A)_x$. This is shown in the courseware by keeping the length $V_x$ equal to $(V_A)_x$. To explain further on the theory, during the motion the user is narrated to reinforce learning and understanding. When the rider reached the maximum height at point $C$, the user can observe that at this instant, $(V_C)_y = 0$ and thus the velocity of the rider at $C$ will be $V_C = (V_C)_x = (V_A)_x$.

• To reinforce theory of the subject matter. When $t = 1.5$ s, the rider strikes the ground at point $B$. The trace of the path taken by the rider can be visualized in step-by-step fashion as shown in Figure 4. The user can easily see and understand that the rider has taken a parabolic path and, as such, is treated as a projectile motion.

The incorporation of multimedia technology in this courseware could give a better understanding of the underlying projectile theory, that is, projectiles travel with a parabolic trajectory due to the fact that the downward force of gravity accelerates the rider downward from his otherwise straight-line, gravity-free trajectory. This downward force and acceleration results in a downward displacement from the position that the object would be if there were no gravity. The force of gravity does not affect the horizontal component of velocity; a projectile maintains a constant horizontal velocity since there are no horizontal forces acting upon it as clearly illustrated in Figure 3. For a slow learner, the motion of the projectile can be replayed as many times necessary and in any order until the user understands the underlying theory and concepts. As such this method of learning could help promote discovery learning.

CONCLUSIONS

The benefits that multimedia could provide in promoting discovery learning are tremendous. Engineering education is an area that holds great interest and potential for virtual engineering courseware developers particularly for developing discovery-learning coursewares. One reason for this is the ability of experiential learning. The multimedia interactive courseware presented in this case study has achieved its objectives as users are able to discover and describe the position, velocity, and acceleration as two-dimensional vectors, recognize two-dimensional projectile motion as simultaneous one-dimensional motion in two directions, and use
the one-dimensional kinematics equations to solve projectile motion. Furthermore, users learn and retain more from personal experience then they do from books and lectures.

This paper described a 2-D multimedia visualization courseware for studying engineering mechanics dynamics involving motion of a projectile. The study revealed and provided some evidence that multimedia technology is a powerful learning aid that could help learners/users to understand, visualize the concepts of projectile motion better and more importantly to promote discovery learning. The interactivity in the courseware allows users to manage and control the delivery of the material and act as a guide in problem solving. The potential benefits required by virtual discovery-learning environment and approaches of learning-by-doing were identified. Further work is in progress to develop and implement realistic 2-D and 3-D virtual discovery-learning environments where users could learn-by-discovery and gain better understanding of the various theories pertaining to mechanical engineering. Our initial step of incorporating multimedia technology in virtual learning environment has enabled the understanding of the process and challenges involved in developing a virtual discovery-learning environment.

REFERENCES


KEY TERMS

**CAL:** A terminology used for imparting educational experiences electronically.

**Courseware:** Software packages that students use in their learning to supplement or replace traditional course activities.

**Discovery Learning:** An inquiry-based learning method where approaches such as experimentation with some extrinsic (what is distinctly outside the thing in question) involvement, for example, clues, coaching, and a framework to help learners get to a reasonable conclusion.

**Engineering Mechanics Dynamics:** A mechanical engineering course subject that deals with accelerated motion of a body.

**Learning Styles:** The way individuals/learners take in and process information.
Mental Models

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INTRODUCTION

It is widely assumed that mental models are internal representations. Humans are capable of constructing these models when required by demands of an external task or by a self-generated stimulus. “Mind’s eye” can see, run, and interact with these mental models. Rather than stored in strictly fixed form in the mind, mental models are constructed on the spot when needed. Repeated application leads to refinement of a mental model and possible automation of its construction and use processes in one’s cognitive practice.

Literature often claims a mental model to be the same as a schema. However, in this chapter the two are different, and this understanding is critical for proper conceptualization of a mental model. Human knowledge is largely conceptual. Concepts are connected to other concepts and in this way, form clusters or larger structures usually referred to as schemata. These links define relationships and are channels through which certain variables and information from an environment (and what we already know) flow through concepts and across schemata. Schemata are deployed in the mind processes of constructing and using mental models. Experts hold more refined and more automated processes for construction and use of mental models, and base these on well-developed concepts and schemata.

Mental models are important for processes such as learning, critical thinking, and problem solving. Capacity to construct and use mental models might also be linked to creative thinking. Learners might benefit from experiences that require them to construct and use mental models, in particular within problem-based tasks. Technology can play an important role through its affordance that allows for creation and delivery of interactive and visual conceptual models (Churchill, 2007). These conceptual models can be designed to reassemble experts’ mental models, and can be externally supplied to learners to support their cognitive processes and task completion. In this way, conceptual models can act as external intellectual supplements, and their use can lead to creation of new or refinement of existing schemata and related concepts and procedures for their use. In addition, their use would lead to more effective mental modeling capacity for learners.

BACKGROUND

The very first attention to mental models was given in 1943 in the work “Nature of Explanation” by Kenneth Craik. Arno Matthias writes, in a Wikipedia article at http://en.wikipedia.org/wiki/Mental_model, that another early claim for existence of internal models was by Georges-Henri Luquet in a book “Children’s Drawings” published in 1927 in Paris. Craik (1943) proposed that humans interpret reality into internal models through interaction with external world. For Craik, humans can use and manipulate mental models and translate them back into action or just register the correspondence between these internal symbolic representations and external world. Another earlier note to mental models is made by Alexander (1964) in the book “Synthesis of Forms,” who suggests that engineers and architects hold mental pictures that they employ during design activities. Since then, in particular during the 1980s, there was huge growth of studies in relation to mental models.

Researchers in areas such as human-machine interaction, human-computer interaction, and skilled performance believe that individuals form mental models of systems that they interact with (e.g., De Kleer & Brown, 1981; Norman, 1983; Staggers & Norcio, 1993; Veldhuyzen & Stassen, 1977). Veldhuyzen and Stassen suggest that such mental models enable a machine operator to assemble and use strategy for managing a task, predict desired results as a consequence of some actions taken, and understand unanticipated phenomena that occur as the task progresses. Operators with well-developed mental models would be able to engage more effectively with a system and predict its behavior. This prediction is carried from inferences, what Norman labels “declarative form of predictability” or by “procedural derivation” made as an individual
runs a mental model. Individuals, for Staggers and Norcio, have ability to run and modify mental models in their minds to test their hypotheses about a system and as they grow in expertise, their ability to manipulate multiple models expands. Jih and Reeves (1992) write that humans also learn to use a computer-based environment by constructing a mental model of its interface. In addition to predictions of results of interaction with a computer-based environment, for Jih and Reeves, mental models also impact the effort that an individual devotes to a task and a level of satisfaction after task completion. A mental model is best understood within a context of a relevant task. Rouse and Morris (1986) suggest that a mental model is a kind of heuristics that brings knowledge and task together. The task might dictate the “level of behavioral discretion” that ranges from unconscious neural information processing to fully conscious decision making. At the same time, an individual might engage with a mental model to a different “level of model manipulation” that can be implicit or explicit, depending if the individual is aware of his or her manipulation of that model. For example, solving a physics problem requires high level of conscious decision making and explicit mental model manipulation. Low level of behavioral discretion is usually present when manipulation of a mental model is driven by outside factors.

Mental model is also discussed in relation to organizational management (Senge, 1990; Senge, McCabe, Lucas, Smith, Dutton, & Kleiner, 2000). According to Senge, one can hold mental models that can vary in scope from simple generalizations to complex theories. When confronted with new experiences, most individuals observe and bring forward only those mental models that reinforce what is important to them. If mental models remain unexamined, they will remain unchanged, that is, the mental models limit individuals’ ability to change (Senge, et al., 2000). For Senge, if an organization wants to introduce progressive changes, it must enable its member to change mental models that might be impeding these changes.

In cognitive psychology, a mental model is considered as a kind of internal symbolic representation that is constructed in the mind by an individual from interaction with and adaptation to the external world. For Johnson-Laird (1989), the purpose of mental models is to make inferences, while reasoning is a process of manipulating mental models. Vosniadou (2002) suggests that it is assumed that mental models are constructed on the spot when needed. However, another form of representation is also central to cognitive psychology: a schema (Paivio, 1974). A schema is “an organized structure that exists in memory and, in aggregate with all other schemata, contains the sum of our knowledge” (Winn & Snyder, 1996, p. 117). A schema is also a dynamic structure composed of concepts that are linked together. Although some literature appears to suggest schema to be the same as a mental model, for Winn and Snyder, the two are different and “a mental model is broader in conception than a schema because it specifies causal actions among objects that take place within it” (p. 118). Similar to others (e.g., De Kleer & Brown, 1981; Mayer, 1989; Seel & Stritmatter, 1989), Winn and Snyder suggest that a key property of a mental model is that it “can be run like a film or computer program and watched in the mind’s eye while it is running” (p. 118). Similarly, Vosniadou suggest that mental models “can be explored extensively, run in the mind’s eye, so to speak, in order to generate predictions and explanations” (p. 4), while for Johnson-Laird (1989), a mental model contains elements of a simulation and by running it, individuals can modify existing models or construct new ones.

What is content of mental models? For Merrill (2002), mental models combine schemata and processes for using this knowledge while Brien and Eastmond (1994) suggest that the mental models combine declarative knowledge (concepts, propositions, principles, laws, and processes) and procedural knowledge (production rules, procedures, and heuristics). Glaser and Bassok (1989) suggest that in addition to declarative and procedural knowledge, mental models also incorporate control knowledge (that determines how declarative and procedural knowledge is used). For Veldhuizen and Stassen (1977), knowledge is summarized in mental models while for Norman (1983), mental models also include beliefs. Others (e.g., Carley & Palmquist, 1992; Staggers & Norcio, 1993) suggest that mental models are organized structures that consist of concepts and their relationships. Staggers and Norcio suggest that mental models are visual, while for Jonassen and Henning (1999), mental models are dynamic, multimodal, and conceptual and operational (rather than just conceptual).

Literature suggests that effective learning experiences should engage learners to construct and use mental models (e.g., Brien & Eastmond, 1994; Jih & Reeves, 1992; Jonassen & Henning, 1999; Merrill,
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2002; Norman, 1983; Vosniadou, 2002). For Jonassen and Henning, learning environments must engage learners to construct “advanced knowledge” that allows for complex performance in problem solving. For Merrill, “solving a problem requires the learner not only to have appropriate knowledge representation (schema or knowledge structure) but he or she must also have algorithms or heuristics for manipulating these knowledge components in order to solve problems” (p.274), that is, problem solving requires application of mental models. For Vosniadou, mental models support learners’ conceptual development and function as (a) aids in the construction of explanation, (b) mediators in understanding of new information, and (c) tools for experimentation and revision of theories. Understanding both, effective and ineffective mental models can provide cues for required scaffolding, modeling, and coaching to support effective mental model construction (Jonassen & Henning, 1999). For Brien and Eastmond, expertise in a domain requires acquisition of the mental models, and this is best achieved by using “analogies” that activate necessary cognitive structures (schemas) essential for learners to construct appropriate mental models.

It can be noted from this literature review that a mental model is characterized with a diversity of views of what it really is. Johnson-Laird (1989) suggests that mental model is “unknown animal,” while Rouse and Morris (1986) write that “…this area of study is rife with terminological inconsistencies and preponderance of conjectures rather than data” (p.360). For Jonassen and Henning (1999) a mental model is a theoretical construct that does not exist in any concrete form, while for Staggers and Norcio (1993), no one actually proved that they exist at all. However, an overall idea is that a mental model is some kind of internal representations. Winn and Snyder (1996) write that how we humans “store information in memory, represent it in our mind’s eye, or manipulate it through the processes of reasoning has always seemed relevant to researchers in educational technology” (p. 117). In this context, this chapter suggests a need for clearer conceptualization of a mental model, the one that will inform a strategy for design of technology-based educational material such as conceptual models and other kinds of learning objects.

CONCEPTUAL MODELS: TOOLS THAT SUPPORT CONSTRUCTION AND USE OF MENTAL MODELS

This article suggests that mental models are best described as symbolic mind representations constructed on the spot when required by demands of an external task or by a self-generated stimulus. “Mind’s eye” can see, run, and interact with these mental models. These models enable activation of relevant schemata in support of learning, critical thinking, and problem solving. Learners in schools should be provided with experiences that lead to development of their mental modeling capacity. Limited mental modeling capacity might be supported by externally supplied conceptual models. In this way, conceptual models can act as external intellectual supplements, and their use can lead to creation of new, or refinement of existing, schemas and related concepts and procedures for their use.

A conceptual model is best described as a particular kind of learning object. A learning object is a representation designed to afford use in different educational contexts (Churchill, 2007). Usually, learning objects reside in digital repositories, ready to be retrieved and utilized by those involved in generating educational activities (e.g., teachers and students). These representations address key concepts from disciplines, in visual and often interactive ways (conceptual models); information (information objects) and situated data (contextual representation objects) that can be useful in the context of developing discipline-specific thinking, a culture of practice, a spirit of inquiry, theoretical knowledge and information; presentation of small, instructional sequences and demonstrations that deliver encapsulated descriptions and illustration of some aspects of subject matter (presentation objects); provide opportunity for practice (practice objects); and simulations of key equipment, tools, and processes from a discipline to support the development of a deeper understanding of artifacts used in a culture of practice (simulation objects). Some of the learning objects from the classification can be combined with other objects into direct instruction products supporting traditional pedagogies (e.g., computer-based tutorials). Other learning objects are more appropriate in the context of contemporary
pedagogical approaches as resources to be deployed in learning tasks designed by teachers. An example of a conceptual model is a representation that allows manipulation of parameters of a triangle, which in turn changes displayed modalities, such as visual representation of a triangle, and numerical values of sizes of its angles and sides, and displays a graph showing changes in relationship between sides or angles. This example is shown in the Figure 1.

Providing learners with a “conceptual model” is an effective way of enabling them to construct and use their own mental models (e.g., Norman, 1983, Mayer, 1989; Staggers & Norcio, 1993; Winn & Snyder, 1996). Staggers and Norcio suggest that a conceptual model is effective because learners more easily incorporate given models than induce new ones, and it provides organizing framework that helps one to organize learning experience. For Norman (1983) and Jih, and Reeves (1992), a conceptual model should be designed to be congruent with a resulting learner’s mental model.

Mayer (1989) conducted a study to explore the impact of a conceptual model upon learners’ conceptual recall, verbatim retention, and transfer of what they learned to solve new problems. A conceptual model for Mayer is a paper-based visual display that “highlights the major objects and actions in a system as well as the causal relations among them” (p. 43). A conceptual model facilitates the development of the learners’ mental model of the system being learnt. By comparing two groups of learners, one that learnt with a conceptual model and another who learnt with conventional text, Mayer understood that a conceptual model led to improved conceptual recall while at the same time, it resulted in reduced verbatim retention. The key understanding from Mayer’s study is that learning with conceptual models improves the ability of learners to use what they have learnt to solve new problems. Mayer suggests that the possible reason for this transfer is that students had constructed mental models that they could mentally manipulate when solving a new problem. What difference does technology make for designing conceptual models? White, as early as in 1984, wrote that interactive visual capabilities of computer technology provide an opportunity for visual displays to be redeveloped into more powerful tools for learning (White, 1984). For Fraser (1999), interactive and visual capabilities of contemporary technology provide a unique opportunity for creation of “pedagogical models,” (conceptual models) that can be used to help learners construct and use suitable mental models. Fraser writes that:

In the past, we relied on words, diagrams, equations, and gesticulations to build those models piece by piece in

**Figure 1. Exploring right-angled triangle conceptual model learning object**
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the minds of the students. We now have a new tool—not one that replaces the older ones, but one that greatly extends them: interactive computer visualization.

Today, a teacher can build a pedagogical model, and both student and teacher can interact with it to explore the behavior of the system in a way inconceivable in earlier times.

For van Someren (1998), technology allows the integration of multiple representational formats into a single multimodal representation for learning (a kind of conceptual model). Modality indicates a particular form of expression, such as text, animation, diagram, graph, algebraic notation, formula, table, and video. Multimodality supports learning by allowing learners to link different representations. The learners who learnt in this way would be able to mentally change modes of internal representation (a mental model), and this would facilitate independent problem-solving and other reasoning tasks (Boshuizen & Hermina, 1998).

CONCLUSION

How knowledge is organized and manipulated in the mind is highly relevant to the design of technology-based educational materials. A mental model is characterized in literature with a diversity of views of what it really is. In addition, it is not clear how a mental model relates to other ideas from a study of cognition such as concepts and schemata. This article suggests a need for clearer conceptualization of a mental model as this would inform more effective design of conceptual models and other kinds of learning objects, and their applications in learning. Overall, a mental model might be best described as a metaphor for certain mind processes that are productive in the context of learning, critical thinking, and problem solving. These processes activate schemata and create temporary models in multimodal form that are open to interrogation and experimentation. In this context, a mental model is not a representation stored in the mind, but the one that is constructed and used on the spot when required. Mental modeling requires an individual to have, in addition to a suitable base of concepts and schemata, a capacity to construct and use mental models. Learners’ deficiencies, either in mental modeling capacity or in conceptual knowledge, can be supplemented by supply of conceptual models. These conceptual models utilize interactive and visual affordances of contemporary technology for design of multimodal representations. They can be manipulated, interrogated, and explored by learners in ways that, in part, reassemble use of mental models. Application of conceptual models would lead to development of learners’ own concepts and schemas, while supporting development of their mental modeling capacity.

REFERENCES


Mental Models


KEY TERMS

**Concept**: The basic element of thought and a mental representation of a category of some entities or phenomenon that forms the basis for meaning making and communication.

**Conceptual Model**: A particular kind of learning object design to be supplied to learners to support their mental modeling.

**Learning Object**: A representation designed to afford use in different educational contexts.

**Mental Model**: Internal representations constructed on the spot when required by demands of an external task or by a self-generated stimulus. It enables activation of relevant schemata, and allows new knowledge to be integrated. It specifies causal actions among concepts that take place within it, and it can be interacted with in the mind.

**Schema**: Organized structure consisting of concepts and their relationship.
Mobile Learning: Learning on the Go

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INTRODUCTION

The mobile revolution is finally here. The evidence of mobile penetration and adoption is irrefutable: smartphones, personal digital assistants (PDAs), portable game devices, portable media players, MP3 and MP4 players, tablet PCs, and laptops abound and can be found everywhere. Also, the increasing availability of high-bandwidth network infrastructures and advances in wireless technologies have opened up new accessibility opportunities (Kinshuk, 2003). No demographic is immune from this phenomenon. People from all walks of life and in all age groups are increasingly connected and communicate electronically with each other nearly everywhere they go (Wagner, 2005). The development of and adoption rate of mobile technologies are advancing rapidly on a global scale (Brown, 2005). Since 2000, there is considerable interest from educators and technical developers in exploiting the universal appeal and unique capabilities of mobile technologies for the use in education and training settings (Naismith, Lonsdale, Vavoula, & Sharples, 2004).

The use of mobile technologies to support, enhance, and improve access to learning is a relatively new idea and many learners are quite comfortable with various mobile devices. M-learning (mobile learning) is consequently an emerging concept as educators are beginning to explore more with mobile technologies in teaching and learning environments. Already, there are numerous applications for mobile technologies in education—from the ability to transmit learning modules and administrative data wirelessly, to enabling learners to communicate with instructors and peers “on-the-go” (Brown, 2005).

Still in its early stages, m-learning is comparable to where e-learning was a few years ago. M-learning is at the point by which mobile computing and e-learning intersect to produce an anytime, anywhere learning experience. Advances in mobile technologies have enhanced m-learning tools at just the right moment to meet the need for more cost-effective just-in-time training options—Learning on the Go. Today, the evidence is overwhelming that m-learning is beginning to take hold:

- The population of mobile and remote access workers in the United States alone will grow to 55.4 million by 2004 (Shepherd, 2001).
- Over 50% of all employees spend up to half of their time outside the office.
- The average employee had less than three days of training in 2003.
- There will be more than 1 billion wireless Internet subscribers worldwide by 2005.
- Multipurpose handheld devices (PDAs and telephones) will outsell laptop/desktop computers combined by 2005.
- Most major U.S. companies will either switch to or adopt wireless networks by 2008 (Ellis, 2003).
- More than 1.5 billion mobile phones are used in the world today. This is more than three times the number of personal computers, and today’s sophisticated phones have the processing power of a mid-1990s personal computer (Attewell, Lonsdale, Vavoula, & Sharples, 2004).
- Smartphones rose by 17% year-on-year in the first part of 2005 in Europe and the Middle East. In contrast, standard mobile phones rose by only 11% (Canalys, 2005).
- Global sales of smart phones will reach 170 million in 4 to 5 years, compared slightly more than 20 million in 2004 (Attewell, 2005).
- More than 16 million 3G phones were sold worldwide in the beginning of 2005, compared to only 10 million 3G handsets sold in September 2004.
- Total U.S. spending on wireless communications will grow 9.3% in 2005, to $158.6 billion.
Mobile Learning

- The wireless market will grow at 10% compound annual growth rate through 2008 (Wagner, 2005).

While mobile devices are approaching ubiquity today, the industry is still in its infancy. Fusing mobile technology and e-learning is very natural. Mobile devices are a natural extension of e-learning because mobile devices have the power to make learning even more widely available and accessible. Imagine the power of learning that is truly “just-in-time,” where learners could actually access training at the precise place and time on the job when needed (Kossen, 2001).

BACKGROUND

Conventional e-learning, delivered to a desktop computer, is leaving a large part of the learners out in the cold. As Elliott Masie (Shepherd, 2001, p. 1) points out:

The assumption here is to dramatically expand the accessibility of learning beyond the physical footprint of the PC. If we remember that over 50% of the workforce does not sit at a desk, but instead is standing, walking or moving around a factory, we see the potential of breaking the tether of the Ethernet wire.

M-learning is designed to fit with the unique work-style requirements of the mobile workforce, linked to their office by mobile devices.

Vavoula and Sharples (2002) suggest three ways in which learning can be considered mobile: (a) learning is mobile in terms of space, (b) learning is mobile in different areas of life, and (c) learning is mobile with respect to time. Their definition suggests that m-learning systems are capable of delivering educational content anywhere and anytime the learners need it.

According to Quinn (2000), m-learning is the intersection of mobile computing and e-learning. M-learning includes anytime, anywhere resources, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment. Chabra and Figueiredo defined m-learning as “the ability to receive learning anytime, anywhere and on any device,” while Harris referred m-learning to “the point at which mobile computing and eLearning intersect to produce an anytime, anywhere learning experience” (Dye, K’Odingo, & Solstad, 2003, p. 6).

Commonly, m-learning refers to learning opportunities through the use of mobile solutions and handheld devices (i.e., mobile phones, smartphones, and PDAs) which are connected to information networks. Mobile implies movement and mobility. Likewise, m-learning implies the opportunity to learn “on the go” (Vanska, 2004). M-learning can be an educational environment in which wireless technology is used to assist students in their studies—both inside and outside the classroom. In a mobile learning scenario, students can access their learning materials from anywhere: on the bus, at the cafeteria, or waiting in line. Also, students can easily contact fellow students, check e-mail, or get feedback from their instructors. Unlike being limited to working online in a computer lab, the library, or at home, students can access online materials regardless of their location. M-learning translates to flexibility in accessing course materials, fellow students, and their instructor anytime, anywhere.

Evans (2005), at the Think-Tank Day for the UK mobile learning community, identified several unique features of mobile devices which could enhance the learning experience:

- **Privacy:** The small size of mobile devices makes it possible to learn “unobtrusively” whenever the learner is located.
- **Support for learning styles:** The mobile devices have potential to support learners with preferences for textual, audio and video presentation of material.
- **Immersive:** The richness and diversity of both content and activity can immerse the learners in their experience.
- **Capture of data:** The mobile devices allow the capture of data anywhere and analyze later.
- **Context:** The ability to automatically receive relevant information.
- **User control:** Learners have more control over when and where they choose to study, and over their interaction with other learners.

In his book *The Future of Learning: From E-Learning to M-Learning*, Keegan (2002) discusses the progression of types of learning from distance, to electronic, to mobile. He indicates that the logical extension...
of PC-based distance learning is mobile learning. He analyzes about 30 global m-learning initiatives regarding to the experimental use of wireless technologies (including wireless Internet environments and wireless classrooms) and various mobile devices for teaching and learning. He concludes regarding the emergence and growing importance of m-learning. M-Learning is the logical extension of asynchronous learning, available not only anytime, but also anywhere.

Many educators and trainers are optimistic about the potentials of m-learning. Wagner (2005) believes that m-learning represents the next step in a long tradition of technology-mediated learning. M-learning will employ new learning strategies, practices, tools, applications, and resources to realize the promise of ubiquitous, pervasive, personal, and connected learning. M-learning connects formal education experience (i.e., taking a class, attending a workshop or seminar, or participating a training session) with informal, situated learning experience (i.e., learning on the go while riding the bus, waiting for a flight in an airport, or receiving performance support while on the job). Wagner further states that m-learning will be built upon the foundations of previous educational technology frameworks (i.e., distance learning, e-learning, flexible learning, modular instructional design, learning and content management), and thus can take full advantage of the experiences, empirical evidence, and effective practice guidelines derived by researchers and practitioners from the preceding technology revolutions in education (Wagner, 2005).

MOBILE TECHNOLOGIES AND NEW LEARNING PARADIGMS

There is no theory of mobile learning. However, m-learning supports a new dimension in the educational process. In the review of new learning and teaching practices, Sharples (2003) concludes the following:

- Learning involves constructing understanding. Learners use their knowledge to construct new knowledge.
- Learning takes place within a community of practice and not only in the classroom or in form of the computer.
- Learning starts from conversation—with oneself and with others. Learning is part of collaborative processes in professional, educational, and daily-life settings.
- Problems provide resources for learning.
- Learning is part of daily living. Learning is dependent on the situation—physical as well as emotional—that it takes place in.
- Learning is lifelong. It takes place over a long period of time and beyond formal education.

Similarly, Ferscha (2002) summarized the new learning paradigms as: (a) individual/learner centered, (b) collaborative learning, (c) situated learning, (d) contextual learning, (e) ubiquitous, and (f) lifelong. In the review of literature concerning new learning and teaching practices and mobile technologies, Naismith et al. (2004) reveal six learning theories and areas of learning relevant to mobile technologies:

1. **Behaviorist learning**: Learning activities that promote learning as a change in observable actions. Mobile technologies provide the ideal opportunity to present content, gather responses, and provide appropriate feedback.

2. **Constructivist learning**: Learning activities in which learners actively construct new ideas or concepts based on both their previous and current knowledge. Mobile devices provide unique opportunities to transform learners from passive recipients of information to active constructors of knowledge.

3. **Situated learning**: Learning activities that promote learning within an authentic context and culture. The portability of mobile devices allows the learning environment to be extended beyond the classroom into authentic and appropriate contexts of use.

4. **Collaborative learning**: Learning activities that promote learning through social interaction. Mobile devices enable learners to share data, files, and messages and provide means of coordination without attempting to replace human-human interactions.

5. **Informal and lifelong**: Learning activities that support learning outside a dedicated learning environment and formal curriculum. Mobile devices with small size and ease of use make them well suited for learning applications outside of formal education.
Learning and teaching support: Activities that assist in the coordination of learners and resources for learning activities. Mobile devices can be used to support learning-related activities for students, teachers, and administrators (Naismith et al., 2004).

WHY MOBILE LEARNING?

According to Brown (2003), m-learning is a natural extension of e-learning. It has the potential to further expand where, how, and when we learn and perform in all the aspects of our life. One of the key benefits of m-learning is its potential for increasing productivity by making learning available anywhere and anytime, allowing learners to participate in educational activities without the restrictions of time and place. Mobile technologies have the power to make learning even more widely available and accessible than we are used to in existing e-learning environments. M-learning could be the first step towards learning that is truly just-in-time where learners could actually access education and training at the place and time that they need it. Brown (2003) further states that integrating electronic performance support systems (EPSS) into the mobile environment will take m-learning even further: m-learning with on-demand access to information, tools, learning feedback, advice, support, learning materials, and so forth.

Mobile technologies can support and monitor student learning activity in real time outside the traditional classroom and promote a learning community. They can help students access learning records, register attendance, access media rich learning materials, collaborate with other learners, and keep in touch with teachers and mentors. Furthermore, mobile devices can support and facilitate learning assessment and the creation of portfolios (Evans, 2005). In addition, there are many other benefits of m-learning:

- Provide real world skills.
- Offer just-in-time learning/reference tool for quick access to data in the field.
- Provide rich interaction with others.
- Offer increased opportunities for students to research by accessing electronic resources (Evans, 2005).

The findings of the m-learning project, funded by the European Commission’s Information Society Technologies (IST) initiative, indicate that mobile devices can be used successfully to involve some of the hardest to reach and most disadvantaged young adults in learning. M-learning has the potential to help these youngsters improve both their skills and their self-confidence (Attewell, 2005). Furthermore, Attewell concludes that the use of m-learning may have a positive contribution in the following areas:

- M-learning helps learners improve their basic skills.
- M-learning can be used to encourage both independent and collaborative learning experiences.
- M-learning helps learners identify areas where they need assistance and support.
- M-learning helps bridge the gap between mobile phone literacy and information and communication technology (ICT) literacy.
- M-learning helps learners engage in learning and maintain their interest levels.
- M-learning helps learners remain more focused for longer periods.

In a survey of expert expectations about m-learning conducted in Germany, Switzerland, and Austria in 2005, Kuszpa finds that a time and place-independent learning alternative is the greatest advantage of m-learning. Also, a learner can individually control his/her speed of learning during the use of mobile devices is considered a strong advantage. However, the greatest disadvantage of m-learning is seen in the need for a higher self-discipline when learning on mobile devices. Furthermore, the majority of experts participated in the survey feel m-learning is an impersonal way of learning. They criticize the small displays and limited input possibilities on mobile devices that give little space for a good presentation of the learning content (Kuszpa, 2005).
Another problem for m-learning is the lack of a standardized platform. The current mobile devices utilize a variety of operating environments, display and sound characteristics, and input devices, making it difficult to develop educational content that will work anywhere for every mobile device (Shepherd, 2001). Mobile devices are getting smaller and more powerful. They have the ability to deliver learning objects and provide access to online systems and services. However, network infrastructure has not quite kept up with the development of mobile hardware. As a result, bandwidth is not yet sufficient for substantial m-learning and coverage, and signal problems are still barriers in many areas when traveling. Attewell suggests a mixture of online learning and learning using materials downloaded onto mobile devices for use off-line is necessary. In addition, due to the immature mobile standards, it is a challenge for educators to develop and implement mobile learning projects. It is almost impossible to develop one generic version of mobile applications to run on all mobile platforms. As a result, educators often develop several versions of learning materials specifically for particular platforms (Attewell, 2005). To support flexible learning requirements of m-learning, solutions are needed that not only support m-learning but also develop frameworks that support automatic adaptation of educational content to suit various mobile devices and individual preferences of the learners using those devices (Kinshuk, 2003).

**FUTURE TRENDS**

According to Wagner (2005), current trends suggest that educational games, language instruction, and performance-support and decision-support tools are likely to lead the mobile movement in the next few years. Particularly, wireless games have taken the world by storm. There are 170 million wireless games worldwide. Eighteen million Americans play wireless games and 6 million users download games to their mobile device each month in the U.S. It is very possible that educational games will provide m-learning with its first success in wide-spread adoption in education.

The future mobile devices will be even more embedded, ubiquitous, and networked than those available today. The capabilities of mobile phones, PDAs, games consoles, and cameras will likely merge within the next few years to provide a networked, personal, portable, and multimedia device that is always with the user. According to Naismith et al. (2004), future mobile technologies will have a greater impact on learning. Learning will move more and more outside of the classroom and into both real and virtual learner’s environments. Learning will involve making rich connections within these environments to both resources and to other people (Naismith et al., 2004). In addition to accessing Internet resources on the move, learners will be able to manage their learning through consultations with their personal diaries and institution-based virtual learning environments. The ability to instantly publish learners’ observations and reflections as digital media will empower them to be researchers. Context-aware applications will enable learners to easily capture and record events in their lives to both assist later recall and share their experiences for collaborative reflection. Opportunities for distributed collaboration and mobile team working will be greatly enhanced (Naismith et al., 2004).

**CONCLUSION**

With the immense penetration and the continuously increasing capabilities of mobile devices, there is a great potential of m-learning in education and training. Learning everywhere and anytime can be a valuable complement, but definitely is not a replacement for traditional learning methods (Kuszpa, 2005). M-learning just provides another way of learning using new mobile technology. As educators, we should embrace the rich learning enhancing possibilities that m-learning already provides and will provide even more so in the future. M-learning fulfills the growing demands for life-long learning opportunities that enable learners to “learn while you are on the go” (Brown, 2005).

M-learning allows truly anywhere, anytime, personalized learning. It can also be used to enrich, enliven, or add variety to conventional lessons or courses. However, the challenge of m-learning is to take advantage of the special needs of mobile learners and the unique characteristics of the mobile devices they use, and to provide an improved m-learning service along with other learning systems (Shepherd, 2001). The success of m-learning does not solely depend on the technological developments and the possibilities they provide. Effective m-learning programs will require digital communication skills, new pedagogies, and
new learning strategies and practices (Wagner, 2005). The ability of educators and instructional designers to develop m-learning activities that provide rich, collaborative, and conversational learning experience is imperative. Also, it is important to identify those applications of mobile technologies that contribute to the optimizing of teaching and learning in the new learning environments.

REFERENCES


**KEY TERMS**

**3G:** Third-generation mobile telephone technology. The 3G services provide the ability to transfer both voice data and non-voice data (music, videos, e-mail, and instant messaging) at the speed of up to two megabits per second.

**4G:** Fourth-generation mobile telephone technology. It is not yet available. 4G will be the successor to 3G and will feature high-speed mobile wireless access with a data transmission speed of up to 100 megabits per second.

**Enhanced Data Rates for GSM Evolution (EDGE):** EDGE is an upgrade of GRS system for data transfer in GSM networks. EDGE increases the capacity and quality and allows the use of advanced services over the existing GSM network.

**General Packet Radio Service (GPRS):** A mobile data service available to users of GSM mobile phones. It is often described as “2.5G,” a technology between the second generation (2G) and third generation (3G) of mobile telephony. It provides moderate speed data transfer, “always on” data connections that are much faster than the traditional 9600 bps, by using unused TDMA channels in the GSM network.

**M-Learning:** A term that refers to the delivery of learning content via mobile devices including PDAs, cell phones, or other handheld devices. It allows users to learn what they want, where they want, and when they want.

**Multimedia Messaging System (MMS):** The successor to SMS. MMS allows subscribers to send multimedia (digital photos, audio, and video) material along with their messages.

**Short Message Service (SMS):** A digital mobile phone service that allows single short messages of up to 160 characters to be passed between mobile phones, fax machines, or e-mail addresses.

**Smartphone:** Smartphones are a hybrid of the functionality of PDAs and mobile phones. They usually provide a means of connecting to a desktop or laptop to perform the same functions as a PDA docking and synchronization cradle.

**WiMax:** A standard based on IEEE 802.16. WiMax offers mobile devices with a wireless, direct connection to the Internet at the speeds of up to 75 megabits per second and over distances of several kilometers.
INTRODUCTION

The development of models for risk stratification in cardiac surgery goes back a number of years. In 1989, the Society of Thoracic Surgeons (STS) created the first database version for use in the USA. In the year 2005 alone, the data from 234,532 operations were recorded in a structured way by 654 participating institutes. The value of these collected data is described by Ferguson (Ferguson, Dziuban, Edwards, Eiken, Shroyer, & Pairolero, 2000): “Because of their collective efforts, the goal to establish the STS National Database as a ‘gold standard’ worldwide for process and outcomes analysis related to cardiothoracic surgery is becoming a reality.” The number of research projects deriving from this is correspondingly large (The Society of Thoracic Surgeons National Database Access and Publications Task Force, 2006).

In the meantime, heart registers have been set up in many countries including, for example, the USA, Canada, the UK, and Australia (Smith, 2001). As a data pool of scientific studies for the construction of new models for risk stratification, these have been used for a number of years as a suitable means of achieving qualitative improvement in the outcome and patient satisfaction, and for raising the quality and cost effectiveness of cardiac surgical interventions (Gale, 2001). After a long-term study of the outcomes of risk stratified patient groups, Grovers concludes: “It appears that the routine feedback of risk-adjusted data on local performance provided by these programs heightens awareness and leads to self-examination and self-assessment, which in turn improves quality and outcomes. This general quality improvement template should be considered for application in other settings beyond cardiac surgery.” (Grover, Shroyer, Hammermeister, Edwards, Ferguson, Dziuban, et al., 2001)

However, the methods of risk stratification are used not only for scientific investigations. Although very controversial, some of the countries with a national heart register started publishing the results of outcome analyses at a very early stage. Green (Green & Wintfeld, 1995) had already summarised the situation in 1995: “Publication of ‘report cards’ on hospitals and surgeons is an important new trend. The New York State Department of Health pioneered this practice by developing the Cardiac Surgery Reporting System (CSRS), which generated the first physician-specific mortality report ever published. This controversial report and its annual updates have received intense publicity, because the results indicated that the percentage of patients who died after heart surgery differed widely among surgeons, even after adjustment for differences in the patients’ attributes. In addition, risk-adjusted death rates for coronary-artery bypass grafting (CABG) reportedly declined in New York after CSRS had been
implemented, leading some people to conclude that such systems may save lives.”

Publication of the outcome down to the level of individual surgeons also takes place in the UK. In Australia, publication of the results is done on the basis of regional centres (Neil, Clarke, & Oakley, 2004).

Even though the risk stratification performed on risk models, the data pool on which these are based, and the methods for determining scoring systems are not undisputed (Iezzoni, 1997; Omar, Ambler, Royston, Eliahou, & Taylor, 2004), in addition to the predominantly risk-group oriented statements on result quality, the results of the predictive models are also used for supporting decision making with respect to chances and risks, for ensuring that all risk factors are ascertained and, last but not least, as a basis for the discussion between surgeons and patients for or against a specific intervention (Bernstein & Parsonnet, 2000; Mauro, Kline-Rogers, Share, O’Donnel, Maxwell-Edward, Meengs, et al., 2001).

The multiple objective associated with risk stratification exerts fundamental influence on selection of the score and on the data to be gathered, and results in the derivation of specific technical requirements of the system design.

**BACKGROUND**

In medicine, the term “risk stratification” means the estimation of the risk of a disease progressing or leading to complications or death. In order to do this, risk factors are recorded that are known to be associated with the progression of a disease or with the occurrence of complications. Based on the individual risk profile, tables, algorithms, or computer programs are used to determine the individual risk of the patient. (Wikipedia, Risk stratification)

Distinctive factors characteristic of the person, their surroundings (environmental factors) or their diet that raise the risk of one or more diseases to an extent significantly above the general risk of disease are designated as health risk factors. Medical findings, a laboratory value or a specific type of behaviour by the
Model-Based Decision Making in Cardiac Surgery

A patient is designated a risk factor if its existence leads to a statistically demonstrable increased occurrence of a disease. (Wikipedia)

In the field of cardiac surgery, the concept of risk stratification is adapted in such a way that, using suitable risk models (also known as predictive models, scoring models, or risk scores), the probability of a patient dying during a specific operation is predicted dependent on their personal risk factors in connection with the (normalised) nature of the intervention (Daley, 1994). Risk stratification comprises an important support for maintaining and improving quality (Swain & Hartz, 2000). The knowledge and results from model-based risk stratification are also used for making predictions of the preoperative risk and the postoperative result quality of the intervention and of organisational units.

The primary and, in practice, the most widely used attribute of the result of a surgical intervention is the 30-day mortality (30d mortality). This states whether the patient is still alive on the 30th day after the operation (positive outcome) or has died (negative outcome). It is clear that simple consideration of the numbers of surviving and deceased patients, without taking account of the individual risks of the operation, cannot lead to a reliable statement about the result quality since the probability of dying is higher for patients with higher risk (i.e., the coincidence of several risk factors) and, conversely, is lower for patients with low risk (standard interventions). Thus, a greater number of deaths would be expected among a population with a higher risk on average, and would therefore not constitute a negative statement about the result quality per se.

The criterion for result quality is

\[
\text{Result quality} = \frac{\text{observed mortality} \, [\%]}{\text{risk-adapted expected mortality} \, [\%]}
\]

**Table 1. Result of contrasting logistic EuroSCORE vs. valve score (Ambler)**

<table>
<thead>
<tr>
<th></th>
<th>Clinic A</th>
<th>Clinic B</th>
<th>Clinic C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Alive (30d mortality)</td>
<td>37</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Dead (30d mortality)</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Age: mean</td>
<td>69.62</td>
<td>67</td>
<td>74.33</td>
</tr>
<tr>
<td>Observed mortality [%]</td>
<td>11.9</td>
<td>11.11</td>
<td>13.33</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pred. mort.</td>
<td>14.37</td>
<td>13.53</td>
<td>15.88</td>
</tr>
<tr>
<td>Performance ratio (pred. mort. / observed mortality)</td>
<td>0.83</td>
<td>0.82</td>
<td>0.84</td>
</tr>
<tr>
<td>Valve score (Ambler)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pred. mort.</td>
<td>6.85</td>
<td>6.08</td>
<td>8.22</td>
</tr>
<tr>
<td>Performance Ratio (pred. mort. / observed mortality)</td>
<td>1.74</td>
<td>1.83</td>
<td>1.62</td>
</tr>
<tr>
<td>Performance ratio valve score / log EuroSCORE30d</td>
<td>2.10</td>
<td>2.23</td>
<td>1.93</td>
</tr>
</tbody>
</table>
Calculation of the risk-adapted expected mortality (RAEM), taking account of individual risk factors (e.g., simple routine bypass, combined bypass and valve operations, age, sex, etc.) is mostly done in the form of multivariable regression models. Selection of the suitable model and the risk factors it contains, and how these are weighted, has considerable influence on the result quality (Krumholz, 1999).

Comparison of the logistic EuroSCORE (Nashef, Roques, Michel, Gauducheau, Lemeshow, & Salmon, 1999; Roques, Michel, Goldstone, & Nashef, 2003) for the subgroup “valve operations,” with a specific score for valve operations, according to Ambler (Ambler, Omar, Royston, Kinsman, Keogh, & KM, 2005), shows that differences of 100% and more can arise between the results obtained from different scores applied to one and the same study group. Data from three heart centres during the period 1 Jan. 2006 to 31 Mar. 2006 were contrasted.

Observation of the outcome by means of comparing the results in the form of a VLAD (Variable Life Adjusted Display) from one centre (period = 1 Jan. 2005 - 31 Dec. 2005, 305 consecutive surgeries) demonstrates the effects of the scoring model used in an easily comprehensible way.

The upper (light grey) curve above shows the path of the VLAD on the basis of the logistic EuroSCORE. The result here is better than average because in the VLAD the graph can be expected on average to swing back and forth across the x-axis. The higher the graph moves above the x-axis, the better the result in comparison with the expected value. In comparison, the valve score, according to Ambler (lower, dark grey curve), shows a greater trend towards the x-axis, which is expressed in this score’s lower expected mortality for the same number of operations and deaths. This example shows that even the concept of result quality, as defined, may be considered only in the context of the model it is based upon.

**MODEL-BASED DECISIONS IN AUSTRIAN CARDIAC SURGERY**

Model-Based Decision Making in Cardiac Surgery

During the period October 2004 to February 2005, as part of the “Cardiac” project for implementation of this register in all nine Austrian heart centres, the corresponding author used a closed-structured survey to ascertain the current recording methods and the scope of the data gathered. A total of three university hospitals and six other hospitals run by different providers were surveyed. The following items were queried.

Six important medical technical criteria were identified as a result:

- The number of parameters to be recorded should be as large as possible in order that the data pool for scientific work be as broad as possible.

<table>
<thead>
<tr>
<th>Item</th>
<th>Hospital-</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record type</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>RAEM</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>30d-Mort</td>
<td></td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>P</td>
<td>P</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Data input</td>
<td></td>
<td>Q</td>
<td>Q</td>
<td>T</td>
<td>Q</td>
<td>O</td>
<td>A</td>
<td>G</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>System interfaces</td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>IT-System</td>
<td></td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>S</td>
<td>F</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>
The model must enable the national and international comparison of result quality.

The model must be relevant for the target population.

The model must deliver significant predictive probabilities for selected subgroups (e.g., type of intervention—valves, bypass, combined interventions—and other selection criteria—e.g., sex, age group, and combinations of these).

The population of the model must be equivalent to the target population regarding age selection (adults from 18 years old) and regarding the reason for the intervention (acquired). Paediatric scores and scores for inherited heart defects (congenital scores) are excluded.

The scoring model must calculate, as a result, at least the risk-adapted expected 30-day mortality.

In addition, four further criteria relevant to organisation were defined:

- The number of relevant parameters to be recorded should be as small as possible without negatively influencing the quality of the prediction.
- The definition for the existence of a positive or negative characteristic, or the grade of the characteristic of a parameter, must be as exact as possible. Large areas of discretion would make the evaluation by non-medical personnel more difficult and would increase the outlay for checks.
- Recording the criteria must lead neither to unreasonable additional administrative outlay as a result of more personnel, nor to a considerable increase in costs.
- The calculation method for the model must be publicly accessible and licence free.

These requirements, which are partly contradictory, exert an influence both on the scoring model and on the data pool on which it is based; in other words, on the structure of the data record.

Application of this criteria for evaluating the scoring models most frequently mentioned in the literature showed that in Austria, the EuroSCORE model seems to be the most suitable for fulfilling the requirements as a basis for a heart register covering the whole of Austria and, at the same time, as a bedside tool. The existence of both a logistic and linear model with, at the same time, very well-defined parameters was judged to be a significant advantage over the other models investigated. The fact that the model does not have an excessive number of parameters also allows its convenient use as a bedside tool.

Scoring systems based on preoperative cardiac risk assessments are generally a means for pre- and/or postoperative risk stratification (Hollenberg, 1999). The data pool is therefore very narrow, corresponding to the respective aim (mortality/morbidity). This is an advantage for data gathering; for using the data as part of a scientific data warehouse, it is an intrinsic disadvantage of the system. The study has shown that only the STS model, whose score is based on the STS data record (The Society of Thoracic Surgeons, 2004) with approximately 300 well-defined database fields, would be capable of closing this gap between the different requirements. The score itself (i.e., the calculation model) is calculated according to the predictive target—mortality or morbidity of different risks—from a maximum of 17 parameters (The Society of Thoracic Surgeons, Variables involved in STS Risk Modelling, 2004) and, unlike the definition of the underlying data record, is subject to licence. Moreover, access to the model is currently intended only for customers from the American market, and its validity for other populations has, therefore, not been confirmed with an adequate number of clinical studies.

In contrast to that, the EuroSCORE is calculated from the same 17 well-defined parameters both in the linear and in the logistic variant. The validity of the EuroSCORE is very well authenticated by a large number of clinical studies. In the Cardiac project, the Austrian project for the national heart register, the EuroSCORE was chosen based on the STS data record, which was extended appropriately in order to be able to meet both requirements. This requires that the STS database fields be mapped accordingly to the EuroSCORE fields.

Two-level Concept of the Austrian Heart Register. Once the medical requirements had been defined as a setting for the component design, it was necessary to determine whether or not the Austrian Heart Register could be implemented as a single, Internet-based central database.

Personal operation data are deemed in Austria to be “sensitive data” from the aspect of data protection law pursuant to the Data Protection Act (DSG 2000,
Table 3. Mapping of EuroSCORE risk factors and STS risk factors

<table>
<thead>
<tr>
<th>EuroSCORE Factor</th>
<th>STS Data Field(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Age</td>
</tr>
<tr>
<td>Sex</td>
<td>Gender</td>
</tr>
<tr>
<td>Chronic pulmonary disease</td>
<td>MedSter, MedBroncho</td>
</tr>
<tr>
<td>Extracardiac arteriopathy</td>
<td>PVD, CVD</td>
</tr>
<tr>
<td>Neurological dysfunction disease</td>
<td>n.A.</td>
</tr>
<tr>
<td>Previous cardiac surgery</td>
<td>PrCAB, PrValve, PrOthCar</td>
</tr>
<tr>
<td>Serum creatinine</td>
<td>CreatLst</td>
</tr>
<tr>
<td>Active endocarditis</td>
<td>InfEndo</td>
</tr>
<tr>
<td>Critical preoperative state</td>
<td>Anuria (oSTS), IABP, IABPWhen, Arrhth, ArrhyTyp, CarShock, Resusc</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>MedNitIV</td>
</tr>
<tr>
<td>LV dysfunction</td>
<td>HDEF</td>
</tr>
<tr>
<td>Recent myocardial infarct</td>
<td>MI, MIWhere</td>
</tr>
<tr>
<td>Pulmonary hypertension</td>
<td>HDPAD, HDPADSyst</td>
</tr>
<tr>
<td>Emergency</td>
<td>Status</td>
</tr>
<tr>
<td>Other than isolated CABG O</td>
<td>pValve, VAD, OpOCARD, OCarASD, OCarACD, OCarOthr</td>
</tr>
<tr>
<td>Surgery on thoracic aorta O</td>
<td>NCAoAn</td>
</tr>
<tr>
<td>Postinfarct septal rupture O</td>
<td>CarVSD</td>
</tr>
</tbody>
</table>

1999), §.4(2). For reasons of data protection, the data protection commission of the hospital in Hietzing, for example, was not prepared, under any circumstances, to allow operation data to be stored on any server other than its own. This alternative had to be excluded from consideration in view of the required multifunctionality of the entire system (individual-related bedside decision tool, risk stratification and analysis tool at surgeon and organisational level). The system design, therefore, provided for every user organisation (i.e., every centre) to gather and store the non-anonymised data locally in its own database and protect it against outside access, in accordance with DSG 2000.

However, participation in result-quality-oriented heart registers is a clearly stated requirement that necessarily demands the existence of a central database. In addition to the local databases with complete, non-anonymised data (individual-related, sensitive data), the system design must therefore provide a central database complying with the requirements of data protection law applicable to the use of data for statistical or scientific evaluations (DSchG 2000, §46, (1)(3), only indirectly individual-related). Only then will it be possible to perform nationwide statistical and quality-relevant evaluations. In achieving the project aim “possibility of benchmarking,” it would be advantageous if queries and evaluations from the national heart register were possible with a minimum of difficulty and without bureaucratic or organizational effort. The possibility of secure, interactive online queries over the Internet...
derives from this requirement.

The Austrian system of the heart register, therefore, emerges as a two-level concept with three basic components:

- **Level 1**: Central database (data warehouse, basic component 1) central register for anonymised operation data and methods for online report compilation based on öSTS and data pool for international comparisons (e.g., European Society of Thoracic Surgeons)

- **Level 2**: In-house client system (basic component 2) data gathering, data storage, analysis and reporting of patient-related, non-anonymised operation data with local (satellite) database based on öSTS. transfer of the local data to the central database and visualisation of the online reporting and benchmarking from the Level 1 database

- Interlevel methods and services for transfer and comparison of the data and for security and protocol functions (basic component 3)

**Technical implementation.** The experience gained during the two-year operation of an individual access program at Innsbruck University Hospital and at Salzburg General Hospital (AKH), with the IT-supported recording of the operation data based on the STS data record (Version 2.41), was defined as the underlying minimum workflow requirement for ergonomic data gathering, and was used to derive an ideal workflow, taking account of the different target user groups. Because the STS data record had already been selected as the foundation of the entire system, the software specification of the STS (The Society of Thoracic Surgeons, Adult Cardiac Surgery National Database, Software Specifications 2004) was used. This was adapted to the specific Austrian situation and the extended project requirements and thus, forms the basis for the implementation of the in-house cardiac application (Level 1).

The local Cardiac application is implemented as a VB fat client that is installed at the respective workplace on a network drive or on an application server (e.g., Citrix). The local database of the respective heart centre is generally realised on a central DB server (MS-SQL)
Apart from the central database, the cardiac communication server is the most important element of the central components (Level 2). The cardiac communication server consists of the cardiac Web server (function of the listener on the central DB side), the client, which is integrated in the local Cardiac application, and the Cardiac report server.

The cardiac Web server is implemented as a Web service that processes messages over the http protocol SOAP. The content of the SOAP messages is transmitted with AES256 encryption so that an http connection (which many administrators do not want) is unnecessary. Even if transmission over the http connection is intercepted by a third party, decryption of the transmitted packets requires such enormous computing effort that the transmission route can be deemed to meet the security requirements. In order to avoid even this minimal risk to data security, the transmission of individual-related data is avoided entirely. In other words, the Austrian Heart Register contains only anonymised data. Information about the surgeon is also removed from the data record, so that it is not possible to generate outcome statistics at the level of centre or surgeon.

Transmission of data from the heart centres to the Austrian Heart Register. Data comparison is basically initiated by the cardiac client in response to a user request. The client calls the server and, after authentication, receives a transaction ID. This (temporary) transaction ID is combined with the (permanent) participant ID to generate a session key whose validity is checked at every transmission. Compilation of the data to be transmitted takes place in the cardiac client in an upstream process step: from the database, an öSTS compliant, non-encrypted data record is generated that is saved to the hard disk of the Cardiac user. This data record, in plain text, can be examined by the user at any time so that there is complete transparency regarding the transmitted data.

After successful initiation of the data transfer, the previously created file is opened, the data are read out record by record, encrypted locally with the session key (see previous) and sent to the server. There, the data record is decrypted (local key) and the comparison with the central heart register is performed (Insert/Update/Delete). The result of the transaction is returned to the client as a result and recorded.

Preparation of online reports. A session is also initiated (see previous) when the cardiac user submits a query to the Austrian Heart Register. After successful establishment of communications, the request for the report and the selection parameters are transmitted. This transmission is also encrypted. The Cardiac report server compiles the requested report as a PDF file on the server, and returns the result to the client in the form of the encrypted link to the PDF document. The client then accesses the PDF and displays the report. The link is valid only once, and may only be accessed within 1 minute from the host that has initiated the session. As security against unauthorised queries, there is a list of blocked fields that may not be included in the query (neither in the Select statement nor in the Where clause). This blocking list can be maintained by the Web server administrator. For reasons of security, all transactions are also recorded in the database.

**FUTURE TRENDS**

Risk stratification in cardiac surgery is, and remains, an important topic whose significance will continue to increase, despite the intense discussion that is already taking place (a search in March 2007 under http://scholar.google.com produced 35,400 hits for “cardiac scoring” and 29,000 hits for “cardiac risk stratification”). The growing demand for specialised scoring systems of risk stratification for selected subgroups, in order to improve predictive accuracy, and the associated need for the qualified data material that provides the base for preparing the underlying regression analyses, is predictable. The primary task in meeting this demand will be to develop new predictive models that are able to analyse the dependencies and influences of specific combinations of attributes. However, it will also be necessary to adapt existing, internationally recognised scoring systems at regular intervals, in order that they remain valid, despite a changing situation: thus, for example, new surgical techniques, such as minimal invasive cardiac operations, the use of robots, and virtual operating theatres, will amplify the demand for new, differently structured data.

The continually growing demand for data and the associated outlay for security and manageability, on the one hand, and the demands for a trivial bedside decision-making tool, on the other, also have organisational consequences:
The trend that has been visible for years in IT generally, and especially, in the computer-supported quality assurance sector (Lübke, 2000), that island solutions in the form of “private” databases developed and operated by individual users or centres are being superseded by integrated overall solutions with practicable workflows and calculable costs, provided by specialist producers, will also prevail in the field of quality assurance in cardiac surgery. Current IT solutions to the problems of data security and data quality, on the one hand, and data protection, on the other, indicate that professional, integrated QA solutions, optimised for the respective task, accelerate the merging of classical risk stratification tools and scientific data warehouse concepts, and improve the exploitability of synergistic effects.

The methods of risk stratification will also embrace further areas of medicine. The vascular surgery sector is an example of another important area in which the advantages can be exploited because of the high level of synergy available at moderate cost.

CONCLUSION

Despite the sometimes contradictory discussion within cardiac surgery, the method of statistical risk stratification is an important means for preoperative risk assessment and patient education, as well as being the basis for performing result-quality-oriented outcome analyses.

It is evident that risk stratification contributes towards improving quality in the cardiac surgery sector; there is still a need for new statistical models. However, the outlay incurred is not limited to the gathering of a few risk factors; rather, it will be necessary, consistently and completely, to gather extensive individual-related, operation-related, and facility-related data. Local recording and storage without central collection and comparison in a national heart register does not enable the generation of the national and international analyses and benchmarks that are the basis for improving the outcome. In contrast to individual databases, however, national heart registers require uniform, standardised data structures and quality-tested data gathering in all areas.

A system in which each centre gathers and stores its own individual-related data, with the possibility of using this data as a bedside decision tool and for individual analyses and statistics in an integrated tool, and which includes an integrated interface to a central repository and analysis pool in the form of a heart register as a data warehouse, will ensure that all the demands of cardiac surgery can be fulfilled.

REFERENCES


KEY TERMS

The Austrian Cardiac Project: The Austrian Cardiac Project had the task of creating an Austria-wide heart register system consisting of a central database and distributed clients that would gather and analyse the data. Under the leadership of the corresponding author, the basis for this was constructed during the period November 2004 to February 2006. Since March 2007, the system is in use in 2/3 of all the Austrian hospitals where cardiac surgical interventions are performed. The Cardiac Project was carried out with the financial support of the Austrian Research Promotion Agency (FFG) and the Tyrolean Future Foundation, supported under the competence centre hitt – health information technologies tirol.

Cardiac Register: Database for gathering and evaluating structured data about cardiac surgical interventions. Cardiac registers are operated by private and public organisations, and serve as a basis for the determination of outcome data and for scientific studies (clinical trials), and for the construction of scoring models.

Outcome: The outcome is the result of an intervention, either referred to an individual intervention or to a number of interventions. In cardiac surgery, the 30-day mortality is the predominant characteristic for the outcome. This is independent of the individual risk of the intervention and states whether the patient is alive or not on the 30th day after the operation. In addition to the simple 30-day mortality, the in-house mortality is frequently used as an outcome characteristic: in
contrast to the simple 30-day mortality, it is determined whether the patient has already left the facility on the 30th day or is in an intensive care unit. In the latter case, monitoring of the mortality is prolonged until the patient has left the facility or the ICU.

**Result Quality:** The result quality is defined as the ratio of the outcome to the risk-adapted expected mortality. The observed mortality, as a given (observed) value within a sample, is constant. Since different scoring models calculate different predicted values for the same population, the result quality may be observed and compared only in the context of the underlying scoring model.

\[
\text{result quality} = \frac{\text{observed mortality} [\%]}{\text{risk-adapted expected mortality} [\%]}
\]

**Risk Stratification:** The estimation based on significant risk factors of the risk of a disease progressing or of a disease or operation leading to complications or death. One or several endpoints can be estimated (morbidity).

**Scoring Model:** A scoring model is a mathematical model that forms the basis for risk stratification. Scoring models generally arise from clinical studies in which statistical methods (e.g., chi square test, ROC curve) are applied to the data of a relevant population in order to identify parameters with a significant influence on the particular issue. Scoring models are either logistic models, in which the coincidence of several parameters leads to a higher risk, or summary models, in which the risks are simply added together. Commonly used risk models are EuroSCORE, Parsonnet, Ontario Province Score, and STS.

**VLAD (Variable life adjusted display or variable life adjusted diagram):** The VLAD is a graphical representation of the result quality for a selected number of cardiac surgical interventions. The interventions are listed chronologically on the x-axis (1 – n). The result quality of the interventions is added together on the y-axis; a positive outcome causes the curve to rise by the risk-adapted expected mortality and a negative outcome causes it to fall by (1 – risk-adapted expected mortality). In this way, the expected risk of the intervention is taken into account. If there is a high degree of uniformity regarding the average risk, the graph can be expected to oscillate about the zero axis. Better results than predicted are recognised as a climbing graph.
Multicultural Education and Technology Integration

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INTRODUCTION

The article includes a description of the foundation of multicultural education and a delineation of the concept and its processes. It will also include a depiction of multicultural instructional strategies, and the transformations academic institutions must undergo to adopt the multicultural philosophy. Finally, the article will include a discussion on how technology can be integrated into multicultural education to assist educators.

Situating Multiculturalism and Multicultural Education

Multiculturalism is a modern philosophy with multi-faceted goals, which are to promote equity pedagogy, social justice, acceptance of diversity, and social reconstruction in public organizations such as educational institutions. The foundation of multiculturalism can be traced to philosophies such as Marxism and Critical Theory. These doctrines question the status quo, and seek to close the gap between the dominant social group and the subordinate or marginalized group.

Karl Marx, the founder of Marxism believed that all institutions rest on an economic base, and that human history is essentially the struggle for economic and social control. The philosophy embodies the idea that the bourgeois (dominant group) control educational and governmental institutions to serve themselves while alienating the proletariat (subordinate group). This inequality in education suggests that the dominant class have better access to superior education opportunities than the subordinate classes. This ethos is inherent in multiculturalism, an ethos that endorses equal education for both the marginalized and non-marginalized or, in Marxist terms, for the bourgeois and proletariat.

Similarly, critical theory philosophy addresses the issues of multiculturalism in American classrooms by recognizing that knowledge does not need to be imparted from a single perspective, but from multiple viewpoints. Critical theorists advocate that students need to share their stories to develop a link to “the larger histories of their respective economic classes and racial, ethnic and language groups” (Ornstein & Levine, 2006, p. 117). Specifically, academic institutions can integrate multicultural education into their teachings by drawing on student’s cultural heritage. Advocates of this philosophy state that students who are allowed to explore their identities and learn about others are better able to deal with discrimination as well as refrain from it.

Multiculturalism as a philosophy sprung out of the doctrines discussed. However, a review of literature indicates that the definition of multiculturalism is usually depicted in terms of ethnicity (Tierney, 1994). Tierney also states that when defining multiculturalism, we must avoid depicting the term in relation to racial identities, with more emphasis on equity for African Americans, thus, providing a narrow definition of multiculturalism. In a general sense, multiculturalism can be depicted as an ideology that embodies the underlying principles inherent in philosophies and theories that include cultural diversity, equity pedagogy, critical theory, and cultural pluralism. Hartman and Gerteis (2005) describe multiculturalism as “a response—or a set of responses—to diversity that seeks to articulate the social conditions under which difference can be incorporated and order achieved from diversity” (p. 222). Therefore, the goal
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of multiculturalism is to address differences in order to make social conditions equal. Similarly, Sims, Perrell-Arnold, Graham, Hughes, Jonikas, Jo, Onaga, and Sardinas, (1998) state that multiculturalism enables the individual to examine their culture, and provides a means of understanding other cultures.

Despite the different rhetoric used to describe this ideology, the overarching theme encapsulated in these definitions is the notion that multiculturalism endorses inclusion and equity in all aspects of life, especially in education. The multiculturalism ideal is aptly summarized by Clery-Lemon (2003), who asserts that the doctrine provides a means for educators to promote equity pedagogy, democratic education, and social justice. Moreover, the multicultural philosophers assert that all individuals should be treated fairly, regardless of race, linguistic diversity, disability, gender, religious orientation, social class, and sexuality. These ideals must be reflected in the school system, curriculum, and in teachers’ behaviors in and outside of the classroom. A secondary theme is social reform that entails using education to change society as whole and actively combating injustice.

Multicultural Education Theoretical Framework

Multicultural education can be characterized as a strategy to drive multiculturalism forward and infuse it into the curriculum and education system. Multicultural education emerged as a result of “the civil rights and equal education movements in 1960s” (Clemons, 2005, p. 289). This was a time in educational history when there was an explicit campaign for desegregating schools. Multicultural education is defined as an approach that brings individuals who have been segregated in education to the forefront so that minorities can identify themselves in the education they receive. Moreover, multicultural education is a means of fostering respect for our differences and endorsing inclusion. Advocates of multicultural education assert that multicultural education is essential because teachers need to be equipped to teach an ever-increasing diverse student body.

A review of literature reveals that the leading scholar in the field of multicultural education is James A. Banks and his depiction and philosophy of multicultural education is chosen as the theoretical framework for this article. However, competing concepts of multicultural education will also be addressed. Banks (2004) offers a cogent description of multicultural education, defining the concept in terms of dimensions, which are now discussed in detail:

- Content integration refers to how teachers integrate examples, information, and data from different cultures or social background into their daily teaching practices.
- Knowledge construction refers how educators can assist students to develop an awareness of “implicit cultural assumptions, frames of reference, perspective and influence the ways in which knowledge is constructed” (p. 5).
- Prejudice reduction focuses on students’ attitudes towards discrimination and how these attitudes can be changed by adapting teaching strategies and resources.
- Equity pedagogy addresses the modification educators make in their teaching activities to accommodate students from diverse cultures, social and racial backgrounds. Moreover, it entails infusing these differences into the curriculum.
- An empowering school culture and social structure refers to the reform of school system to eliminate discrimination, advocate fairness, and create an egalitarian society.

Banks (2004) asserts that the primary objective of multicultural education is to modify all academic institutions “so that students from diverse racial, ethnic, and social-class groups will experience educational equality” (p. 3). The underlying theme of Banks’ multicultural education is to enforce parity through institutional change. This description of multicultural education encapsulates the idea that all aspect of educational organizations should change in order to foster equality in schools. This equality pertains to all students, specifically those who have been disenfranchised because of their race, physical disability, gender, linguistic ability, and sexuality.

Similarly, an equally prominent multicultural theorist and supporter, Christine Bennett, defines multicultural education as an instructional strategy as opposed to a philosophy. Bennett (2003) affirms that this approach to teaching is founded on democratic doctrine and principles that uphold “cultural pluralism within culturally diverse societies in an interdependent world” (p. 14). Bennett affirms that the conditions of
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schools prevent students from excelling and typically, this has an adverse effect on minority students. Thus, in order for multicultural education to be successful, education administrators must strive to improve instructional situations in schools, specifically, improving teacher training, instructional strategies, materials, and resources. According to Bennett (2003), multicultural proponents contend that the purpose of education is to cultivate student’s academic and interpersonal abilities, and to develop their potential to become functioning citizens in a diverse society.

Conversely, Tiedt and Tiedt (2005) affirm that the inherent objective of multicultural education is inclusion and providing the “best education to all students regardless of race, gender, language…” (p. 21). The authors purport that multicultural education concerns everyone in society. More importantly, they recognize that schools, colleges, and universities face different multicultural problems that may be associated with race, religious bigotry, disparity in attainment, linguistic diversity, sexism, and disability, and that educational institutions should adapt their multicultural practices to accommodate their needs. The authors maintain multicultural education is designed to counter cultural prejudice by encouraging students to explore their cultural identity in the classroom, a view also endorsed by Banks and Bennett. Tiedt and Tiedt perceive multicultural education as a means of developing the students’ intellectual and emotional well-being.

Evidently, commonalities can be deduced from each of the approaches discussed; however, each theorist emphasizes different objectives. Banks avers that multicultural education means systemic change in schools to achieve social justice and equity in education. In contrast, Bennett stresses the need to change the school environment itself, and provide appropriate support and training for teachers and students. While Tiedt and Tiedt view multicultural education as raising consciousness about intolerance as means of eradicating it and raising students’ self-esteem.

Multicultural Instructional Strategies

In a society that promotes liberty and social justice, the tenets of multicultural education should be easy to accomplish; however, this is not the case in the American education system, specifically in higher education. The application of multicultural education has been problematic due to the lack of coherent definition of the term multicultural education and its inherent goals. Multicultural education has often been perceived as a panacea for dealing with all forms of discrimination and even as a means of eliminating inequality, but the history of the multicultural education movement shows that this is a futile aspiration. Instead, experts in the field, such as James Banks, suggest that multicultural education should serve as a catalyst for discussions about diversity, that is, an approach that encourages teachers and students to learn about other cultural and social backgrounds as opposed to only learning about mainstream customs. This is important because society is diverse and thus, education serves as a vehicle to prepare students to be better able to deal with diversity. Scott and Pinto (2001) state that “educators, teachers, and administrators alike should develop and maintain a moral responsibility for social justice” (p. 38). Thus, they ask the question “how then can educators develop and maintain an ethical commitment to multicultural education and the students who may differ from them?” (p. 38).

Accomplishing all the facets of multicultural education is problematic due to a number of reasons; multicultural education has unrealistically high expectations of teachers who have little or no training or knowledge about how to apply multicultural education. The problem therein lies with equipping teachers with the relevant knowledge and skills to enable them to implement the multicultural education pedagogy in the classroom. Gay (2003) avers that first and foremost, it is vital that teachers acknowledge differences, such as race and disabilities, and exhibit a commitment to accommodating differences. Specifically, Gay perceives multicultural education as a process and a belief system that teachers must adopt wholeheartedly in order for it to be utilized effectively. Educators must embrace diversity in their classrooms by striving for fairness and reducing bigotry in their teaching practices in and outside of the classroom. In support, Moll and Gonzalez (2004) state that “…if we are to appropriate pedagogically the richness of diversity, including its multiculturalism, it is certainly insufficient to simply acknowledge diversity. Instead, it is indispensable, to provide schools with the “didactic” tools to work with diversity” (p. 700). The authors acknowledge that in order for multicultural theories to be effective, educators must possess the knowledge and skill to put it into practice. Thus, this section of the paper will focus on the different postulations of multicultural instructional strategies.
The instructional strategies delineated in the paper focus on curriculum reform and instructional methods. Gay (2003) recognizes that achieving equality and greatness in education for every student is unfeasible without considering multicultural education in all facets of academia. Banks (2004) multicultural instructional strategy entails a detailed examination of how the curriculum should be reformed to accommodate multicultural principles. The author advocates a constructivist approach because it allows students to construct their own epistemology. Banks’ instructional strategy is divided into four levels described next:

- **Level 1, the contribution approach:** This approach is a commonly utilized method in schools, and typically involves schools celebrating the accomplishments of illustrious minority or “ethnic heroes” (p. 61) individuals. This approach requires no change to the curriculum and is the simplest method of infusing multicultural concepts in the classroom. However, the author argues that this strategy “often results in the trivialization of ethnic cultures…” (p. 61). Banks maintains that students are not provided with in-depth insight into cultural differences and skims the real experiences of prejudice and subjugation faced by these eminent individuals.

- **Level 2, the ethnic additive approach:** Involves adding something novel to the curriculum, such as a new course module or a book. This strategy allows educators to integrate new concepts into the curriculum without modifying its goals or restructuring it. However, it shares the same limitations as the aforementioned method in that it does not provide students with a detailed or critical outlook of the ethnic content.

- **Level 3, the transformation approach:** Is very different to the two previous strategies discussed because it requires tremendous change in the structure, purpose, and content of the curriculum. Students are provided with the opportunity to analyze, depict, and evaluate a particular subject from various viewpoints. It also allows students to interact with diverse groups. The approach encourages the use of primary sources to give students the opportunity to receive a robust educational experience.

- **Level 4, the decision-making and social-action approach:** This strategy includes all the elements of the transformation method, but also necessitates students to “make decisions and to take action related to the concept, issue or problem they have studied” (Banks, 2004, p. 63). In specie, students are encouraged to take action to reduce bias in their learning environments by examining their behaviors and assumptions. This approach endorses empowerment and providing students with the impetus to enforce change.

In sum, Banks states that the ideal multicultural strategy should aim to transform the whole school setting, beginning with the curriculum and how it is delivered in the classroom. This strategy will help to ensure that the diverse student population will receive an equal education. Banks recommends that the instructional strategies are not mutually exclusive, and each can be integrated to accommodate the individual learning environment.

Similarly, Ladson-Billing (1994) conducted a 3-year ethnographic study in a California school district whose student body was primarily impecunious African Americans and Caucasian students. The purpose of the study was to record the activities of “highly effective teachers of African American students” (Ladson-Billing, 1994, p. 145). The researcher used “teacher selection, teacher interviews, classroom observation and videotaping, and collective interpretation and analysis” (p. 145) to understand the strategies the teachers used in the classroom. The researcher described the practices of these teachers (who were racially diverse) as benchmark for culturally relevant teaching. Culturally relevant teaching is defined as a teaching approach that “empowers students intellectually, socially, emotionally and politically by using cultural referents to impart knowledge, skills and attitudes” (Ladson-Billing, 1994, p. 18). Culturally relevant teaching involves accommodating students’ cultural experiences and teaching to students’ strengths. This teaching methodology is applicable to all students, especially racially and ethnically, linguistically diverse, and underprivileged students. Ladson-Billings developed effective cultural relevant teaching strategies based on the findings of the ethnographic study. Essentially teachers must:

- Perceive themselves as a member of the community, and that their profession is about teaching in a manner that improves students and society at large. They should enable students to connect the
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knowledge they acquired to their local, national, and international communities
• Believe that all students are able to excel and view teaching as building on knowledge, not “banking” (p. 34) information
• View knowledge as evolving and not stagnant; in addition, consider the impact of diversity on learning. Teachers should view learning as conscious raising, and allow students to evaluate what they have been taught
• Be passionate about their profession and committed to helping their students become functional members of a diverse society. Teachers should stress cooperation not rivalry amongst students

Ladson-Billings states that these qualities or practices were commonly exhibited by the teachers who participated in the study. The researcher also asserts that the teachers who participated in the study worked against the system that employed them; challenged mainstream teaching methods by adapting them to suit their learning environments, and the students’ learning needs and cultural backgrounds. However, it is important to note that Ladson-Billings strategy has been criticized for representing excellent teaching, not necessarily multicultural teaching.

Conversely, Tiedt and Tiedt (2005) put forward multicultural instructional strategies that can be applied to many levels of education, from nursery to higher education. Unlike the previous authors, Tiedt and Tiedt recommend a practical approach rather than a theoretical method to implementing multicultural teaching strategies. The strategies are depicted as follows:

• **Reading out loud**: Is an approach that is particularly useful in K-12 education because it is an efficient and easy way to include all students. “It is an outstanding method of assuring that even less able readers have an opportunity to know good literature” (Tiedt & Tiedt, 2005, p. 79). The authors maintain that teachers could add a multicultural context by reading multicultural text.
• **Meaningful discussions**: Help students discuss litigious issues in a neutral environment. They recommend discussions that are student centered not teacher driven, and assert that this approach can be used with students of all ages.

• **International pen pals**: Is a strategy that will enable students to meet many students from diverse cultures and make learning a global phenomenon.
• **Libraries**: Allow students to conduct research and apply critical thinking skills. They also allow for the combination of multicultural content in the curriculum.

Tiedt and Tiedt support the teaching strategies that are student-centered and encourage cooperative learning groups. The strategies are practicable and uncomplicated for teachers to implement in the classroom. Moreover, the authors recognize the importance of using technology to aid multicultural teaching.

Furthermore, Bennett (2003) supports the use of the following instructional strategies to drive the multicultural initiative:

• **Learning styles**: Stresses the importance of considering learning styles as a teaching strategy. Learning styles have been considered by educators in all academic fields. It provides teachers with the opportunity to diversify teaching to cater to individual learning differences. From a multicultural perspective, Bennett (2003) affirms that there is a connection between culture and learning styles. Particularly, learning styles are influenced by societal and cultural structures. Thus “when teachers misunderstand their student’s cultural behavioral styles, they underestimate their intellectual potential and unknowingly misplace, mislabel and mistreat them” (Bennett, 2003, p. 199). They further assert that failure to understand differences in learning can be a problem in the classroom.
• **Cooperative learning**: Is an alternative to traditional teaching methods. The author states that cooperative learning is an effective method of working with diverse student populations. The approach was originally devised for desegregated schools, but is now used in all schools. Bennett states that studies have revealed that cooperative learning has been successful in diminishing the achievement gap between minority and non-minority students.
• **Mastery learning**: Is an approach that is based on the notion that all students have the ability to learn. The strategy involves breaking down
a particular subject into smaller topics that are taught consecutively. It is a strategy that is based on behaviorism, which focuses on setting and meeting objectives and modifying behaviors. Teachers can integrate multicultural concepts into manageable units to be taught. The merit of mastery learning is that students are able to excel at the units and achieve learning outcomes and objectives. In addition, all students are able to learn the material and no student is left behind. However, there are some notable limitations to this approach. Bennett points out that teachers report that more time is “spent waiting for slower learners to catch up” (p. 266) and are often held accountable if the students fail to achieve.

- **Experiential learning**: Relies on students’ experiences, and cultural and social background. This approach supports multicultural concepts, and is based on humanistic theory that places the individual at the forefront of the learning experience. This strategy lends itself to multicultural principles because it allows teachers to help the student discover knowledge. Bennett affirms this approach is effective when combined with mastery learning because attainable objectives can be established.

- **Bilingual education**: Is another multicultural teaching strategy designed to cater to linguistically diverse students. This strategy entails teaching students in the two languages; in English and in their native language. Bennett notes that for some languages, offering bilingual education is difficult, so a language maintenance program is an effective alternative. This strategy is based on the belief that maintaining the native language will assist the learning of English while preserving the student’s cultural identity.

Bennett concludes that the overall goal of these strategies is to create a “supportive, noncompetitive, communal learning environment” (p. 286) where students are inspired to excel to the best of their abilities. Moreover, the strategies address the need to integrate multicultural education in a manner that does not have a deleterious effect on the standard program of study.

**The Application of Technology in Multicultural Education**

In this technological era, it is prudent for educators to use the technology available to them to its full potential in order to best serve learners and society at large. Educational institutions and businesses recognize the obvious benefits of technology in all aspects of our lives. Shelly, Cashman, Gunter, and Gunter (2004) point out that “computers play an essential role in how individuals work, live, and learn. Organizations of all sizes—even the smallest schools and business—rely on computers to help them operate more efficiently and effectively” (p. 1.01). The growth of technology usage and reliance has prompted educational institutions to acknowledge the ways technology can enhance, support, and innovate the instructional experience for both the teacher and the learner. Moreover, Lever-Duffy, Mcdonald, and Mizell (2003) state that educational technology includes all the pedagogical processes, resources, tools, and materials that can be used to enhance teaching and learning. It incorporates the methods of designing, developing, implementing, assessing, maintaining technology effectively to ensure meaningful learning. “Educational technology can be a support for teaching and learning that both teacher and learner can call on to help ensure the opportunity for optimum performance” (Lever-Duffy et al., 2003, p. 24). It is therefore necessary for educational institutions to place a high premium on educational technology in order to ensure it is successfully applied to pedagogical and andragogical practices.

Consequently, the integration of technology is vital in education, with educators stressing the need for instructors to acquire, update, and maintain their technological skills in order to best serve their students. However, the use of technology to implement multicultural education is an area that has scarcely been addressed in the academic arena. The benefits of technology in education is well documented; it enables instructors to overcome the constraints of distance and time. Technology can enable instructors to bring diversity into the classroom, using the Internet and multimedia to provide varying viewpoints from diverse backgrounds. For instance, an instructor of philosophy in higher education can pool technological resources to present ideas from philosophers that include the well-known Aristotle and Plato, and also the works of Mary Wollstonecraft, who advocated equality for
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women, and/or Angela Davis and Patricia Hill Collins, renowned African American feminists and activists. Technology can provide teachers with access to the works of lesser-known philosophers through resources such as online databases. In addition, teachers could encourage students to create electronic portfolios that showcase the scholarly efforts of those individuals that are ignored in academia. Moreover, multimedia such as audio and video can be used to enhance instruction as well as engage students. Moreover, instructors can gain access to information using the Internet to expose their students to cultures that are different from their own. In doing so, students are exposed to robust knowledge and not solely the mainstream curriculum. Technology, specifically interactive multimedia, is an effective method of supporting and endorsing teachers’ application of multicultural theory and its integration into the curriculum.

Thus, giving the obvious benefits of using technology, it is necessary for educators to recognize the opportunities educational technology provides with regards to multicultural education. Shelly et al. (2004) postulate that technology can offer authentic and efficient opportunities for teaching and learning. Technology can facilitate multicultural teaching by making it possible to infuse cultural issues into the curricula. In support, Bush (2005) states that “web access crosses cultural boundaries, providing expanded opportunities to gain insight about how other cultures operate” (p. 224). Bush also maintains that using multimedia and Web technologies when teaching helps to reveal aspects of a culture that is not easily available because time and distance constraints.

However, despite the apparent merits of integrating technology in education, there is little research about the multicultural paradigm and technology (Grant, Elsbree, & Fondrie, 2004). Similarly, Cummins, Brown, and Sayers (2007) state that educators have failed to take advantage of the potential of technology in field of diversity. The authors state that the problem lies with the pedagogy as opposed to the technology itself. Grant et al. (2004) state that there is a need for multicultural theorists to develop practical approaches to multicultural education. In addition, resistance to technology coupled with deficiency in technological skills and knowledge confounds the issue further. The author also states that while educators acknowledge that technology can enhance their teaching practices, their technological ability does not match that of their students. This emphasizes the need for a new trend in multicultural research and literature to address how technology can facilitate multicultural ideology.

Notably, there are a number of multicultural theorists who have identified some ways in which technology can be utilized to advance multicultural instruction. Tiedt et al. (2005) recommend some strategies for using technology to assist multicultural teaching:

- Computer software applications provide teachers and students with an excellent means of integrating multimedia with multicultural concepts in mind. The use of software applications can enable teachers and students to create multicultural documents in addition to enhancing their writing and research skills.
- CD-ROM programs include an array of multimedia programs that sustain a wide variety of subject areas from social sciences to mathematics. This technology allows teachers to make use of virtual reality in the form of “virtual field trips” (p. 83) that engages students in exigent tasks that encourages critical thinking. The use of CD-ROM programs can facilitate teachers to add multicultural content to the curricula.
- World Wide Web is available in the majority of academic institutions and according to Tiedt and Tiedt, the Web provides a plethora of “possibilities to add content and interest to multicultural studies” (p. 84). The Internet allows access to current information on all subjects, interchange of thoughts and opinions with people within and outside one’s culture. The use of the Internet support the multicultural objectives by allowing students to collate, investigate, critically assess, and present information pertaining to diversity issues. Tiedt and Tiedt affirm that the Internet enables students to discover and access information about the world that may be not readily available to them. Moreover, distance learning can provide a meaningful and enriching learning experiences if managed properly (Emurian, 2006). Distance learning allows educators to reach students that cannot attend classes on campus such as working individuals, international students, or students with physical disabilities. Distance learning has helped overcome the boundaries associated with accessibility. Many students are now able to learn at a time that is convenient to them. Distance
learning drives multicultural initiatives because education is available to all. An example of this is the use of WebQuest as an instructional tool that is becoming increasingly prevalent in education because it is a fast and easy method of integrating technology in education. WebQuest is “an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the Internet” (Smith, Draper, & Sabey, 2005, p. 99). The use of this instructional tool encourages students to synthesize and evaluate information, and it is a tool that can be married with multicultural concepts.

In addition, Brown (2004) assessed the addition of technology to a teacher education cultural diversity course. The course incorporated technology through the use of a Web-based instructional tool (Blackboard) to increase interaction among students, students, and teacher, and to facilitate discussions on multicultural issues such as race, gender, religion, and sexuality. The author concluded that technology benefited students by allowing them to find relevant multicultural materials and information; connect multicultural theory to practice and to view how technology can help educators teach multicultural pedagogy. The author found that with regards to the instructors, the technology provided them with a means to supervise students’ progress; inspire critical inquiry through discussion boards, collect and store multicultural instructional materials. Additionally, the students reported that they were able to find and carry out multicultural research, and experience firsthand how multicultural education can be integrated into the curriculum. The author concluded that the amalgamation of technology helped to create a “more dynamic and rewarding for both the instructor and the students” (p. 555), particularly when the students state they use what they learned in the course in their own teaching practices.

Likewise, Furstenberg, Levet, English, and Maillet (2001) designed a Web-based intercultural curricular initiative entitled Cultura, which involved using a constructivist approach to teaching and learning. Students were given the opportunity to build their knowledge about cross-cultural literacy by examining the interaction between “language, communication and culture” (p. 57). Furstenberg et al. concluded from working on the project that computer-assisted interaction brings to light the concealed facets of cultures and assists students to acquire an awareness of other cultures. Bush affirms that teaching students how to interact interculturally and to work successfully in a diverse global environment is essential in light of the changing business climate. In support, Tiedt and Tiedt (2005) asserts that educators can offer students the prospect of enhancing their interpersonal skills by using technology to teach multiculturalism.

Similarly, Chaney and Martin (2005) state that technology can help to endorse cultural awareness in education and business. They suggest that technologies such as electronic media, simulations, and Web sites can assist educators to connect cultural differences to the curricula. These technologies are discussed in detail as follows:

- **Electronic media** includes the use of multimedia technologies. Multimedia incorporates text, graphics, audio, video, and animation (Shelly et al., 2004). Each media type can be used to enable teachers to become better multicultural instructors. For example, the use of video can be more effective than using traditional lecture method to explain a particular climate in history. A poignant example is the viewing of Martin Luther King, Jr.’s “I have a dream speech” to helps students understand the frustration and hopes of people who were ostracized from society because of their race. Chaney and Martin report that the use of video can augment instruction and stimulate students. Moreover, didactic television programs can be used to introduce multicultural concepts in the classroom.

- **Simulations** allow students to participate in experiential learning. They can help students develop multicultural problem solving and critical thinking competences (Chaney & Martin, 2005). Simulation software can include cultural tasks that students can complete to cultivate learning.

However, although technology can make incorporating multicultural concepts into the curriculum unproblematic, the digital divide is still a persistent problem. The digital divide “separates lower-income from higher-income families and the social and educational consequences of these disparities” (Cummins et al., 2007, p. 94). This divide has a deleterious impact on students learning in a technologically enriched climate. Moreover, Clark (2004) states that students from well-
to-do families continuously receive high-quality education than those from underprivileged backgrounds. Clark cites an example that although all students are encouraged to use technology; with poor students the learning is isolated and often they use technology to enable them to memorize information to reiterate at a later date. In contrast, privileged students who also have access to technology are taught in an enriched and creative manner, they learn through problem-based learning, and teachers make connections between lessons. The learning is meaningful and engaging. Lever-Duffy et al. (2003) recommends that to overcome this problem, education policy makers, administrators, and teachers need to be aware of the divide “along ethnic, economic, gender, and education lines” (p. 388) so that they can be responsive to student’s needs.

**CONCLUSION**

In conclusion, multicultural education is a philosophy that advocates equity in aspects of education and fairness in instruction. The philosophy encourages educators to modify the curriculum to accommodate diversity issues with regards to gender, race, language, religious affiliation, and sexuality. However, discrepancies in defining multicultural education have led to difficulties in implementation in the classroom. Multicultural theorists put forward multicultural instructional strategies that endorse changes in school systems and environment so that minority students can be accommodated in the curriculum. Some stress curriculum reform while others emphasize that teachers need to change their belief systems to become both a multicultural individual and an educator. The multicultural teaching strategies endorse a constructivist approach to teaching, placing the student at the core of learning experience and building on existing knowledge. Moreover, the literature and research on using technology to facilitate multicultural education is scant. Nonetheless, some multicultural theorists recommended the use of Internet and other Web technologies including electronic media as methods of adding multicultural content in the curriculum. A review of literature revealed the need for proponents of multicultural education to conduct more research that assesses how technology can facilitate multicultural instruction to better assist educators.

**REFERENCES**


**KEY TERMS**

**Cultural diversity** refers to the differences in individual’s heritage in relation to social conditions, environment, language, race, food, and belief systems.

**Multicultural education** is a strategy to enforce multiculturalism and is defined as an approach that connects race, language, culture, gender, disability and, to a certain extent, social stratification to school curriculum. The approach incorporates constructivist doctrine, and maintains that students should discover knowledge as opposed to having it imparted on them. Moreover, the approach focuses on drawing student’s cultural heritage and experiences so that they can view themselves within mainstream curricula, and to prepare to live in a diverse society.

**Multiculturalism** is a philosophy that embodies equity pedagogy and social justice for all individuals that have been marginalized because of their race, gender, sexuality, disability, linguistic abilities, and religious affiliation. The philosophy endorses inclusion for individuals in education, and the need for multiple perspectives to be addressed by the curriculum.

**Technology integration** involves integrating all technology software and hardware into teaching and learning process. The technology integration process involves detailed planning, design, and evaluation of technology to be used for didactic purposes.
Multiple Intelligences

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INTRODUCTION

The multidimensional approach to education has existed for quite a long time. For instance, educators in the early and mid-19th Century, such as Edward Séguin (Montessori, 1965), already had ideas about physical and mental training. Froebel’s (1894) *Mother-Play and Nursery Songs* aimed toward the development of the whole child. Rich in songs with lyrics, the book contained activities designed to develop empathy in children through play with their mothers. Moreover, the book is full of beautiful illustrations and kinesthetic activities. Also, Thurstone (1938) designed intelligence testing method for measuring abstraction, verbal, spatial, numerical, numerical figure recognition, and other abilities.

Additionally, Montessori (1965) considered moral, physical, tactile, literal, and sensory developments as important elements in education, and she developed methodologies for teaching geometry and arithmetic. Guilford (1967) included abilities such as multilimb coordination, spatial orientation, symbol recognition, verbalization, reasoning, and social cognition as components of human intelligence. After this long tradition of referring to multiple intelligences, Gardner (1983) suggested that intelligence is the ability to define and solve problems in real life, insisting that there is a wide range of intelligence that is represented by different abilities. However, there is the misconception that Gardner invented the multiple intelligences framework. For example, Teele (1995, p.2) refers to Gardner’s as a “new paradigm.”

BACKGROUND

Gardner (1983) described different types of intelligences:

1. **Linguistic intelligence:** Is represented by a highly developed sense of phonology, semantics, and syntax. There are four domains of linguistic intelligence:
   a. **Rhetoric:** Persuading others through language
   b. **Mnemonic:** Using language to remember.
   c. **Explanation:** Using language to explain.
   d. **Metalinguistic:** Using language to think about language.

2. **Musical intelligence:** Consists of the ability to recognize and replicate pitch and rhythm, as well as the ability to compose music and express feelings through music.

3. **Logical-Mathematical intelligence:** Is associated with formal mental operations. Abstract thinking is the signature of logical-mathematical thinking, although some may conclude that any mathematical activities foster logical-mathematical intelligence. On the contrary, Gardner (1983, p.138) argues that, “mathematicians are seldom talented in finance or the law. What characterizes the individual is a love of dealing with abstraction.”

4. **Spatial intelligence:** Involves the ability to grasp visual worlds correctly, to transform visual perception, and to recreate what one has seen before.

5. **Bodily-Kinesthetic intelligence**: Involves the skill to use one’s body to accomplish tasks. Dancers and actors, for example, possess such skill.

6. **Intrapersonal intelligence:** Refers to self-knowledge. Gardner refers to Erikson’s (1963) framework of identity development.

7. **Interpersonal intelligence:** Concerns the ability to form friendships and maintain social sensibility.

In addition to the seven original intelligences, Gardner (1999) later added naturalist intelligence:

8. **Naturalist intelligence:** Is linked to the ability to classify biological features of animals and plants.
It is noteworthy to point out a key difference between Gardner’s view of intelligence and that of other scholars. The sharp difference seems to lie in spiritual education. In traditional education in both Europe and the United States, spiritual development is considered to be extremely important. On the contrary, Gardner (1999) opines that spiritual intelligence is not admissible. Nonetheless, exploration of spiritual detention is not altogether dismissed by current scholars. Goleman (2003), for instance, implies that one can train oneself to control negative emotions by meditation, typically practiced by Buddhists, and encourages constructive dialogue between scientists and spiritual leaders.

Some teachers have the misconception that multiple intelligences theory is concerned with determining learners’ most developed intelligences and adjusting instruction to accommodate these intelligences. Such teachers may not require weaker writers to write as much as they should and say that it is acceptable for them to express themselves through drawing, music, or dance. To the contrary, Gardner believes that underdeveloped intelligences should be nurtured. For example, Piaget (1980), whom Gardner (1983) quotes in *Frames of Mind*, believed that logical-mathematical thinking is not endogenous, but develops as the result of a learner’s knowledge construction while she adapts to specific external environments.

In terms of musical intelligence, if someone grows up in a culture that trains children in the community to become skilled at rhythm and tone, almost all members in the community are likely to have musical intelligence. In some cultures it is believed that musical talents are not inborn, but are developed by stimulus and training. In addition, Gardner (1983) insists that with the right training, most people could play the violin skillfully, although few would become concert violinists. Some are born with exceptional talents, but the nurturing of these talents is paramount to the development of intelligence. The exception is those with legion or sickness of brain (Gardner, 1983, 1993).

It is likely that more than one intelligence is used in an activity because solving an authentic problem normally requires the interaction of several types of intelligence. Therefore, a class activity can simultaneously employ multiple intelligences (Armstrong, 2000). For example, effective communication with others involves social competency and verbal skills. For young children, speech is mainly used for social interaction. Later, children develop inner speech, which fosters logical thinking (Vygotsky, 1986). This means that communication for older learners entails interpersonal, linguistic, and logical intelligences. The next section will examine some uses of technology that allows multiple intelligences to interact.

**MAIN THRUST OF THE ARTICLE**

The best way to nurture multiple intelligences is to have learners engage in an authentic problem solving. Real-life problems are often messy. In order to develop life-long learning skills, students need to identify unknown problems and then develop solutions. Even though real-life problems are messy, educators mainly design well-structured problems for classroom activities. This gap can inhibit the development of the ability to become successful problem solvers in real life (Jonassen, 2003). Therefore, it makes sense to facilitate authentic, nonlinear activities using technology; but it is naïve to think that a given technology tool will automatically foster a certain intelligence. Any technology can either facilitate or deter learning. Successful use of technology that nurtures multiple intelligences, therefore, depends on the pedagogical skills and the academic content expertise of the instructor.

The first example of technology that assists real-life problem solving necessitating multiple intelligences is *WebQuest* (available at http://www.webquest.org/), an online problem-solving template created by Dodge (2006). With WebQuest, students follow the directions and search the Internet to find information for completing tasks defined by the teacher. It is a very well-supported form of Internet activity, as evidenced by nearly 2,000 examples created by classroom teachers, which were found on the WebQuest database when this article was written. Activities can range from weather forecasting to evaluating persuasive text to playground designing. A world language teacher may have students make a brochure for the best trip in the target country on a designated budget, requiring students to include texts in the target language and graphics. Moreover, multiple senses can be stimulated as learners read the directions, evaluate text and pictorial information on the Web sites, negotiate with peers to solve problems, and plan the logistics of the projects. However, careless implementation of WebQuest can result in a mindless time-filler (Jonassen, Howland, Moore, & Marra, 2003).
The basic assumption of WebQuest is group collaboration. Nonetheless, interpersonal intelligence is not automatically promoted with WebQuest, and it is possible that negative interaction among peers can occur when the teacher is not monitoring the class. It is also possible that hard feelings may develop as some learners in the group do most of the work and others do very minimal. Yet, if implemented wisely, learners can strengthen the skills that they need to develop through the use of multiple senses. Nevertheless, this can also deprive learners of opportunities to develop their underdeveloped intelligences. For instance, a student with weak linguistic ability can shy away from reading and writing and leave the task to strong writers in the group, and the group can produce beautiful writing without the input of the weak writer. If this happens, the teacher may not detect that the weak writer needs encouragement in writing because the group product misrepresents the skill of only some of the group members.

The next example is multimedia. Construction of multimedia can be a great activity for stimulating musical, logical, spatial, and linguistic intelligences. There is no official definition for multimedia because there are different views regarding it (Mayer, 2001). Bender and Bender (1996) define multimedia as a combination of audio, text, videotape, print, and graphics through the computer screen. It is also defined as different media in a same package (Smaldino, Russell, Heinich, & Molenda, 2005), or a combination of pictorial and text stimuli can qualify as multimedia (Mayer, 2001).

If students need to plan an auto-play PowerPoint presentation or digital movie production, they can use their logical intelligence to plan the production, linguistic intelligence to write the script, and spatial and musical intelligences to create the audio-visual presentation. When this author facilitated a digital video exchange between American students and Japanese students, intrapersonal intelligences and interpersonal intelligences were also targeted because the learners talked about themselves or school activities they liked with Japanese teenagers in mind. Moreover, group collaboration was also emphasized during this project.

In addition, teachers can produce multimedia to assist instruction. Graphics in multimedia can assist students in grasping textual meaning before actually reading the text, and this can be especially useful for non-native speakers of English or novice readers. Specifically, they may first listen to the audio text and look at the visual information prior to reading the visual text. Then they can use the graphical cues and the visual text to read the text aloud.

Nonetheless, premature understanding about multiple intelligences theory accompanied by a lack of knowledge about information processing theory can result in the production and use of multimedia that interfere with the learning process. For example, a novice teacher may believe that more stimuli are better and, thus, insert animation, noise, or slide transitions that are unrelated to learning the content. Moreover, novices also think that a game in which students need to earn as many points as possible in a limited amount of time is fun. However, this also can cause cognitive overload in working memory, which is capable of processing only very limited amounts of information at a time (Miller, 1956); and cognitive overload can interfere with learning (Kalyuga, Chandler, & Sweller, 2000; Mayer, 2001). In addition, duplication of audio text and visual text can cause cognitive overload, causing learning to be ineffective (Mayer, 2001).

When the presented material is simple, such as matching Spanish words to English words, cognitive overload in working memory is not likely to be an issue. However, as the complexity of the material increases, learners must use their working memory for simultaneously attending to various sources of information (Carlson, Chandler, & Sweller, 2003; Leahy, Chandler, & Sweller, 2003; Sweller & Chandler, 1994). Thus, teachers need to select or design simple multimedia for complex material. Furthermore, giving the learners control over their media’s presentation speed can also reduce cognitive overload (Mayer, 2001).

The third example is distance online collaboration. Interpersonal intelligence can be enhanced as learners engage in collaborative activities with technology. If proper writing styles, sharp focus, and smooth flow of arguments are required, then linguistic and logical intelligences can be nurtured as well. Online discussion board, blog, chat room, or Wiki can facilitate collaborative writing or active group engagements.

Nonetheless, haphazard use of these tools on the part of the teacher can have a negative impact. For example, while students are engaged in an online communication they may forget that there are real people behind the computer. As a result, students may be more blunt in this online environment, as compared to a face-to-face setting. Moreover, body language, facial expressions, or a tone of voice that carries meaningful
messages in a face-to-face environment disappears in the cyber communication. Hence, a comment meant to be humorous may be interpreted as an insult during cyber communication. Specifically, anger can build up among the participants, which can result in blatant outrage.

Hence, to deter such outrage, the instructor needs to teach *netiquette*, etiquette over the Internet, to students prior to online communication activities. In addition, the instructor should regularly monitor activities and intervene when there is a sign of bluntness, anger, frustration, or misunderstanding. Since some employers are dismissing workers for their misuse of the Internet (Ashe & Nealy, 2002), it is imperative that the schools teach netiquette. Thus, responsible use of technology is a part of the National Educational Technology Standards for Students (NETS*S) (International Society for Technology in Education, 2000).

**FUTURE TRENDS**

Many believe that intelligences are nurtured. Gardner (1983) also insists that, in most cases, intelligences can increase with training, even though they may not extend as far as those of world-renowned poets or composers. On the basis of this belief, methodologies for developing different types of intelligences have mushroomed, and a large number of teachers’ resources about developing multiple intelligences has been published. Specifically, on a Google search the combined search words “multiple intelligences” and “teacher’s guide” yielded more than 26,000 hits at the time of this printing, and this flood of information can be overwhelming for teachers who are looking for classroom activities. Moreover, the suggested activities do not always truly foster different types of intelligences among learners.

Educators should not blindly believe that an intervention to stimulate learners’ multiple intelligences will actually increase the targeted intelligences. Rather, they should make *data-driven decisions* and employ methods and materials that are known to produce results. Hence, the need for developing a test to measure multiple intelligences arises (Gardner, 1993; McMahon & Rose, 2004). However, McMahon and Rose (2004) investigated the validity and reliability of the *Teele Inventory of Multiple Intelligences* (Teele, 1992) and concluded that the test is not reliable. Nevertheless, the development of a dependable assessment tool for multiple intelligences could help educators collect empirical evidence about which, if any, treatment actually increases different types of intelligences among learners. Yet, another attempt to create *multiple intelligence assessment* has been made by Shearer (2004), but is yet to be confirmed for its validity and reliability on a wide scale. Accumulation of data for methods that are proven to promote multiple intelligences would definitely help teachers make classroom decisions.

*Cultural bias* should be considered when constructing a measurement tool for intelligences. For example, differences in culture can play an important role in oral or written communication, affecting how linguistic intelligence is defined. For example, American children are taught to express themselves clearly and directly, whereas directness in verbal communication can be interpreted as a sign of aggression or lack of consideration by those from a Japanese society. As a teacher of Japanese at a predominantly Caucasian high school in Western Pennsylvania, this author taught the American students to say, “That is a little…,” then pause without completing the sentence, instead of saying “No” when they wanted to reject the other party’s request. A listener is expected to figure out that the request is a little too unreasonable; therefore, it is not going to be granted, even if the speaker does not verbally communicate it.

Cultural differences can influence interpersonal and intrapersonal intelligences, too. Western culture develops a strong sense of “independent” self, while some Asian cultures promote an “interdependent” self. Therefore, a sense of humility, which is highly valued in Asian cultures, can be mistaken as a sign of weakness in American culture (Goleman, 2003, p. 241). There seems to be a distinct division between self and society in American culture, whereas the Japanese and the Chinese obtain their identities from the groups to which they belong. Hence, it is possible that the ability to show respect for others and maintain harmony in a group are connected to self-esteem in some Asian cultures. “The squeaky wheel gets the grease,” an American proverb, represents the belief that one should claim his or her rights in America. To the contrary, it is “The nail that stands out gets pounded down,” according to a Japanese proverb (Goleman, 2003).

Differences in perception of oneself also influence languages. In Western culture, children are taught to have self-confidence. On the other hand, excessive self-confidence is viewed as arrogance in Japanese
Multiple Intelligences

culture. When an American is complemented, a typical response is “Thank you.” Such a response can be viewed as a lack of humility in Japan, where people are expected to say, “No, I’m not that good.” Since culture can make differences in how linguistic, interpersonal, and intrapersonal intelligences are defined, it would be challenging to design a multiple intelligences assessment tool or a method that would be free of cultural biases.

Another possibility for future research is a systematic approach for teaching the developing of all intelligences. There are curricula tied to the development of linguistic, logical-mathematical, musical, spatial, bodily-kinesthetic, and naturalist intelligences in the K-12 environment. However, even though emotional intelligence, the equivalent of interpersonal and intrapersonal intelligences, is recognized as an important disposition for the workforce (Goleman, 1998), there is no required curriculum designated for the enhancement of the emotional intelligence in a P-12 environment, although the development of emotional intelligence can have a positive impact on academic performance as well. In Emotional Intelligence, Goleman (1995) mentions that 4-year-old children who demonstrate their competence in delayed gratification tend to score high on the SAT later in their life, as compared to impulsive 4-year-olds. Therefore, it is worthwhile to look further into a curriculum that promotes self-control, especially because this can be taught successfully (Greenberg, Kusche, Cook, & Quamma, 1995; Kelly, Longbottom, Potts, & Williamson, 2004).

The promotion of interpersonal and intrapersonal intelligences is already incorporated in some professional training programs. For instance, standards for teacher training have knowledge, skills, and disposition as the three pillars for teacher candidates’ competency (National Council for Accreditation of Teacher Education, 2002). Disposition denotes attitude or professional conduct. In particular, teacher candidates are required to know when and how their dispositions need to be adjusted, and have the capability to work effectively with students, parents, and school personnel (National Council for Accreditation of Teacher Education, 2002, p.16).

It is relatively easy to write cognitive components into a course syllabus. However, it is more difficult to set standards for disposition. However, disposition rubric constructed and implemented for physical education students has been designed (Wayda & Lund, 2005).

The aim of this rubric is to communicate expected professional behavior among future physical education teachers and to assess their dispositions. The rubric can also be used to assess the dispositions of preprofessionals outside the area of physical education. For instance, one of its assessment criteria concerns the valuing of collaboration. In this criterion, the attitude of respecting others’ ideas and contributing to the group is measured. This rubric can be applied as a part of departmental assessment of students enrolled in teacher education programs. Research to determine the external validity of the rubric could a topic for future research.

CONCLUSION

Although the idea of multiple intelligences has been examined since the early 19th Century, Gardner’s approach has recently received overwhelming attention. Fortunately, educators can use technology to develop multiple intelligences among learners. However, they need to be aware that technology does not automatically enhance multiple intelligences in the absence of strong pedagogy and careful planning. Also, online communication can cause students to forget that there are people, not machines, behind the computer screen, which removes the interpersonal element from communication. Thus, schools should teach netiquette, etiquette in the cyberspace, to prepare students to become good citizens and productive members of the workforce. School curricula designated to teach both interpersonal and intrapersonal intelligence are likely to produce an effective future workforce. Finally, teachers should not blindly buy into teaching methods that claim to stimulate multiple intelligences, unless supported strongly by valid research. Instead, dependable tools or methods for assessing multiple intelligences should be developed.

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**KEY TERMS**

**Blog:** Blog is another name for Web Log. Strands of online discussions can be facilitated with Blog and can be publicly available. Blog participation can be restricted to designated users or it can be open to anyone with access to the Internet.

**Cognitive Overload:** Learners process information in working memory so new knowledge will become a part of their long term memory. Working memory can process very limited amount of information at one time and if there is too much stimuli, cognitive overload would occur and learning would become ineffective. Premature understanding about multiple intelligences can lead a teacher to create or choose multimedia with excess stimuli and this can cause cognitive overload among learners.

**Flaming:** Flaming is a public attack on another person in a cyber space. Since flaming makes other people uncomfortable, it can disable a well-functioning online community. For instance, if it happens in a LISTSERV, flaming can cause members to leave the group (Pankoko-Babatz & Jeffrey, 2002).

**Montessori Method:** Montessori (1965) created a curriculum that combine muscular, verbal, numerical, geometric, social, artistic, and musical training realizing promotion of multiple intelligences. She also facilitated the interaction between children and animals and plants through agricultural education.

**Netiquette:** As online communication has become part of our life, netiquette, etiquette in cyber space, has increased its importance. Netiquette includes refraining from offensive comments, avoiding all capital letters because it looks like shouting, not forwarding e-mail messages without the original sender’s permission, and not forwarding jokes or any other items that may crowd the recipient’s inbox.

**Online Discussion Board:** Online discussion board is a common place in which participants of an online class can post and read messages.

**Redundancy:** Some educators may think it is a good idea to present the same material with text and audio so that students can use different modes of learning. However, identical audio text and visual text can cause redundancy, a form of cognitive overload (Mayers, 2001).

**Teele Inventory of Multiple Intelligences:** Sue Teele (1992) created an assessment tool for Multiple Intelligences using Gardner’s (1983) framework of linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, intrapersonal, and interpersonal intelligences. The purpose of this tool was to find out the dominant intelligence for learners (Teele, 1995).

**WebQuest:** WebQuest is an online problem solving template created by Dodge (2006). It typically assumes a group project that involves online research to complete an authentic task.

**Wiki:** Wiki is an online server that allows viewers to create or edit entries. Wikipedia, an open encyclopedia that any viewers can edit entries, is a popular Wiki.
Net Generation

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INTRODUCTION

The Net Generation refers to the description given to young Americans born from 1976 to 2001. Although the individuals of the Net Generation (or Net Gens) are the last generation of the 20th century, they are considered the first generation to grow up in an Internet culture and a multimedia driven environment.

BACKGROUND

In Growing Up Digital, Don Tapscott (1998) coined the term “Net Generation” pointing out the significance that individuals born between the years 1976-2001 were the first group of people to grow up immersed in a digital world. Other popular terms that have been used to describe this group of people include: Generation Y, Digital Natives, and Millennials. While Net Gens are primarily the children of Baby Boomers and older Generation Xers, Howe and Strauss (2000) suggest that the attitudes of Net Gens best resemble those manners of their grandparents’ generation, “The Greatest Generation”. However, Taylor (2002) argues that despite the perceived similarities between the two generations, Net Gens are perhaps “the most disengaged” of all generational groups.

As a cohort group, Net Gens are seen as the first true “multi-tasking generation”. The process of communication for this generation has included such behavior as instant messaging, “texting” instead of talking on the phone, and sending pictures of real-time events instead of describing the details in person. In turn, this group has a need to be connected to information continuously (hence, fostering the concept of “24/7”). For the most part, Net Gens have been raised in an environment of instantaneous responses: fast food services, instant banking, and touch button technologies. Raines (2002) notes that the Net Gens have become the “busiest generation of children” because from the moment they were born, their lives have been micro-managed. In her research of Net Gen lifestyles, Raines notes that this group has had very little “unstructured free time” from the moment they have been born citing examples of schedules for “play dates” and extended day programs. The managed lifestyle of this generation has placed greater social pressures of this group to meet parental expectations. In turn, peer social interaction often occurs in more readily in cyberspace environments rather than traditional spaces.

FOCUS

Since generations are often defined by the world events that make an impact on them when they are young adults, it is no wonder why Net Gens are advocates of patriotism and globalism. The September 11th terrorist attacks on the World Trade Center, the subsequent war in Iraq, and the conflicts in the Middle East have shaped the social-political mindset of this generation. In addition, the Columbine shootings, the Oklahoma bombing, and the Hurricane Katrina and tsunami disasters have shown this generation that security is transparent. Hence, this group of young adults is more apt to depend on its parents more so than any other generation for direction and guidance. Yet, the rise of service learning and sense of volunteering has also increased with this generational group. Research on civic engagement indicates that Net Gens are very much involved in community service projects.

Some of the collective philosophies of this generation have arisen from various cultural and social ideologies that emerged during their formative years. The legislative concept of “No Child Left Behind” has led many of the Net Gen individuals to believe that education is an entitlement rather than a privilege. As students, this group desires customer service in their educational experience. Oblinger (2003) notes that many colleges and universities are individualizing their student services and academic affairs departments to meet the needs of Net Gens. In turn, many admissions departments have gone to the Web to target and recruit this incoming group of new students. Applications and
information about the colleges are now available for instant access on student Web portals. Likewise, the Patriot Act has given this generation the sense that government intrusion is acceptable in terms of securing the country. Privacy issues seem unimportant to this group who makes use of blogs and Web communities to share information about their personal lives and beliefs with others across the Internet. Finally, it appears that Net Gens tend to be more supportive of multi-culturalism.

Since Net Gens are the first generation to be immersed into Internet culture, they see the Internet as their primary source of information and major communication resource. The rise of interactive technologies that provide immediate access without the need for a manual or instruction has transformed the ways in which companies do business with Net Gen consumers. Trends in digital media have transformed the manner in which this group accesses music, film, research, and other materials. Digital cameras, scanners, and other simulation software enable people to manipulate reality. Often referred to as the “Google” generation, Net Gens expect to find anything they need through the Internet. In turn, the consciousness of this generation has influenced many companies and industries to develop more interactive Web-based advertising and marketing. Online purchasing, online banking, and the culture of eBay have transformed the way in which services are provided due to the extensive use of the Internet by this demographic group. In order to understand the social reality for this generation, Jason Frand (2000) describes ten attributes of the Net Gen mindset:

1. Computers aren’t technology.
2. The Internet is better than TV.
3. Reality is no longer real.
4. Doing is more important than knowing.
5. Learning more closely resembles Nintendo than logic.
6. Multitasking is a way of life.
7. Typing is preferred to handwriting.
8. Staying connected is essential.
9. There is zero tolerance for delays.
10. Consumer and creator are blurring.

In similar fashion, Net Gens have transformed the foundations of education. For Net Gens, relationships, and not technology is the driving force in the learning process (McNeely, 2005). Collaborative learning, group think, and social interaction are motivating factors in educating this generation. In terms of their attitudes toward education, Taylor (2002) argues that this group of students shows the following characteristics:

- **Consumer Orientation:** “Students seek instant gratification, look for the best deal, want to negotiate, and might become litigious if disappointed” (Raines, 2002). Taylor (2002) has noted that there exists a prevalent attitude that “I paid tuition, now provide me with knowledge” (or a grade) approach.

- **Entertainment Orientation:** Taylor (2002) cites that students do not accept the lecture-based methods of traditional education because they have been culture into thinking that everything they do must be fun.

- **Entitlement:** Students think that they deserve a certain grade for a class because they paid for it. They believe they deserve extra credit, extra time to complete assignments, and any additional tutoring to ensure that the grade they receive meets their expectation. Students also think that instructors are there to provide a service (in this case instruction).

Given these ideas, Net Gens are more inclined to look for experiential, interactive, and authentic learning environments. As these students come to campus, they are transforming the lecture-driven traditions of colleges and universities. In fact, in many instances the presentation of linear content has been transformed into a more interactive display that includes simulations, gaming, and instant feedback. The concept of “edutainment” has begun to be linked to some teaching methodology.

The emergence of the Web-based classroom has also increased connectivity for students and expanded the diversity of classroom culture. Yet, this group is also more likely to cheat and engage in plagiarism using technology. Students are apt to download papers from the Internet, “cut and paste” text from the Internet or electronic articles into their documents, and even help each other the answers on a test. File sharing is seen as collaborative work rather than academic misconduct. Students e-mail or text message each other information about the class, the assignments, and even the instructors. Web sites that describe the teaching styles of instructors as well as the assignments of the
class are often used by Net Gens to determine whether they will enroll in the class.

Taylor (2002) argues that Net Gens have a postmodernistic attitude. This group looks for experience rather than reason, mistrusts any form of authority, and accepts the notion that nothing is certain. As children of fragmented familial environments (latchkey kids, daycare children, and television as their companion), these individuals often struggle with fostering relationships with individuals in authority. Hence, Net Gens are less likely to seek counsel from educators and bosses, and spend more time relating to their peers to resolve personal or other social challenges.

Despite educational programs regarding the abuse of drugs and alcohol (the “Just Say No Campaign” D.A.R.E., and S.A.D.D. organizations), research shows that Net Gens have a greater use of recreational drugs and alcohol more than any other generation. This generation is also the most medically mediated generation. Prescriptions for treating attention deficit disorder, hyperactivity, depression, and several other types of social disorders have also risen. The overprotective and social conscious nature of their parents has contributed greatly to the rise of plastic surgery, therapy, and other self-improvement programs for this group of young adults. The perceived need to perfect has unfortunately also increased the rate of suicide for this generation.

FUTURE TRENDS

Since this generation is just entering the workforce, it is too early to determine the long range contributions of this group of people. Judd (2000) notes that those Millennials just entering the workforce accept the view that they will be working more than 40 hours per week and that they will move on to a number of companies during their lifetime of work. As a result, it is quite possible that Millennials will change the way work schedules are managed and even change the way society views work as a static place. The idea of the virtual employee may become a standard practice for firms trying to attract the best employees from this generation. However, Raines warns that since so many Net Gens are overprotected by their parents, they are unable to take initiatives or leadership roles when assigned to complete a task. The expectation of a typical Net Gen is to be told what to do next. In turn, as Net Gens begin to enter the workplace, they will behave as followers more readily than leaders, lacking the skills or confidence to set agendas and manage others. Teamwork, collaborative projects, and project-based assignments will work best with this group. Technology will also be paramount in completing work-related assignments. Meetings will be through technology-mediated systems rather than face-to-face interactions. Net Gens will expect to work as mobile employees.

Another aspect of this generation that is difficult to forecast is its political mindset. Since 2004 was the first national election in which older Net Gen individuals were able to vote, as a lobbying group it is too early to tell what special interests may be paramount to this group. However, of these voters, many voiced interest in third-party or independent political ideal. The rise of volunteerism among this group is also indicative of the civic duty of this generation and may have bearing on future elections. While Galston (2001) argues that Net Gens tend to reject existing social structures, Howe and Strauss (2000) note that Net Gens do maintain a sense of good citizenship. In turn, the collaborative nature of this group may yield new types of leadership models and governing structures.

CONCLUSION

As a group, Net Gens are transforming the foundations of educational practices, social interactions, and cultural attitudes. As they enter into the workforce, their manner will also influence the corporate environment. Planning for neo-millennial styles will require educators, business leaders, and social-political leaders to take a careful look at the cultural shifts that Net Gens are now inspiring. The information-age mindset of this generation will influence the ways in which we learn and work, and develop future initiatives.

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**KEY TERMS**

24/7: An acronym used to refer to the concept of 24 hours a day, seven days a week indicating a constant non-stop situation.

Millennial: Another term often associated with defining the net generation. This term was coined by Howe and Strauss (2000) in their research about this generational group.

Net Generation: Refers to the description given to young Americans born from 1976 to 2001.
INTRODUCTION

Forming relationships on the Internet through various means of communication is a growing trend in cyberspace. The Internet is a medium that allows people to converse and express thoughts, feelings, viewpoints, and information posting messages electronically for others to view (Pankoke-Babatz & Jeffrey, 2002). Education has been taking advantage of these electronic communication mediums to teach content areas, help teachers and students form relationships, and serve as a vehicle of dialogue between teachers, parents, and students ( Forceir & Descy, 2005; Roblyer, 2006). Although electronic communications in education grow and proliferate, the rules of engagement must be maintained to prevent miscommunication and online traffic and noise (Kallos, 2006). This article discusses the importance of upholding netiquette conventions among its users in education because without adhering to certain guidelines and protocols, electronic forms of communication can deter the teaching and learning processes.

BACKGROUND

The term netiquette is the combination of two separate words—network etiquette (Kallos, 2006; Mallon & Oppenheim, 2002). The term is a word used to denote etiquette or manners that should occur on the Internet by its users when conversing electronically. In other words, netiquette comprises of rules for good behavior that has been adapted for an electronic form of communication (Sullivan, 2002). According to Webopedia (2006), netiquette involves etiquette guidelines for posting messages to online services, and particularly Internet newsgroups. Netiquette covers not only rules to maintain civility in discussions (i.e., avoiding flames), but also special guidelines unique to the electronic nature of forum messages.

Netiquette rules are not considered the same in every online electronic medium, however. Although online manners are socially expected, the types of netiquette used in different electronic communication mediums vary (Shea, 2004). For instance, some newsgroups accept abrasive “flaming” while in other groups politeness, helpfulness, and tolerance are expected. Thus, venturing into the online environment to assess what has been said before posting any messages to the group is advisable in this situation.

Electronic forms of communication include both older and newer forms of Internet technologies (Mills, 2006). Former technologies include electronic mail (e-mail), bulletin board services (BBS), listservs or discussion/mailing lists, and newsgroups. Internet relay chat (IRC), instant messaging, message boards, Webcasting, and Web logs are considered contemporary forms of Internet technologies. There is no real advantage between using the older or newer forms of technology. Selecting the type of electronic communication to use rests solely upon the medium that users want to adopt and the availability of the electronic medium at hand.

In terms of interactivity and time variables, these electronic forms of communication are either asynchronous or synchronous (Lever-Duffy, McDonald, & Mizell, 2005). Asynchronous communication is time-shifted in that the sender and receiver do not have to be physically online to proceed with the conversation such as using e-mail, bulletin boards, listservs or mailing lists, newsgroups, message boards, and Web logs. However, synchronous communication is real-time in that both the sender and recipient are expected to be available for instantaneous communication as with chats, instant messaging, and Webcasting, or videoconferencing (Roblyer, 2006).

There are several reasons why netiquette is important in an online environment whereby effective communication is a concern. As with traditional forms of communication, using common courtesy, grace, and socially acceptable behaviors are important for promoting the exchange of ideas. Without the use of these factors, one can easily appear lazy, rude, arrogant, or uneducated (Kallos, 2006). Furthermore, without the nonverbal cues...
that one may receive in face-to-face communication, the electronic message itself may appear distant. According to Donald Fuller (2004), e-mail is considered as a “cold” medium in that written messages viewed on a computer screen lacks the warmth of face-to-face discussions. The speed of online communication is another reason why netiquette is necessary. Electronic messages today can be written and sent very quickly and often times sent before thinking much about what is written or how the receiver will view the message’s content (Fuller, 2004; Spinks, Wells, & Meche, 1999). This can lead toward some unpleasant situations when senders do not reflect over the messages. Hence, netiquette can help resolve some of these problems found in today’s online communication.

Critical to Learning Success

In the educational setting, teaching students how to properly use netiquette when communicating online is critical because of the need to maintain a safe and effective learning environment. A primary reason for requiring netiquette is to help ensure the collective benefit of the group. In education, this collective group involves the instructors and students in a particular course/classroom (Pankoke-Babatz & Jeffrey, 2002). If educators integrate electronic communications as part of classroom activities, the responsibility falls upon educators in establishing norms, conventions, shared understandings, and group cohesiveness.

One way to avoid a detrimental situation is to teach students proper online conduct and etiquette. Based upon the electronic medium being used, the instructor needs to go over the rules of conduct and address what ramifications can result from noncompliance. The educator can also model appropriate behaviors for students to follow such as not writing long-winded messages and always typing his/her name at the end of messages so that students will know who is catfish@usm.edu (Johnson, 1998).

Just as learning social manners, individuals must be repeatedly taught netiquette conventions. Educators can correct electronic messages or postings made by students that do not follow netiquette guidelines. In addition, constant reminders sent to senders and receivers of online communication messages can ensure that netiquette remains on the minds of students. If computer technology is used regularly in the classroom, posting rules of netiquette around the classroom can help. Within an online course environment, educators can hold discussions about netiquette and what are the acceptable behaviors for the course. Thus, to embed the rules in the minds of the communicators, practice and prompts are required.

An educator may ask what are the rules of netiquette. Netiquette rules do alter somewhat depending upon the electronic medium being used. The following are some “generic” rules that can be applied to all electronic communications (Newby, Stepich, Lehman, & Russell, 2000; Smaldino, Russell, Heinich, & Molenda, 2005).

• Keeping messages short and simple will prevent confusion and reader fatigue (reading text on the computer screen is different than on paper). Be specific, brief, and to the point. In fact, messages should not be longer than 300 words. If this word limit cannot be helped, then send the message via an attachment.
• Always identify oneself within the message. Some message services do not include names in the senders’ e-mail addresses.
• Including a portion of a message being replied to is appropriate. However, only include portions that are relevant to the response (e.g., do not just hit the reply button and keep everything there).
• Electronic messages are public. For instance, e-mail and listserv administrators can see all the messages being sent. Do not include information that may be detrimental to you as the sender.
• Always check for spelling, grammar, punctuation, and so forth. Nothing is more annoying than reading a message that has so many errors that it takes twice the time to read.
• Use upper and lower cases when writing messages. Do not use all CAPS because this indicates shouting, plus it takes more time to read all CAPS.
• Sensitivity to others is critical when trying to promote a cordial and safe atmosphere. Showing respect and courtesy to others’ backgrounds, experiences, and cultures can help encourage a positive environment.
• Humor should be used with precaution. Without the verbal and nonverbal cues in electronic messages, humor can be taken the wrong way. In addition, different cultures may perceive humor in different ways.
• Consider one as being a guest. Showing cooperation and sharing information with others can aid
the person in receiving the same assistance later on.

• Copyright is still an issue in electronic communications. Although information can be copied electronically, it does not mean that one can distribute the information freely. This also includes information that others send through electronic messages (e.g., someone offering her ideas about the prevention of global warming).

• Obscenity and profanity should never be used even if a particular medium may accept them. There are federal laws and regulations against using obscenity, and in a classroom situation, these should never be used.

Along with these general rules are medium-specific standards that educators and students must uphold. The following information pertains to a few of the electronic communications used in education.

E-mail

In education, e-mail is primarily used as the form of communication between teacher-student and student-student. E-pals is a popular use of electronic mail in instruction as well delivering announcements, homework assignments, related links to Web sites, and so forth. However, e-mail communication also has its conventions to help minimize traffic, misunderstanding, and confusion. These netiquette rules should be taught to students and modeled by instructors to reinforce netiquette’s importance (Hambridge, 1995; Kallos, 2006).

• Never send chain letters over the Internet. Actually, chain letters are forbidden on the Internet and the service provider can revoke Internet privileges.

• When forwarding or reposting a message received, do not alter the wording unless granted permission.

• Electronic mail is not secure and others can read messages such as systems administrators.

• Check all messages first “before” replying to a message sent by someone. That same person could have told you to disregard the message sent earlier.

• Avoid attaching large files because the receiver may not be able to open them.

• Use the recipients’ names when sending e-mail.

• Include a subject heading indicating the content of the message to help the recipient organize messages.

• If a message is considered important, feel free to send a brief indicator that you received.

• Creating a signature file that includes some contact information can help recipients identify who you are.

• When replying to an e-mail, always type the response at the top of the message box. Also, remember to include enough detail from the message being replied to, so that the new message could be understood.

• Using “smileys” to indicate tone of voice can be helpful especially when the subject matter may be “iffy.” However, “smileys” should be used sparingly and do not assume that the smiley will be received the same way on the other end.

• Avoid flaming or sending heated messages.

• If the message contains direct quotes, all quotes should be cited to respect copyright issues.

• Do not cut and paste materials from Web sites into messages. If a Web site offers pertinent information, provide only the Web site’s URL and a brief explanation of the site.

• Refrain from formatting e-mail with colored text and background colors or images. Readability becomes a major problem with such contrasts.

• If sending a message to a group of people, list the recipients in the blind carbon copy (BCC) field to avoid others seeing everyone’s e-mail addresses.

• Do not use Return Receipt Request (RR) for each e-mail because it is intrusive on one’s privacy. Only use RRs when it is necessary to know that others have received the e-mail.

• All e-mail is considered to be copyrighted material by the original author so be careful when forwarding e-mails to others.

Listserves or Mailing Lists

Listserves are beneficial when one wants to send an e-mail to many people and netiquette does apply to listserves. Instructors need to establish netiquette rules for students such as those listed below (Hambridge, 1995):

• Send subscribe and unsubscribe messages to the appropriate address.

• Save subscription messages for any list joined.
Netiquette

- Be careful when replying to messages because they could go back to the listserv. Check the address to make sure that it is the person and not the listserv that will be receiving the replied response.
- Delivery receipts, nondelivery notices, and vacation programs are not reliable across systems. They are invasive when sent to mailing lists and sometimes vacation messages can cause a loop because such messages are automatic.
- Avoid sending derogatory or flaming messages about someone on the listserv.
- If a disagreement about a topic occurs between two people, e-mail each other personally instead of holding a debate on the listserv.
- Be careful of using monospaced fonts and diagrams because everyone’s systems are different and may not project the message correctly.
- Because some listserv strip the headers with people’s e-mail addresses and names, be sure to have a signature file attached.
- Never leave subject lines blank. Members need to know what the message contains to determine whether it is worth reading or not.
- Avoid advertising unless it is acceptable by members of the listserv.
- Do not post anything but plain text with line length under 80 characters.
- Avoid posting just to say hello or thank you.
- Consider that a large audience will be reading the posts and many are archived for later retrieval.
- Subject lines should follow the conventions of the group and do not write something like “please help me” because the phrase does not adequately address the question being asked in the post.
- Advertising is allowed on some newsgroups but abhorred by others, so check.
- Spamming every newsgroup possible by sending advertisements or unrelated messages to the groups is prohibited.
- Be cautious of replying back to messages because the reply may be going back to the entire group.
- If a personal message is accidentally sent to the group, apologize to the group.
- Avoid getting involved in flame wars or do not post anything defamatory about another individual to the group.

Newsgroups

A newsgroup is a public forum that is dedicated to a specific topic such as social events, humanities, computers, and entertainment. In education, newsgroups are generally used for research when a pertinent question comes to mind. A student or instructor can post a question to a newsgroup and then return later to read all of the answers, postings, and/or suggestions that others have given. Rules of conduct also apply in newsgroups. Instructors should make sure that they are aware of the rules as well as their students. The following netiquette conventions apply primarily to newsgroups (Hambridge, 1995; Korpela, 2002):

- Read messages in a newsgroup for a month before making the first posting. This will help give you a sense of the newsgroup’s culture.
- Consult the Frequently Asked Questions (FAQ’s) first before posting because someone may have already asked that question previously.

Chat

Chat is a service offered by Internet services that set aside a virtual space in which two or more Internet users can meet in real-time. In education, chats can have various applications such as providing students with access to experts within the field, giving instructors an opportunity to hold online office hours, and using chat logs from previous sessions to help students remember certain information or be used by the instructor for evaluating student participation (Mills, 2006). However, instructors and students must sustain proper netiquette conventions to make sure that the virtual environment is productive. Certain chat-specific conventions are (Chat Etiquette, 1998; Kids Turn Central, 2006; Rowe, 1998):

- Remember that no chat is private.
- Do say hello to others in the chat room.
- Address the person by their nickname or name when chatting otherwise the whole group will respond back.
- Use boldface type or caps only for emphasis.
- When entering the room, take a few moments to obtain a feel for the climate of the room before jumping in.
• Chats work best with groups of five or fewer. Students and instructors should take this into consideration when forming chats.
• Wait for someone to finish before typing your response because of time lags.
• Do not give out personal information unless you know who the chatters are in the room (e.g., fellow students).
• Do not flood the room with repeated typing of the same word or number.
• Avoid typing long passages in the posts to prevent others from scrolling down to read the message.

FUTURE CONSIDERATIONS

Research in this field needs to be conducted to fully understand netiquette’s potential in assisting students and educators to address topics, convey and express ideas and thoughts, and prevent miscommunication based upon the occurrence and design of electronic messages. As noted, not much research has been performed in this particular area. The few studies that have been completed on netiquette issues focused primarily on e-mail content (Mallon & Oppenheim, 2002; Spinks et al., 1999) or whether different electronic communication services gave their rules of conduct to users for different synchronous and asynchronous mediums (Pankoke-Babatz & Jeffrey, 2002). These studies did reveal some interesting findings such as how students and faculty members viewed and used e-mail in different situations and whether netiquette was important for different electronic mediums; however, these studies were not related to education. Therefore, performing more research on netiquette, both quantitative and qualitative, for instructional purposes would help determine (a) whether students can learn proper netiquette, (b) whether teachers can become good role models in using proper netiquette, and (c) whether netiquette can have an effect on the potency and significance of messages when expressing thoughts, perceptions, and ideas about a specific content area.

An emerging area of examination in this related field is tech etiquette. Because this area is relatively new, not much literature can be found concerning this particular topic. However, with the increasing amount of technologies being made available to individuals, tech etiquette will become a very important topic to examine (Silver, 2006). Tech etiquette involves the appropriate use of digital devices such as portable digital assistants, laptop computers, cell phones, MP3 players, and so forth, in public spaces. The annoying cell phone call in a classroom lecture hall and students typing away on their laptops during class are examples of poor tech etiquette. This has become a growing problem in education and many schools and higher education institutions have been taking actions such as setting up policies and finding ways to remove the annoying devices completely from classrooms (eSchool News, 2003; Sinetos, 2006). Because of the growing numbers of such digital technologies in the hands of individuals, tech etiquette should be investigated more closely.

CONCLUSION

Teachers, students, and parents can benefit greatly from electronic communications. These electronic forms provide a quick way to convey information in little time if Internet connectivity is available. However, users must be aware of certain issues surrounding different electronic communications and follow proper netiquette. Group cohesiveness is important in a classroom environment by which instructors and students interact, participate, share, and support one another. This is also true in the virtual environment whereby electronic communications come to play. To create a virtual environment conducive to learning, netiquette protocols must be followed to ensure that misunderstandings, confusion, and unpleasantness do not occur. If they do occur, then communication stops completely, which will deter any learning. If netiquette is adhered to, everyone can have a safe and amiable virtual environment in which to exchange information, interact, and form learning networks.

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Netiquette

**KEY TERMS**

**Asynchronous:** Asynchronous electronic communications do not require real-time interaction. In other words, the sender and receiver do not have to be online concurrently to interact.

**Electronic Communications:** Communication mediums that are electronic in form. There are many different types of electronic communication tools such as e-mail, listservs, Web logs, chat, and so forth.

**Flaming:** Flaming is a public personal attack that has been made to someone. If a simple, rude comment is made to a group, the message could incite a flame war.

**Netiquette:** A term that comprises the combination of two words—network etiquette. Netiquette encompasses proper protocol or manners when making use of the Internet and in particular with electronic communications.

**Spamming:** Spamming is the practice of sending repeated pieces of mail to a wide-variety of newsgroups, listservs, and/or e-mail addresses. Spamming is generally unwanted mail that does not pertain to the individuals receiving the messages.

**Synchronous:** Synchronous electronic communications require real-time interface in that both the sender and receiver are expected to interact simultaneously.

**Tech Etiquette:** Tech etiquette involves the proper use of digital technologies such as laptops, notebooks, portable digital assistants, cell phones, MP3 players, and so forth. There are guidelines by which users of these technologies must follow to avoid being considered rude, remiss, impassive, and unproductive.
Neural Informatics

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INTRODUCTION

The development of classical and contemporary informatics, the cross fertilization between computer science, systems science, cybernetics, computer/software engineering, cognitive science, neuropsychology, knowledge engineering, and life science, has led to a new research field known as Cognitive Informatics (Wang, 2002a/2003a/2003b/2004/2006a/2007b; Wang, Johnston, & Smith, 2002; Wang & Kinsner, 2006). An important branch of cognitive informatics is neural informatics (Wang, 2007b), which reduces cognitive informatics theories and the studies on the internal information processing mechanisms of the brain onto the neuron and physiological level.

Definition 1

Neural informatics is a new interdisciplinary enquiry of the biological and physiological representation of information and knowledge in the brain at the neuron level and their abstract mathematical models.

In neural informatics, memory is recognized as the foundation and platform of any natural or machine intelligence based on the Object-Attribute-Relation (OAR) model (Wang, 2007c; Wang & Wang, 2006) of information/knowledge representation. The cognitive models of human memory (Wang & Wang, 2006), particularly the sensory buffer memory (SBM), short-term memory (STM), long-term memory (LTM), action-buffer memory (ABM), and their mapping onto the physiological organs of the brain reveals the fundamental mechanisms of neural informatics.

FUNDAMENTAL MODELS OF NEURAL INFORMATICS

The theories of neural informatics explain a number of important questions in the study of natural intelligence. Enlightening findings in neural informatics are such as (a) LTM establishment is a subconscious process; (b) The long-term memory is established during sleeping; (c) The major mechanism for LTM establishment is by sleeping; (d) The general acquisition cycle of LTM is equal to or longer than 24 hours; (e) The mechanism of LTM establishment is to update the entire memory of information represented as an OAR model in the brain (Wang, 2007c); and (f) Eye movement and dreams play an important role in LTM creation.

Neural Informatics Models of Memory

In neural informatics, the taxonomy of memory is categorized into four forms, as given in the following cognitive model of memory.

Definition 2

The Cognitive Models of Memory (CMM) states that the architecture of human memory is parallel configured by SBM, STM, LTM, and ABM, where the ABM is newly identified in Wang and Wang (2006).

The major organ that accommodate memories in the brain is the cerebrum or the cerebral cortex. In particular, the association and premotor cortex in the frontal lobe, the temporal lobe, sensory cortex in the frontal lobe, visual cortex in the occipital lobe, primary motor cortex in the frontal lobe, supplementary motor area in the frontal lobe, and procedural memory in cerebellum (Wang & Wang, 2006; Wilson & Keil, 2001). The CMM model and the mapping of the four types of human memory onto the physiological organs in the brain reveal a set of fundamental mechanisms of neural informatics (Wang, 2007b).

Definition 3

The functional model of LTM can be described as a Hierarchical Neural Cluster (HNC) model with partially connected neurons via synapses.

The HNC model of LTM consists of dynamic and partially interconnected neural networks. In the HNC model, a physiological connection between a pair of
neurons via a synapse represents a logical relation between two abstract objects or concepts. The hierarchical and partially connected neural clusters are the foundation for information and knowledge representation in LTM.

Conventionally, LTM is perceived as static and fixed in adult brains (Baddeley, 1990; James, 1890; Rosenzweig, Leiman, & Breedlove, 1999; Smith, 1993; Sternberg, 1998). This was based on the observation that the capacity of adult brains has already reached a stable state and would not grow continuously. However, recent discoveries in neuroscience and cognitive informatics indicate that LTM is dynamically reconfiguring, particularly at the lower levels of the neural clusters (Gabrieli, 1998; Rosenzweig et al., 1999; Squire, Knowlton, & Musen, 1993; Wang, 2007c; Wang & Wang, 2006). Otherwise, the mechanisms of memory establishment, enhancement, and evolution that are functioning everyday in the brain cannot be explained. Actually, the two perceptions are not contradictory. The former observes that the macronumber of neurons will not change significantly in an adult brain. The latter reveals that information and knowledge are physically and physiologically retained in LTM via newly created synapses between neurons rather than the neurons themselves.

Therefore, there is a need to seek a new model rather than the conventional container model to explain how information and knowledge are represented and retained in the brain. For this purpose, a relational model of human memory is developed as described.

**Definition 4**

The relational model of memory is a logical memory model that states information is represented and retained in the memory by relations, which is embodied by the synaptic connections among neurons.

In contrary to the conventional container metaphor, the relational metaphor indicates that the brain does not create new neurons to represent newly acquired information; instead, it generates new synapses between the existing neurons in order to represent new information.

The reconfigurable neural clusters of STM cohere and connect related objects such as images, data, and concepts, and their attributes by synapses in order to form contexts and threads of thinking. Therefore, the main function of STM may be analogized to an index memory connecting to other memories, particularly LTM. STM is the working memory of the brain. The capacity of STM is much smaller than that of LTM, but it is a hundred times greater than 7±2 digits as Miller proposed (Miller, 1956). Limited by the temporal space of STM, one has to write complicated things on paper or other types of external memories in order to compensate the required working memory space in a thinking process.

**Theorem 1**

The dynamic neural cluster model states that the LTM is dynamic. New neurons (to represent objects or attributes) are assigning, and new connections (to represent relations) are creating and reconfiguring all the time in the brain.

**Neural Informatics Models of Internal Knowledge Representation—OAR**

To rigorously explain the hierarchical and dynamic neural cluster model of memory at physiological level, a logical model of memory is needed, as given in Definition 5, known as the Object-Attribute-Relation (OAR) model (Wang, 2007c).

**Definition 5**

The OAR model of LTM can be described as a triple, that is:

\[
\text{OAR} \triangleq (O, A, R)
\]  

where O is a finite set of objects identified by unique symbolic names, that is:

\[
O = \{o_1, o_2, \ldots, o_i, \ldots, o_n\}
\]  

For each given \(o_i \in O\), \(1 \leq i \leq n\), \(A_i\) is a finite set of attributes for characterizing the object, that is:

\[
A_i = \{A_{i1}, A_{i2}, \ldots, A_{ij}, \ldots, A_{im}\}
\]

where each \(o_i \in O\) or \(A_{ij} \in A_i\), \(1 \leq i \leq n\), \(1 \leq j \leq m\), is physiologically implemented by a neuron in the brain.
For each given $o_i \in O$, $1 \leq i \leq n$, $R_i$ is a set of relations between $o_i$ and other objects or attributes of other objects, that is:

$$R_i = \{R_{i1}, R_{i2}, \ldots, R_{ik}, \ldots, R_{iq}\} \quad (4)$$

where $R_{ik}$ is a relation between two objects, $o_i$ and $o_{i'}$, and their attributes $A_{ij}$ and $A_{i'j}$, $1 \leq i \leq n$, $1 \leq j \leq m$, that is:

$$R_{ik} = r(o_i, o_{i'})$$
$$|r(o_i, A_{ij})|$$
$$|r(A_{ij}, o_{i'})|$$
$$|r(A_{ij}, A_{i'j})|, \quad 1 \leq k \leq q \quad (5)$$

To a certain extent, the entire knowledge in the brain can be modeled as a global OAR model as given in Figure 1.

**Theorem 2**

The capacity of human memory $C_m$ is determined by the total potential relational combinations, $C'_n$, among all neurons $n = 10^{11}$ and their average synaptic connections $s = 10^3$ to various related subset of entire neurons, that is:

$$C_n = \binom{n}{s}$$
$$= \frac{10^{11}!}{10^3!(10^{11} - 10^3)!}$$
$$= 10^{8,432} \text{ [bit]} \quad (6)$$

Theorem 2 provides a mathematical explanation of the upper limit of the potential number of connections among neurons in the brain. Using approximation theory and a computational algorithm, the solution of Eq. 6 had been successfully obtained in (Wang et al., 2003) as given previously.

The finding on the magnitude of the human memory capacity on the order as high as $10^{8,432}$ bits reveals an interesting mechanism of the brain in neural informatics. That is, the brain does not create new neurons to represent new information, instead, it generates new synapses between the existing neurons in order to represent new information. The observations in neuropsychology are that the number of neurons is kept stable rather than continuously increasing in adult brains (Marieb, 1992; Pinel, 1997; Rosenzweig et al., 1999) provided evidences for the relational cognitive model of information representation in human memory.

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**Figure 1. The OAR model of logical memory architectures**

The diagram illustrates the OAR model of logical memory architectures, showing how relations $R_{ij}$ between objects $o_i$ and their attributes $A_{ij}$ form a network of connections. Each object $o_i$ is connected to other objects and attributes, demonstrating the relational aspects of memory. The diagram helps visualize the complexity of information representation in the brain, emphasizing the importance of relational connections in memory storage.
APPLICATIONS OF NEURAL INFORMATICS THEORIES

Neural Informatics Models of Memorization

Definition 6

Memorization is a cognitive process of the brain at the meta cognitive layer that establishes (encodes and retains) and reconstructs (retrieves and decodes) information in LTM.

As learning is aimed at acquiring new knowledge based on comprehension (Wang & Davrondjon, 2003), memorization is required to create or update LTM by searching and analyzing the contents of STM and selecting useful (i.e., most frequently used) information into LTM.

According to the OAR model, the result of knowledge acquisition or learning can be embodied by the updating of the existing OAR in the brain.

Theorem 3

The entire knowledge model maintained in the brain states that the internal memory or the representation of learning results in the form of the OAR structure, which can be updated by concept compositions between the existing OAR and the newly created sub-OAR (sOAR), that is:

\[
\text{OAR}_{ST} \triangleq \text{OAR}_{ST} \uplus \text{sOAR}_{ST} = \text{OAR}_{ST} \uplus (O_x, A_x, R_x) \quad (7)
\]

where \(ST\) is the system structure type suffix as defined in Real-Time Process Algebra (RTPA) (Wang, 2002b, 2003c, 2006b, 2007b), and \(\uplus\) denotes the concept composition operation in concept algebra (Wang, 2006c, 2007a).

Neural Informatics Models of Knowledge

Corresponding to the forms of memories in the brain, human knowledge as cognized or comprehended information can be defined in both a narrow and a broad sense.

Definition 7

Knowledge, in the narrow sense, is acquired information in LTM or acquired skills in ABM through learning. In the broad sense, knowledge is acquired information in forms of abstract knowledge, behavior, experience, and skills through learning in LTM or ABM.

Abstraction is a gifted capability of human beings. It is a basic cognitive process of the brain at the metacognitive layer according to the Layered Reference Model of the Brain (LRMB) (Wang, Wang, Patel, & Patel, 2006). Only by abstraction, the important theorems and laws about objects under study may be elicited and discovered from a great variety of phenomena and empirical observations in an area of inquiry.

Definition 8

Abstraction is a process to elicit a subset of objects that shares a common property from a given set of objects, and to use the property to identify and distinguish the subset from the whole in order to facilitate reasoning.

Abstraction as a cognitive process has been formally described in Wang (2007a). Abstraction is a powerful means of philosophy and mathematics. All formal logical inferences and reasonings can only be carried out on the basis of common and abstract properties shared by a given set of objects under study.

According to the Information-Matter-Energy (IME) model (Wang, 2002a, 2007b), there are two categories of objects under studies in science and engineering known as the concrete entities in the real world and the abstract objects in the information world. In the latter, an important part of the abstract objects are human or system behaviors that are planned or executed actions onto the real-world entities and abstract objects. The abstract levels of cognitive information of both the objects and their behaviors can be divided into five levels, as follows.

Theorem 4

The Hierarchical Abstraction Model (HAM) of knowledge states that the abstract levels of cognitive information of both the objects and their behaviors can be divided into five levels such as those of analogue objects, diagrams, natural languages, professional notations, and mathematics.
According to the HAM model, the higher the abstraction level of an object, the more complicated the description means. There are two approaches to system description known as abstraction and explanation. The former enables the increase of the descriptive power in terms of expressiveness, precise, and rigor; while the latter enables the improvement of the intuitiveness of understanding and comprehension, using a means of description that is much closer to the real-world images and analogue objects directly acquired by the sensations of the brain.

CONCLUSION

Neural informatics has been presented as a new interdisciplinary enquiry of the biological and physiological representation of information and knowledge in the brain at the neuron level and their abstract mathematical models. Neural informatics has been developed as an important branch of cognitive informatics that reduces cognitive informatics theories and the internal information processing in the brain onto the neuron and physiological level. The theories of neural informatics explain a number of important questions in the study of natural intelligence such as the mechanisms of long-term memory establishment, and the 24-hour law of long-term memory establishment cycles. The latest development in neural informatics has led to the determination of the magnitude of human memory and the mechanisms of internal knowledge representation, memorization, and learning.

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KEY TERMS

Cognitive Models of Memory (CMM): The architecture of human memory is parallel configured by the Sensory Buffer Memory (SBM), Short-Term Memory (STM), Long-Term Memory (LTM), and Action-Buffer Memory (ABM).

Dynamic Neural Cluster Model: The LTM is dynamic. New neurons (to represent objects or attributes) are assigning, and new connections (to represent relations) are creating and reconfiguring all the time in the brain.

Functional Model of LTM: A Hierarchical Neural Cluster (HNC) model with partially connected neurons via synapses.

Hierarchical Abstraction Model (HAM): The abstract levels of cognitive information of both the objects and their behaviors can be divided into five levels such as those of analogue objects, diagrams, natural languages, professional notations, and mathematics.

Knowledge: In the narrow sense, knowledge is acquired information in LTM or acquired skills in ABM through learning. In the broad sense, knowledge is acquired information in forms of abstract knowledge, behavior, experience, and skills through learning in LTM or ABM.

Knowledge Model: The internal memory or the representation of learning results in the form of the OAR structure that can be updated by concept compositions between the existing OAR and the newly created sub-OAR (sOAR),
**Neural Informatics**

**Memorization:** A cognitive process of the brain at the metacognitive layer that establishes (encodes and retains) and reconstructs (retrieves and decodes) information in LTM.

**Neural Informatics:** A new interdisciplinary enquiry of the biological and physiological representation of information and knowledge in the brain at the neuron level and their abstract mathematical models.

**Relational Model of Memory:** A logical memory model that states information is represented and retained in the memory by relations, which is embodied by the synaptic connections among neurons.
No Child Left Behind

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INTRODUCTION

The Federal Government passed the Elementary and Secondary Education Act (ESEA) in 1965 to enable the federal government to finance public schools (Paige, 2004). This law was signed by President Johnson and has been revised every 5 years since then (Wisconsin Education Association Council, n.d.). ESEA started the provision of Title I funding, the federal money given to a school district to assist students who are falling behind academically (Public Schools of North Carolina, n.d.). President George W. Bush signed the ESEA, No Child Left Behind Act of 2001 (NCLB) (P.L. 107-110), on January 8, 2002 (U.S. Department of Education, n.d.). This provision designated that total federal funding of $116,250 million was to be dispensed between 2002 and 2007. The Act was strongly supported by both parties: the final vote was 87 to 10 in the Senate and 381 to 41 in the House (Paige, 2004). This article will address the necessity for teacher training caused by the educational institution’s accountability imposed by No Child Left Behind, and the stronger need to assist disabled learners affirmed by the law.

BACKGROUND

The main ideas of No Child Left Behind are:

• **Accountability:** State decides students’ performance level to be met and systematically monitors school districts’ progress (Paige, 2004; U.S. Department of Education, 2003). Data for 2001-2002 was marked as a base year to measure the students’ academic achievement. Ninety-five percent of students enrolled in a school must be assessed for academic performance and schools need to ensure that all students achieve or exceed the proficiency level designated by the State. The assessment has to occur at least once during grades 3 through 5, grades 6 through 9, and grades 10 through 12 (P.L. 107-110).

• **Flexibility:** School districts can use federal money according to their needs (U. S. Department of Education, 2004b). There are four major federal grants, including Teacher Quality State Grants, Educational Technology State Grants, Safe and Drug-Free Schools and Communities State Grants, and State Grants for Innovative programs (Paige, 2004).

• **Proven education results:** Rigorous scientific research is encouraged to prove which programs are successful (U.S. Department of Education, 2004a).

• **School choices for parents:** If a family lives in a school district that fails to meet the achievement level for 2 consecutive years, parents have the option to educate their children through charter schools or home schooling. Parents can also send their children to higher performing schools (Paige, 2004; U.S. Department of Education, 2006).

States are responsible for writing a grant for improving education by consulting local educational agencies. Federal funds are first distributed to states and then passed on to school districts in the states. In addition, states are responsible for creating challenging standards. No Child Left Behind requires that the same standards apply to all students within the state. At the latest, math and reading or language arts’ standards were to be established by the beginning of the 2005-2006 academic year. Moreover, states had to develop an accountability system to monitor the progress of local educational agencies. Accountability must be based on state standards. Assessment for students’ academic achievement in math and reading or language arts had to occur during the 2005-2006 school year. During the following year, measurement for science has been mandated to take place.

The accountability system may change the nature of teaching. Take Pennsylvania’s Academic Standards for History, for example. By the end of sixth grade, students are supposed to “identify and explain political and cultural contributions of individuals and groups
to Pennsylvania history (PA Academic Standards for History 8.2.6).” By the time they finish ninth grade, they need to “analyze the political and cultural contributions of individuals and groups to Pennsylvania history (PA Academic Standards for History 8.2.9).” Finally, students are expected to “evaluate the political and cultural contribution of individuals and groups to Pennsylvania history (PA Academic Standards for History 8.2.12).” For those familiar to Bloom’s Taxonomy of the Cognitive Domain, “rigorous standards” designated by a state seem to address analysis, synthesis, and evaluation. It is clear that students need to establish the logical link between the part and the whole or one part to another part by grade nine: students are expected to analyze the historical context of a person or a group, and how the individual or the group made change into the society or to the history. The task for twelfth graders becomes more complicated because they need to evaluate political, economical, and/or social motives for a historical figure’s actions and evaluate the impact of his or her actions supported by evidence. According to Pennsylvania’s Academic Standards for Reading, Writing, Speaking, and Listening (n.d.), students are expected to evaluate whether texts are effectively and logically organized, produce work, analyze a link between choice of words and main theme, and produce media to show understanding by the time they graduate high school.

The quality of teachers is a crucial element for the students’ high achievement (Paige, 2004). No Child Left Behind requires teachers to be highly qualified by June 30, 2006 (Public Schools of North Carolina, n.d.). In order to be considered highly qualified, teachers must have content knowledge, be certified, and have a bachelor’s degree (Paige, 2004).

**MAIN THRUST OF THE ARTICLE**

**Accountability and Teacher Training.** Some teachers already use a variety of evaluation methods, ensuring that students meet requirements/goals to analyze, synthesize, and evaluate facts. While many in-service teachers are capable of aligning their curriculum with the standards associated with critical thinking, some teachers have their students merely list the facts or retell what the students have read, only taking them to the knowledge or comprehension levels in terms of Bloom’s Taxonomy of the Cognitive Domain; this occurs even in secondary schools. It takes competent teachers to use technology to assist students in achieving high academic standards.

Technology, when it is used adequately, can foster critical thinking in students. However, misuse of technology can result in the deterrence of higher-order thinking. Competent teachers would design technology use to facilitate their programming, intentional data collection, data analysis or problem solving. Some, however, use technology for mindless drills, simple listing and labeling, or entertainment. While the use of computer related low-order thinking is negatively correlated to student achievement, teacher training to facilitate higher-order thinking with technology is positively correlated with students’ academic achievement (Wenglinsky, 1998).

The Mindtool concept (Jonassen, 2000; Jonassen, Carr, & Yueh, 1998; Jonassen, Howland, Moore, & Marra, 2003) is a useful framework to design technology use to promote complex thinking. According to this concept, technology is a means for students to construct meaning in their own unique way, process information to create something new, or to represent their knowledge. For example, if students are asked to find a brief description of characters, plots, and settings of Nathaniel Hawthorne’s *The Scarlet Letter* via Internet search, technology is not used as a Mindtool. On the other hand, if students are asked to do research about the biography of Hawthorne and the moral clashes that existed in the Puritan community and write about Hawthorne’s intentions about writing the story by using scenes from the stories and information collected by the Internet search, then students would use technology as a Mindtool. By the same token, if a French teacher uses PowerPoint only to present the relationship between French movies and the perception of the culture, then have students memorize the contents and take tests, PowerPoint is not being used as a Mindtool. If this teacher sets up a theme about a French movie and has students put together a presentation to show they think unique perceptions in French culture are reflected in a French movie, then PowerPoint becomes a Mindtool.

Naturally, knowledge and skills about technology alone do not help teachers become proficient in guiding students to meet rigorous state standards with technology. Technology training isolated from curriculum does not transfer to successful classroom use of technology. A teacher without a solid grip on content and pedagogy may use technology just for technology’s sake, without
a focus on students’ learning (Pierson, 2001). Nonetheless, the majority of technology training for educators is based on the use of software or hardware with the absence of subject content. As a result, only one third of public school teachers feel prepared to integrate technology to strengthen their teaching (Hughes & Ooms, 2004). Curriculum-and-pedagogy-centered technology training for teachers is necessary (Diaz, 2001; Diaz & Bontenbal, 2000).

In sum, the determinant factor for students’ success in using computers is the quality of their teachers. School districts, therefore, should set aside an adequate amount of funding for teacher training within their technology budget. Specifically, technology training for teachers must be curriculum and pedagogy centered in order to link the technology use within the district to higher student achievement. It is ideal that staff are trained in both technology use and pedagogy work with teachers (i.e., content specialists) to conduct pedagogy and curriculum-centered technology training sessions for teachers. Since such individuals need to work with all teachers in the district, interpersonal skill is also required.

However, some school districts do not have the financial resources to realize adequate technology training for teachers. Unless the federal government can supplement the cost, the No Child Left Behind Act sets up lower-income school districts for failure. Only about one third of schools eligible for Title I funding receive the federal money. This means that the majority of school districts have come up with their own funding to meet the state mandated performance level (Public Schools of North Carolina, n.d.). Furthermore, school districts that are not poor enough for federal funding but not wealthy enough to attract and train skilled teachers are likely to struggle.

**Accountability For All Students Including Disabilities**

Another issue related to No Child Left Behind is using technology to support all students with disabilities. Even though students who are severely challenged can take alternate assessment to measure their achievement (Paige, 2004) and take the test under different conditions, students with disabilities are also assessed for their academic achievement. It is believed that the inclusion of all learners will ensure the quality of education for the students with special needs (Thurlow, Lazarus, Thompson, & Blount Morse, 2005). Educators, therefore, are called to become familiar with successful practices that are linked to supporting diverse learners. This requirement is consistent with the expectation that teachers are able to use technology to meet the diverse needs of students (International Society for Technology in Education, 2003; National Council for Accreditation of Teacher Education, 2002).

It has been recognized that verbal development can propel the cognitive development of learners (Vygotsky, 1986). Thus, research studies have been conducted about strengthening the literacy skills of disabled learners. Students with attention deficit and hyperactivity or with dyslexia may be able to use their speech and pictures to organize their thoughts by creating multimedia and this may nurture complex thinking (Faux, 2005). While good writers may not be able to benefit significantly from the use of spoken language, use of spoken words with multimedia creation can make a significant difference to learners with low literacy (Carlin-Menter & Shuell, 2003).

Some learners, on the other hand, need to overcome an inability to speak. For autistic learners, the ability to spell correctly plays an important role. Speech-generating devices (SGDs) seem helpful to both because SGDs produce both audio and visual feedback. However, what works can not be generalized because some autistic learners benefit from audio feedback and some benefit from visual feedback (Schlosser & Blischak, 2004). Nonverbal reading instruction using audio-visual PowerPoint was suggested as an effective tool by Coleman-Martin, Wolf Heller, Cihak, and Irvine (2005).

**FUTURE TRENDS**

It has been confirmed that even though the needs for pedagogy-centered technology training is ideal for educators, main-stream training in the past has been centered on hardware and software. Successful examples of educators’ technology training within a context of curriculum should be widely disseminated so schools that have not implemented curriculum-centered technology training can learn. Curriculum-centered technology training has been conducted with Preparing Tomorrow’s Teachers to Use Technology (PT3) since 1999. Higher education institutions have collaborated with k-12 to train educators to use technology in a real classroom.
context with this grant (Brush et al., 2003; O’Bannon & Judge, 2004). In terms of meeting No Child Left Behind accountability, technology trainings for preservice and inservice teachers within the context of state academic standards are likely to be more helpful to teachers than trainings that are not aligned with standards: there is a need for such a trend to grow.

The accountability system for all children makes research for successful methods to support disabled learners valuable. In particular, the accountability for reading and language arts makes assisting the speech impaired an urgent problem to be solved. Even though there has been an inadequate amount of research about how technology can help students with speech problems (Blischak & Schlosser, 2003), the need for such study will become increasingly acute. In addition, the feasibility of teachers creating materials for a nonverbal reading approach is suggested (Coleman-Martin et al., 2005). Coleman-Martin et al. (2005) indicated that teachers who used audio-visual PowerPoint became positive about the computer-assisted instruction and said they will make them. This study, however, was a case study with a small sample size. If the benefit of audio-visual PowerPoint was taught to a greater number of teachers, combined with the specific methods to create them for nonverbal reading, it could be possible to conduct a quantitative study about the increase in teachers’ willingness to create audio-visual PowerPoint for the speech-impaired.

CONCLUSION

No Child Left Behind requires that all students achieve proficient or higher academic performance designated by the state. The state monitors local educational institutions’ growth every year. If a school fails to meet the performance level two consecutive years, parents in the school district can choose to provide other forms of education. The accountability placed on a school intensifies the need for higher quality teachers. This, in turn, creates more need for training for teachers.

Technology training for educators should not focus on software or hardware but start with students’ learning goals derived from academic standards. Assisting teachers to develop strategies to promote higher order thinking within the context of academic standards can help teachers facilitate their students’ academic success. Curriculum-centered technology training has been conducted with Preparing Tomorrow’s Teachers to Use Technology (PT3) since 1999.

Since learners with disabilities are also included in No Child Left Behind, it is beneficial to train teachers to use technology for assisting diverse students. Literacy skill promotes complex thinking so more research about literacy training for disabled students is suggested.

REFERENCES


KEY TERMS

Accountability: Local educational agencies are held responsible for making students meet or exceed proficient level of academic achievement designated by the state. At least 95% of the students enrolled to schools needs to be assessed for the state to monitor adequate yearly progress. If students in a school fail to pass for the proficient level for 2 consecutive years, parents in the school district have the alternative to provide other means of education including private schools, charter school, and homeschooling.

Adequate Yearly Progress (AYP): States must decide how they monitor annual progresses of school districts. The 2001-2002 academic year determined the base line for monitoring AYP. Normally state standardized tests are administered to monitor progress.

Accommodation of standardized test for learners with disabilities: Accommodation is made for learners with disabilities when they take standardized tests whether with procedure or with materials (Thurlow et al., 2005). Individuals with Disabilities Education Act (IDEA) Amendments of 1997, section 614 (3) (B) specifies that students with disabilities must take any standardized test under these conditions:

• The purpose of the tests have been validated
• Trained and knowledgeable personnel give the tests
• The instruction by the tests’ producer are followed

Challenging academic standards: States are required to spell out what students are expected to know and do, including basic level for lower-achieving students, proficient and advanced levels for higher-achieving students. The standards need to be coherent and rigorous.

Charter schools: No Child Left Behind promotes charter schools. Even though charter schools have to produce the same academic achievement, they enjoy more lax regulation compared to traditional schools (Paige, 2004).

Homeschooling: If Title 1 schools fail to meet the Adequate Yearly Progress (AYP), parents in the school district have the option to home school their children. In 2003, 85.4% of the parents of homeschooled children said that they chose homeschooling due to concern about the school’s environment, and 68.2% chose home schooling because of dissatisfaction with instruction (National Center for Educational Statistics, 2006).

Higher-order thinking: The most commonly used framework to define higher-order thinking is Benjamin Bloom’s (1956) Taxonomy of Cognitive Domain. Knowledge represented by fact recall, comprehension represented by retelling or summarizing, and application that prompts learners to use knowledge to complete a simple task are considered lower-order thinking. In contrast, analysis, synthesis, and evaluation are considered higher-order thinking (Bloom, 1956). For learners to become critical thinkers, instructions need to occur in analysis, synthesis, and evaluation levels. Unfortunately, the majority of the questions asked in the classroom are either at knowledge or comprehension level (Martin, 2003).

Highly qualified teachers: Highly qualified teachers are defined as those “who hold . . . at least a bachelor’s degree, ha[ve] obtained full State certification, and ha[ve] demonstrated knowledge in the core academic subjects [they] teach[].” (Spellings, 2005, ¶ 1)
**Mindtool:** This is a term created by David Jonassen. The three pillars of *Mindtool* are critical thinking, creative thinking, and content/basic thinking (Jonassen, 2000). In classrooms, learners are to use technology to construct and represent their own meaning. Thus, the use of technology for simple drills or memorization does not qualify for *Mindtool*.

**Title I schools:** Title I schools are the schools that receive Title I money. Low-income schools are eligible for the funding and they can use the money to hire new teachers, acquire technology, professional development, or any other means that help students meet the achievement level set by the state. Low income schools are determined by the percentage of students eligible for free or reduced priced lunch (Public Schools of North Carolina, n.d.).
INTRODUCTION

With the vast majority of higher education institutions now being populated with millennial students and distance learners, it is necessary to change the way academic advising is conducted on the typical college campus. Howe and Strauss (2000) define millennial students as the generation born from 1982-2000. These students are known for being technologically confident and overly involved in scheduled activities (Howe & Strauss, 2003). The millennial generation spends less time than earlier generations on creative play and watching television, and more time on the computer and involved in structured activities. In addition, more students are enrolling in courses that are conducted online via the Internet instead of in the traditional classroom setting. These students are known as distance learners. This population needs to be successfully advised, even though they may never physically step foot on their degree granting college campus, has become a focus of higher educational institutions. Most distance learners are working adults who have other responsibilities, such as families. More millennials are also being drawn to online education because of the time flexibility it offers students (Steele, 2005).

To keep up with the busy schedules and time-constraints of these student populations, it is important that college administrators understand and acknowledge the need to implement technology-assisted academic advising. This technology can be in the form of computer-assisted information systems, digital communication options, and the Internet (NBCC, 2007). The following article will address what can be implemented into an academic advising program to add a technological advantage to both students and advisors alike.

BACKGROUND

In the 1960s, large mainframe computers were replaced with personal computers. The cost to use technology was greatly reduced, and the idea of utilizing technology for advising purposes immerged on college campuses (Granello, 2000). The first virtual counselor came to fruition in 1966, named ELIZA (http://www-ai.ijs.si/eliza/eliza.html). It still functions today, though basic in comparison to the extensive technology-based counseling systems that institutions now employ (Kostin, 2003). The use of virtual counseling continued to grow into the 1980s, as computer systems were developed that could combat and assist counselors in the area of cognitive psychology. For example, two that changed the realm of cognitive therapy include MORTON and PlatoDCS. MORTON was utilized in the treatment of mental illnesses, such as depression and PlatoDCS was utilized to assist clients with solving dilemmas and decision making (Selmi, Klein, Griest, & Harris, 1982; Wagman & Keber, 1984).

The computer explosion continued to enhance and change the way counseling was conducted. One might predict that technology will continue to surmount traditional, face-to-face academic advising in the future (Garcia & Ruiz, 2005). It is also important to note that even if a student prefers to meet individually, in-person with an advisor, technology can be implemented to greatly enhance that experience (Granello, 2000). Today, the use of the technology for offering guidance regarding academics has been termed virtual, Web-based, cyber, and online advising or counseling (NBCC, 2007). It can be described simply, as the delivery of information, instruction, and/or advice that occurs when a student and advisor are in remote locations. This virtual communication can occur asynchronously (occurring at different times) or synchronously (occurring simultaneously).

The millennial generation has changed the genre of student services on a college campus in three ways. First, millennial students contact and partake in more visits to support services, such as academic advising, tutoring, mental health counseling, and the career center on a regular basis. This can lead to over-worked, understaffed educational employees, which may persuade higher education institutions to development and design autonomous advising and counseling systems, like the
ELIZA, that will be able to offer students support 24 hours a day. Second, this generation is technologically savvy and has grown up relying on modern electronics in their everyday lives. However, it is important to mention that millennials are not the first generation to be ingrained, enthralled, and raised in a technological world. Much of today’s technology was designed by the generation prior to the millennial one, generation X. According to Howe and Strauss (2004), these students have never experienced a television that did not have a remote control, an automobile without a compact disc player, or a store that did not have a scanner at the checkout. Millennials enter college with the premise that higher education will also encompass technology that will make their lives more convenient.

Finally, this generation possesses a consumer-like mentality and expects immediate responses and information regarding their concerns 24 hours a day. This can put the traditional academic advisor in a predicament. In the past, it was adequate for students to participate in traditional academic advising where an advisor and student met one-on-one, in person, at a scheduled time to discuss course registration, academic, personal, or career issues. Most advising offices are open during the typical working hours of 8:30 a.m. to 5 p.m., times when the majority of the millennial students are attending class or engaging in activities that comprise the college experience, while distance learners are working full-time jobs. Students are now requesting that an academic advisor be available during untraditional hours, such as in the evenings. This demand has led to the initiation and acceptance of utilizing technology to assist in the advising process on college campuses all over the country. As with all colleges, retention of students is crucial. The need to offer competitive and supportive services is of the highest importance; therefore, it becomes necessary for administration to look to the arena of technology.

ONLINE ACADEMIC ADVISING TOOLS, TRENDS, AND CHALLENGES

Today, much of our daily lives are infused with technology. We bring our laptops, which store our interactive PowerPoint presentations, with us when we conduct group advising sessions; we look up a student’s academic record or midterm grades utilizing an online data management system; and we e-mail an advisee the answer to a registration question. Without technology, it seems life would move at a much slower and perhaps less effective pace. As advisors, we cannot discard or ignore all the modern technologies that are at our fingertips. Gone are the days when students presented paper schedules to their advisors that highlighted their next semester courses; then, upon approval, waited in line to have the Registrar enter those courses into a database. Some advisors remember those days and were ecstatic when scheduling went digital. However, there are many institutions behind the eight ball when it comes to utilizing technology for online advising.

Habley (2004) assessed technology used to enhance academic advising, and his results determined that only 2 out of 10 technologies necessary for virtual advising were on half of college campuses, those being online registration and degree audit systems. There are institutions that issue laptops to all incoming students, offer free Internet access in the resident halls, and maintain a wireless Internet connection across campus; nevertheless, these are not typical offerings on most college campuses.

So begins the review of available online services and methods that can be utilized for improving academic advising practices. First, the most common and preferred technological tool in use today is electronic mail, referred to as e-mail (Moneta, 1997). Electronic communication is rapidly growing due to campuses becoming “wired,” which means being connected through Intranet and/or Internet capabilities. The design of e-mail packages, such as Outlook, have allowed advisors, to manage distribution lists, post auto-replies for extended absences, and disseminate announcements, directions, information, and/or newsletters at the click of a button via the Internet. An added benefit of e-mail is it provides a record of communication and allows the information to be distributed to others in a timely manner.

Conversely, e-mail does have some disadvantages. E-mail can wreak havoc on a busy advisor who is inundated with a steady flow of messages. It also has the ability to be forwarded to individuals whom the original writer might have not wanted shared with others. This can, and has, led to legal action regarding redistribution of information without the consent of the student. For example, it is illegal without a student’s consent to forward a letter of recommendation via the Internet to a graduate school or potential employer. Therefore, it becomes important for educational staff to be trained on
e-mail legal and ethical standards, especially those associated with the Family Education Rights and Privacy Act (FERPA). Another negative distinction that can be affiliated with e-mail is that the tone of the message can be interpreted by the reader in a different manner than it was originally intended. This tool has significant reader perception and can create misunderstandings between individuals. Since it is communication by words, the non-verbal and personal elements are removed from the experience. E-mail contact should never be used as a means to discuss personal or failing academic issues. Those will always best be served through in-person meetings (Ross, Dearstyne, Gunay, & Love, 1999).

An online chat room can be set up via an instructional management system such as eCollege (http://www.ecollege.com), Blackboard (http://www.blackboard.com/us/index.Bb), or other Internet options. It is an inexpensive method to digitally reach large groups of students synchronously. Chats can become a source of support for students, as they will read about others facing similar challenges or issues (Woods, 2004). Online chats can be a form of peer mentoring, where upper-class students enter a chat room to offer support and to answer basic, non-confidential academic questions. This tool has the added advantage of time, as millennial students and distance learners tend to be available to interact in the evening, and an advisor can enter the digital conversation from their home computer. It is best to schedule chat sessions for 60 minutes. No special equipment is needed other than an Internet connection.

Another option that can be established through an instructional management system is a threaded discussion that is moderated by an advisor. The advisor can post questions and information of interest, while encouraging advisees to partake in dialogue. Threads function best for intact groups when used in collaboration with a course, such as Career Exploration class, First-Year, or New Student Seminar. Students can engage with other students in digital conversation regarding academic concerns, and the moderator and other students can post advice and support. It must be noted that threaded discussion works best for the discussion of basic academic issues, and should not be used to pass along complicated information.

Instant messenger (IM) allows for continuous online communication between an advisor and a student. IM closely resembles normal speech patterns in that one thought builds off another to digitally mirror natural conversation. This technology usually has no cost associated with it, due to the large number of instant messenger services available for free download. For example, AOL/AIM (http://www.aim.com), MSN (http://webmessenger.msn.com), and Yahoo (http://www.messenger.yahoo.com) are some of the popular options. A major disadvantage with this technology is when an advisor has a large caseload of advisees, it becomes cumbersome for instant messenger to accommodate more than one student at a given time. At peak times, it could create a backlog of advisees wanting to IM and an advisor only being able to engage in one online conversation at a time. Instant messenger does have a group function, but when used, it becomes confusing to recognize user names associated with each student or negotiating identity. Confidential matters cannot be addressed. An advantage to IM is it does happen synchronously, which allows a student to retrieve and get answers to questions concurrently. This medium is most efficient if there are predetermined times during the week that an advisor will be available to IM students. A major disadvantage is that not all IM software is compatible. Therefore, a campus would need to mandate a particular system to be used by all.

Electronic mailing lists, often called ListServes are electronic e-mail-based Internet forums that allow a student to subscribe to a distribution list of interest to gain access to group information. Typically, electronic lists are set up according to topics. For example, an advisor can have a ListSrv for registration information, upcoming events, and changes in curriculum. It provides students the option to subscribe to topics that they feel are most relevant and beneficial to their educational needs. As you may be aware, students delete messages from their overloaded inboxes without ever reading. The electronic mailing list provides students with some sense of ownership as to what information they will receive and therefore increases reading rates.

Facebook (http://www.facebook.com) made its launch to change the world of education in 2004. Today the site has some 19 million users. It has become an important aspect in advising because it allows for the facilitation of relevant information through social networks. This site permits registered members to create profiles, join and organize groups, send messages, post photos, advertise events, and encourages students to bond with fellow classmates. Amazingly, the services are totally cost free. The downside of Facebook is that many students do not take their postings seriously.
You can view profiles filled with profanity, pictures of underage students consuming alcoholic beverages, illicit drug use, and barely-clothed co-eds. This leads to repercussions for students exhibiting such behavior. For example, in 2005, two athletes at Louisiana State University were dismissed from their athletic teams after posting irreparable comments about their coaches on the site (Brady & Libit, 2006). Institutions across the country are advising students to be cautious about the content that they post online, and to avoid anything that would represent them in a negative way. Advisors have an obligation to educate students on proper Internet etiquette. Advisors can hold workshops related to the issue of posting information via the Internet, to ensure institutions are upholding their position in developing morally responsible students (Arrington, 2005).

An advisor’s blog is a simple and easy way for advisors to establish a personal connection with their advisees. This Web-based communication tool has an advisor making entries as though writing in a journal or diary. Most blogs are written in a less-formal, light-hearted manner. Information can incorporate text, images, or links and displayed in reverse chronological order. Readers can be given the opportunity to leave comments in an interactive format. A blog can maintain communication with advisees when they are away from campus for semester breaks, during the summer, or studying abroad. A blog works especially well for incoming freshmen. This medium can encourage a student to see an advisor in a less threatening, more personal light. Advising blogs are written to invoke empowerment and encourage academic success; hence, why written in the first person. This medium should never be used to distribute important academic information.

Podcasting is one of the newest elements being introduced into academic advising. It involves utilizing a media file that is distributed over the Internet and can be played back on personal computers or portable media players, such as the Apple IPod. It offers direct, automatic streaming of audio and video. This method is widely accepted by the millennial generation. Students enter the Web site “iTunes” and conduct a search under “education” then to “higher education” to bring up a list of podcasts available for immediate download. Podcasting disseminates information with the touch of a button and can assist students in understanding complicated materials, such as preregistration information. It is also an effective tool for those students that prefer auditory learning. If you think a student will not be able to access the information without purchasing an expensive portable media player, good news, downloading the necessary software to your computer is free at http://www.apple.com/itunes/download. Many colleges distribute IPods to incoming freshmen at orientation, downloaded with information regarding their upcoming first-year. Thus podcasting can be a way to introduce a large amount of information in a creative way. This technology allows students to take the information with them, listen and rewind at their own speed, instead of feeling overwhelmed at all that was presented to them at orientation.

For incoming students, online placement testing can become an effective and efficient tool for academic course assignment. It guarantees never having to return to the old paper and pencil format. During the summer, students are directed, usually through e-mail, to complete a required mathematics, English, and/or writing placement test. The test is then administered through an instructional management, internally designed, or packaged software system. A student logs into the system, at their convenience, with either a student ID or an assigned code. Online placement tests then walk the student through directions and display a time limit set for completion. The results are then compiled and either sent directly to advisors or the system displays the results. Seeing all the scores at one time makes compiling statistics or comparisons easy. Online placement testing saves time, as it eliminates the need for a student to spend countless hours completing tests during orientation. In addition, it also eliminates a staff member from administering tests time and time again, which results in reduces staffing costs.

Lastly, students located all around the world can complete the testing effortlessly in the comfort of their own home. Keep in mind, the potential to cheat, plagiarize, or use assistance from a calculator or dictionary is increased with online placement testing. Students should be required to read a statement regarding ethical behavior in test taking and acknowledge that they will abide by the policies set forth, though to some this may seem unworkable in scope. To deter potential devious acts, students can be required to mail their scratch paper or outline to the institution in a postage-paid envelope that can be attached with the initial mailing about the online placement tests. With virtual advising, enters the control and management of remote student policies and procedures that need to be established and enforced in the same manner as traditional classrooms.
Lastly, online computer-based training can assist students in learning how to use various online student information systems. Web shots, virtual instruction, and interactive demonstrations can walk students through a series of steps, such as how to log onto their advising accounts, retrieve grades, change mailing information, register for classes, and print an academic audit. Students move at their own speed through the material and can use it as a quick reference in the future, often referring to it instead of burdening an advisor with every little question. This online technology can encompass, visual, audio, and hands-on learning elements, which is sure to appeal to every type of learning style.

ONLINE TRAINING AND FUNDING

Levin (1999) completed a study that determined, while the use of Internet-based technologies is convenient and easy for students, it can pose inherent issues for institutions. There is an increased need for investment of time and staffing in order to implement, maintain, and train staff, faculty, and students on advising technologies. Colleges must consider these elements before implementing online technologies. With some technologies experiencing escalating costs, it is necessary for administration to allocate funding to be used exclusively to enhance online advising programs. To ensure adequate budgetary support, colleges may need to add a technology fee to tuition billing, or offer technological advances to students by an à la carte venue, where each student was free to determine his/her own technology menu. As a final point, with the development of new technology, it is essential that institutions look past the latest trends to determine what their students will use, and benefit from. The best technological advances can be executed, but if advisors and students perceive those as a hindrance, then in fact, technology is not being used as an enrichment tool (Woods, 2004).

CONCLUSION

With the need to successfully serve millennial students and distance learners alike, there is an increasing need to shift the paradigm from traditional, face-to-face advising to a more diverse, effective, and access friendly approach. A solution might be to utilize and include technology to enhance the advisement process. With the ever-shrinking college budget, it is no wonder that funds are not designated to online-based technology resources; however, this authors hopes that administration will understand that not all technology comes at extraordinary costs. Technology is a creative canvas, and how you use technology on your campus is your vision. The best advice is to always incorporate student ideas into your technology plan, as they are the true consumers and user of the digital tools that are implemented. Online advising might never replace face-to-face academic counseling entirely, but if implemented strategically, it can greatly supplement and enhance an academic advising program in higher education.

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**KEY TERMS**

**Advisor Blog:** An online/Web communication tool, written in the first person, that allows the owner to make entries as though he/she is writing in a journal or diary. Information can incorporate text, images, and links and is displayed in reverse chronological order. Readers are given the opportunity to leave comments in an interactive format.

**Asynchronous Communication:** This type of communication does not occur in real time and there is a lapse that happens between the sending and receiving of message content. One such example is e-mail.

**Electronic Mailing List (ListServ):** An electronic e-mail-based list or Internet forum that allows a person to subscribe to a distribution list to gain access to group information. These electronic lists are usually set up by topics.

**Facebook:** A popular Web site, 19 million strong, that has become an important aspect in the world of higher education because it allows for facilitation of relevant information through social and academic networks. It allows users to create personal profiles, join and organize groups, send messages, post photos, advertise events, and interact digitally with fellow classmates (http://www.facebook.com/).

**Instant Messenger (IM):** This form of technology allows for text, audio, video, and images to be sent simultaneously in real time. It functions similar to e-mail but messages are sent instantly, without delay, from one individual to another. It functions similar to a natural conversation. Members are required to set up a contact list that will allow others to view your online status, online or off-line, to determine when you are available to have a digital conversation. Typically it is a one-on-one conversation, but IM does have the ability to be used for groups.
**Intranet:** An electronic mail system that operates as an internal mode of digital communication and information sharing within one organization. It is usually safeguarded against illegal access with an employee or student password.

**Millennial Generation:** This term is used in association with individuals that were born during the years of 1982 to 2000. This generation is the first to grow up in a world immersed by modern technological conveniences and have been able to fully excel in the digital revolution.

**Online or Virtual Advising:** The technological digital delivery of information, instruction, or advice, when a student and advisor are in remote locations.

**Podcasting:** Is a type of media file that is distributed over the Internet and can be played back on personal computers or portable media players. It is a method of syndication that offers direct, automatic downloading and streaming of video and audio. This method is widely being used to service the millennial generation of students.

**Synchronous Communication:** This type of communication occurs in real time and allows an individual to retrieve an answer to a question simultaneously. One such example is instant messenger (IM).

**Threaded Discussions:** An instructional-based course management shell such as eCollege, Blackboard, or Internet portals, that allows students to pose and answer questions while participating in a shared discussion, where one conversation builds off another. Most often, the instructor functions as the moderator and threads are implemented into the methodology of a college course. This technology can be asynchronous or synchronous.
Online Course Settings and African–American Women Participation

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INTRODUCTION

Over the past decade, distance education has changed the dynamics of the traditional learning environment. According to the U.S. Department of Education, the most commonly used technologies in distance education, besides print, are asynchronous computer-based instruction, two-way interactive video, and one-way prerecorded video. Although distance education meets the educational needs of some of its participants, frequently there are issues to be dealt with. For instance, although online courses offer a number of solutions to the inequality of the “digital divide,” a term used to describe the disparity in access to technology that exists across certain demographic groups. See Armstrong (2000) and Attewell (2001), as cited in Soker (2005) question whether online instruction contributes to the “inclusion” of nontraditional students or does it on the contrary cause “exclusion,” or create new barriers for these students. Of the growing number of nontraditional students that enroll in online courses, a severely overlooked but expanding population is comprised of African-American women. From this analysis, it is clearly shown that there are certain attitudes that African-American women have concerning online learning, that race and gender have an impact on the confidence of African-American women when compared to Caucasian students in online collaboration and discussions, and that there are certain group dynamics that African-American women prefer while participating in online discussions.

This article describes constraining factors that fifteen African American women in an advanced degree instructional technology program experience through participation in an online course setting. The constraining factors can be categorized into two areas of concentration included extrinsic and intrinsic barriers: They are social limitations (academic, financial, and technical problems) and the intangible aspects of racism (sense of isolation and belonging, often harbor feelings of inferiority and unworthiness). Taking a relatively long-term perspective, changing online learning participation patterns during the last decade are also examined.

BACKGROUND

The available racial-difference research in education often shares the general theories that are developed to address educational achievement and attainment (e.g., Coleman, 1988; Freeman, 1997; McDonough, 1997). Integrating socioeconomic status and social capital (shared values, beliefs, and information resources that enhance achievement), such theories have guided empirical studies of minorities’ education to examine family socioeconomic background, parental involvement, school environment, quality of instruction and curricula, and academic performance (e.g., Peng, Wright, & Hill, 1995). While these concepts account for achievement and attainment, they are not sufficient in explaining specific processes and outcomes such as online learning process and outcomes. Building upon the generic “attainment” research, this study seeks to understand specific phases or stages in online learning paths by linking them to individual psychological and behavioral patterns (motivation to learn, educational and occupational aspiration, and learning behavior) and institutional conditions--including those attainment predictors. This approach may enable us to reveal the mechanisms that affect online learning and that could be altered by policy or program changes.

There is strong evidence that controlling for educational attainment and income, Blacks and other race-ethnicity still lag behind the dominant majority in using computer and accessing the Internet (Hoffman, 1993).
In broad educational achievement measures, socioeconomic status (SES) does not explain all the differences between minorities and the others (e.g., NCES, 2000a). The persistent racial gaps imply differences in organizational environments and personal social interaction that go beyond the larger socioeconomic stratification. Obtuse in analyzing micro-level personal choices and intellectual inclinations, the stratification theory needs to integrate organizational and individual processes that modify the structural patterns in various ways.

In addition to SES, a wide array of concepts is possible explanation for minority groups’ disadvantage in online learning. Personality, personal value and beliefs, motivation, intellectual orientation, family cultural capital, and personal social network are influential to the racial disparities in educational attainment.

It is overly simplistic to assume that online learning will uniformly benefit all students. Many believe that with powerful and cost-effective technologies, including WebCT ownership, Internet access, e-mail use, online instruction and interactive systems, minority and poor students will be able to receive education of the same quality as their more fortunate peers (Gladieux & Swail, 1999; Panel on Educational Technology, 1997). However, access to technology is not equitable across socio-demographic categories since it is determined by resources available to the schools, communities, and households. New technologies including online instruction and interactive systems seem to best accommodate those who already take advantage of available educational opportunities (Barley, 1997). The rate of the Internet access among individuals with high income and higher education are greater than that among those with low income and less education. Race/ethnicity was an important stratification factor in the rate of Internet access it is possible that use of these may widen the educational gap in such a way that “advantage magnifies advantage” (Gladieux & Swail, 1999) as the advantaged benefit most from cutting-edge technologies whereas the most needy benefit least.

Individual psychological and behavioral patterns (motivation to learn, educational and occupational aspiration, and learning behavior) are another potentially confounding factor related to the effect of online learning quality. A recent study (Warschauer, 2000) suggests that computer-based educational programs did not benefit female students as much as it benefited male students because females were likely to be disinterested in the learning settings presented by the available computer products, typically with drastic movement and even violent images. Some researchers claim that women are disadvantaged in online courses (e.g., Blum, 1999) and that we need “women friendly cyber-classrooms”. Relative to White students, African American women were less motivated to participate in computer-based programs because of a misperception of computers and mathematics as overwhelmingly complicated (National Science Foundation, 1997). African-American women enrolled in online courses typically have children, family burdens, or demanding jobs to consider, and their attitudes toward online courses are typically uneasy or stressful causing a lack of intellectual interest resulting in a great deal of time spent on a online course. In short, online learning per se potentially may either reduce or widen gaps between the advantaged and the disadvantaged.

This article explored constraining factors that African American women in instructional technology programs for advanced degrees through participation in an online course setting. We propose that African-American women have certain barriers that discourage their participation in online classes. We analyzed these factors together with specific online learning process and outcomes. Specifically, we attempt to address the following issues:

- What extrinsic barriers constrain African-American women to participate in online courses and how do they affect their online course performance?
- What intrinsic barriers discourage African-American women to participate in online courses and how do they limit their successful completion of their online course?

**Extrinsic Barriers Discouraging Participation in Online Course**

Extrinsic barriers that discouraged the participation of African-American women in this study included social limitations that hindered them. Academically, online courses require large amounts of writing and communication, while technically these courses require large amounts of computer use. African-American women in this study often lacked computer and language skills because of inadequate training. Also, the fear of using new technologies, browsers, hardware, and software was a hindrance. Financially, computers and technologies are expensive and require upgrading. Because of
other responsibilities, the African-American women often did not have the financial resources to purchase and upkeep computer systems and the Internet. Technical problems, insufficient training to use the delivery system, fear of new tools for online learning, and lack of consistent platforms, browsers, and software are also discouraging factors for these African American women. Often, the women have not had adequate training in computer applications, so taking an online course was somewhat of a challenge. Without the knowledge of how to attach a file or working in the online course management system, students cannot be successful.

Academic skills are also an important discouraging factor. The African American women in this study felt that they did not have the proper communication, language, and writing skills to express themselves to their professors and group members.

Extrinsic barriers focusing on social limitations play a major role in discouraging participation in online courses, especially participation by these African-American females. Social limitations included financial and time management, computers that were subpar in maintenance repairs, the high cost of Internet, and family and other obligations made it extremely difficult for many of them to participate in online courses. Writing and communication skills were also a major barrier for these African-American females as they felt that they did not have the necessary communication skills to promote successful online experiences. The amount of technology experience required also hindered many African-American females in their online class because they have not received proper training.

**Intrinsic Barriers Discouraging Participation in Online Course**

Perhaps intrinsic barriers that discourage African-American women are the intangible aspects of racism. The African-American women in this study faced feelings of inferiority, loneliness, unworthiness, and isolation. Often they found themselves to be the only student of their ethnic background in their classes, causing them to feel that they have no one in which to relate. They also felt that their skills were inferior and that they were slow or unworthy of working in groups through online discussions, manner of speech, and communication skills. Although online courses offer a certain level of “invisibility,” many of these women routinely felt that others can mentally visualize their ethnicity. This feeling caused an overly conscious emotion of a “lack of belonging” because of their ethnic background.

Whether it be from shyness or wishing to be sure that they understand the topic before posting their response to the topic, these African-American female students were more cautious and wanted to be aware of the mood of the discussion and what was being said before they joined in.

After posting, they often worried that other members of the class would think their posts or questions are unintelligent or not as good as others.

Although during online courses group members cannot visibly see their color, these women still harbor feelings of “lack” or “inferiority” when participating in online courses because they are overly conscious of their color and ethnic background.

If they posted a poor question, they were more likely to ask another minority classmate for help rather than ask the teacher. They felt inferior to others and felt the Caucasian instructors were not as concerned about their wellbeing as they were about other Caucasian students and often felt intimated by other Caucasian classmates and their ideas online. They felt isolated and were not as open with their feelings.

African-American females were discouraged in participating in online courses by intrinsic barriers. One of the major intrinsic barriers they encountered was seemingly based on racism. Many times they explained that they are the only one of their ethnicity in the class. Because of this uneven ratio of ethnicity, often the sense of not belonging occurred and they began to feel inferior to others in the class. As a result, they tended to prefer working in small groups where they could lead and not allow others to control their learning but where they could control and limit the learning of others. They also distrusted everyone in the class including the teacher and had a tendency to only post after reading the posts of their classmates because they did not want anything they did to make them feel less than they already may have felt in the class.

**DISCUSSION AND CONCLUSION**

African-American women are, in increasing numbers, enrolling in online courses because of the conveniences that it offers. Pasty D. Moskal (2001) accounts that 79% of students take online courses because of the conve-
nience of not coming to campus. However, although online courses do allow African-American women the liberty to handle all of the other responsibilities they may have in life, family, work, and so forth, the amount of time that is required in order to be successful in an online course is substantial. Contrary to popular belief, successful students in online courses spend more time during coursework than in traditional courses.

Because African-American women enrolled in online courses typically have husbands, children, family members, or demanding jobs to consider, their attitudes toward online courses are typically uneasy or stressful. African-American women fit the demands of the online courses they take into any available remaining time they may have and much of the work may be restricted to weekends and evenings (Hudson, McCloud, Buhler, Cramer, Greer, & Paugh, 1998). Because of family responsibilities and other obligations, African-American women who are enrolled in online courses must stretch out their available hours in a day in the attempt to perform their class work. Those women enrolled in online courses have an additional load because of the additional work that is required in online classes. African-American women must stay motivated, whether intrinsically or extrinsically, to complete their courses. As different cultures structure and stratify themselves differently, the African-American culture is centered on the African-American woman. So, the African-American woman must find the appropriate balance. The African-American woman, the center of a wealth of needs in her life and academics, continues to be needed by her child and expected by society to either fail or succeed at all odds.

As evidenced from a previous study, “New computing technologies are intended to empower historically disadvantaged groups by giving them greater access to better learning tools” (Du & Anderson, 2003, p. 7). However, if the method of instruction does not change to suit the situation and student, the underrepresented minorities will continue to lag behind the general population in technology affluence. The digital divide has continued the segregation of our society by disproportionately affecting African-Americans woman and causing them to suffer some of the same educational and economic plights as they did in civil rights during the 1960s and before. Hence, a vicious cycle develops with African-Americans lagging behind the general population economically and, therefore, having less access to quality technologies and computers. This greater degree of separation from quality computer access and usage causes African-Americans to lag behind the general population in other areas.

Another problem that African-American women encountered that makes online courses so appealing is discrimination because of race and gender. Since African-American women are marginalized by race and gender, online courses present less possibility of racism and sexism, since students and teachers cannot see or hear each other (Kramarae, 2001, Spahn, 2001). African-American women face a lot of trepidation when deciding to take an online course, but the need for education supercedes that fear. Being African-American and a woman, online instruction appeals to African-American women because it allows them, in some cases, to be seen for their achievement and academic performance. In traditional classes, on predominantly white campuses, especially, African-American women have to deal with low expectations from others about them as scholars—the stigma of the perception that African-American women, because of their race and gender, can neither write nor think critically (De Veaux, 1995).

Race plays a major role in the confidence of African-American women in online collaboration and online discussion, when compared to Caucasian students. Although online courses reduce the occurrence of discrimination, many African-American women feel that old bases for judgment and bias may be replaced with new cues, especially those of writing style and content (Kramarae, 2001). While online courses do offer African-American women the opportunity to be seen and judged by their academic achievement, teachers usually have access to some personal information about students and always have students’ names, which often carry gender and ethnicity clues (Kramarae, 2001). African-American women, although they are in online courses, feel that they are inferior and are often times seen as inferior to the represented majority of the class and share the perception that their scholarship is of little real interest to their university, because the university is interested in matters of academe and not improving African-Americans’ lives. They share the justifiable paranoia of people on guard, because they feel they are always under attack in this society (De Veaux, 1995). Bernetta Simpson contends that there are African-American women in this country who are struggling, not only with the conventional barriers and stresses of education, but also with feeling isolated and
lonely, conscious of the importance of their work, but longing desperately for support (Simpson, 2001). As participants noted often in their personal experience, when in online courses, they are the only one of their ethnic background in the class. This fact only intensifies the feelings of isolation and loneliness. “Even as women have made considerable gains in education, the challenges for African-American women have always been separate from the women’s movement, due in large part to the fact that African-American women are marginalized by race” (Olisemeka, 2004). As African-American women continue to feel lonely and inferior to other students in their online class, their participation in activities diminishes.

Further, in online collaboration, the over represented majority, Caucasian students, may feel that they are vastly different from African-American women and may not be able to communicate effectively with them. African-American women, as a result, could feel isolated and lonely. They may often feel like “outsiders within the halls of academe” (De Veaux, 1995) and they may also experience “intellectual isolation from other classmates” (Carter-Obayuwana, 1995). Further, because African-American women typically have different writing styles, language patterns, and communication styles that are different from other classmates, they may feel as if they are unintelligent or inferior to other students. Despite all the feelings of isolation and loneliness that African-American women may feel as they participate in online courses, their attitudes about being African-American or female (Collins & Lightsey, 2001) may help serve as coping resources, leading to a positive sense of self, a sense of control, and reasons to maintain hope and effort (Pyant & Yanico, 1991). Hence, the negative feelings that African-American women may incur because of their participation in online courses are often used as an impetus to excel in education.

One significant aspect of online education that is traditionally common is the aspect of group collaboration. While working in groups, African-American women tend to have certain dynamics that they prefer. “African-American women learners come into classes with specific personal histories, learning styles, and expectations” (Burge & Lenksyj, 1990). In cases of group work, African-American women tend to want to control their own learning and often desire to be group leaders. In today’s society, especially in the African-American culture, the older female is seen as the leader and backbone of the family. While working in online group collaboration activities, African-American women tend to progress forward as the group leader. As the group leader, they are allowed the advantage of controlling what aspects of required activities the group focuses on. As a result, they tend to choose activities and support material that they are very knowledgeable of, thus reducing feelings of inferiority.

In conclusion, African-American women are marginalized in education by both race and gender. With all of the factors that may motivate African-American women to participate in online courses, there are just as many negative factors that should be considered. African-American women often feel isolated because of the lack of representation that they have in higher education and online courses. Also, because of their differences in writing styles, language use, and communication skills, African-American women tend to feel inferior to other classmates that may be present in online courses, but their feelings of isolation and inferiority tend to motivate them to succeed in education. While working in groups, they tend to prefer to be leaders so that they can control the intensity of group work in order to reduce their feelings of unworthiness and isolation. With all of the advancements that the United States has made in education and philosophy, there still seems to be a disparity between different participants in education. Online courses seem to lessen the disadvantaged minority and the advantaged majority, but there are areas where minorities are perpetually at a widening disadvantage. While participating in online courses, African-American women face much trepidation; however, for the sake of their livelihoods, the women in this study still found a way to succeed.

**IMPLICATIONS AND TRENDS**

The study is to promote an equitable participation of African American women for online learning across all United State academic institutions that reflect the current and future student body and as a model for application beyond the local boundaries. The findings suggest that a racial culture perspective can provide a powerful analytical framework for understanding that online courses are not completely beneficial to all students and to encourage the policymakers and the educational practices they promote, to be restructured in an effort to condense the equitable achievement gaps that now exist.
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KEY WORDS

Constrain. Force; to compel. Thesaurus: impel, oblige, urge, necessitate, drive. To limit the freedom, scope or range of someone. Constric, bind, tighten, restrain, confine.

Discourage. Deprive someone of confidence, hope, or the will to continue. Dishearten, dispirit, intimidate, deject, prostrate, unnerve, dampen, dismay, daunt, demoralize, set back; Antonym: encourage, hearten. And seek to prevent (a person or an action) with advice or persuasion. Warn, dissuade, alarm, scare, deter, restrain, obstruct, impede, check, inhibit, repress, curb.

Ethnicity. A term which represents social groups with a shared history, sense of identity, geography, and cultural roots which may occur despite racial difference.

Gender Identity. How a person sees himself or herself, whether masculine, feminine, or somewhere in-between. Gender role is the objective, public presentation in our culture as masculine, feminine, or mixed. For most people, gender identity is consistent with gender role (as when a man has an inner sense of his masculinity and publicly acts in ways that support this feeling.

Online Course. Defined as one for which all regularly scheduled classroom time is replaced by required activities completed at distance and managed online. Online courses allow students to take courses from geographically remote locations, without any need to come to campus (for instance, while deployed in the military).

Race. The term race describes populations or groups of people distinguished by different sets of characteristics and beliefs about common ancestry. The most widely used human racial categories are based on visible traits (especially skin color, facial features, and hair texture) and self-identification.
Online Curriculum Development: A Mezzanine Approach

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INTRODUCTION

The development of online curriculum provides an opportunity to rethink traditional workflows and approaches to curriculum mapping. An XML-based single-source model is used to illustrate some key practical and conceptual challenges. A mezzanine approach to curriculum is proposed, which seeks to conceive of curriculum as a three-dimensional space embedded within various networks.

The final part of the discussion then seeks to contextualise these challenges in the recent climate in which user-generated, participatory technologies have made a resurgence. Here, the single source case study highlights some complimentary benefits of using a conventional learning-object approach that provides scope to encompass the social, participatory, and collaborative aspects of “E-learning 2.0.”

BACKGROUND

Beneath the familiar hyperbole associated with the latest technological trends, the development of user-driven and computer-supported collaborative learning applications (such as blogs and wikis) have simplified the use and sharing of educational resources and experiences. Many educators now incorporate these software applications into their courses, as well as the ethos of user collaboration driving their development (Augar, Raitman, & Zhou, 2006). Controversially labelled “Web 2.0,” this broad attitudinal shift is also characterised by the adoption of open standards and applications that are interoperable and widely accessible. Educators are increasingly aware of how the educational use of Web-based approaches, such as collaborative learning through virtual learning environments (VLEs), impact upon student learning by supporting valuable processes of knowledge construction and online collaboration.

Trends, such as E-learning 2.0, reflect a similar shift in educational thinking beyond the conventional digital repository and learning object approach. Much of the current educational literature on e-learning seems, however, to be cautious; perhaps in part to counterbalance the excessive enthusiasm and hyperbole accompanying e-learning during the late twentieth century. Halavais, for example, soberly reflects that “the software designed to maintain weblogs is little more than a simplified content management system… The excitement… has less to do with flexible systems that ease the process of web publishing, and—like many technologies that allow for virtual interaction—more to do with the cultural practices that have evolved using these technologies as a foundation” (2006, p. 1215).

There is certainly greater understanding and awareness of how technology should service and enable educational processes and practices rather than define them. And while educational needs and goals should always precede the educational use of any technology, the transformative capacity of Web-based information and communication technologies (ICTs) to challenge how educators think about sharing information, social interaction and knowledge building remains significant; moreover, it provides a positive opportunity to reflect on how we teach and learn.

RETHINKING ONLINE CURRICULUM: A MEZZANINE APPROACH

Following Halavais’ reflection, this discussion is concerned with the practices that arise from the educational use of ICTs rather than any particular technology; namely, the benefits of developing curriculum for use via online, paper, and other methods.

Rather than focus on the use of participatory applications such as blogging and wikis, the positive and negative challenges arising from an XML-based
approach to developing online curriculum content will be used as an illustrative example. This example is suitable for the dissemination of educational content to a large number of students via a variety of platforms (particularly print and online), and whose content consists of multiple course and/or grade level groupings. The aim is not to promote this particular single source application of XML per se, but to use this example as a basis for rethinking the practice of curriculum development.

Marking Up from a Single Source: Using XML

The first practical and educational challenge for repurposing curriculum for the Web arises from the process of rethinking how curriculum content can be effectively restructured for Web delivery in ways that exploit the medium. One reason for marking up a curriculum document using XML is to fully develop the document as a learning object that can be made more accessible, dynamic, and repurposed to suit a range of uses, audiences, and outputs.

XML is widely used in areas such as digital publishing (Kasdorf, 2003). It is a customisable text-based markup language that enables the developer to construct her/his own specialised markup to transmit formatted data (Bray, Sperberg-McQueen, Maler, Yergeau, & Cowan, 2004). XML is used to encode and structure information from one source. It enables the format of curriculum to vary according to how it is accessed and who is accessing it. XML standards are open and internationally recognised. As an “extensible” markup language, XML enables those responsible for maintaining, editing, and marking up the document to determine their own markup vocabulary that makes sense to them. A single source of curriculum content is created as a single raw XML source file that is used for generating all forms of output (e.g., HTML for the Web, PDF for print).

Repurposing a curriculum document using this approach involves several basic steps: firstly, the curriculum is authored using a standard word processing package, such as MS Word. The development of this kind of integrated approach begins with the identification of suitable and appropriate curriculum document. Basic styles (e.g., for topic headings) are formatted in this document, which is marked up using some form of XML editing software. (XML editing software is available that plugs into common word processing applications). The document is then structured and tagged according to a document type definition (DTD). This modular DTD serves to define the XML elements to be used. This separate file functions as a kind of template for the XML source, defining the order and structure of the curriculum. General purpose DTDs, such as DocBook, are freely available. It states what elements must be present and which ones can be optional, their attributes, and how they relate to each other. The XML document containing the curriculum guide must conform to the DTD to ensure that the document will be displayable in a given format (Web, print, etc.). This process of validation ensures that the document has followed the DTD structure.

The “raw” single-source XML document generated at the end of this process serves as the source for printed, online, and other versions as necessary. This XML source file not only contains the raw content of the curriculum guide, it also contains metadata; that is, attributes and values identifying further information about the content, such as authorship details, the version, subject area, course details, and so forth. Customised tags and metadata are used to break the curriculum document up into modules or “learning objects” that can be updated on a regular basis. More sophisticated metadata describes how components of the content appear and relate to each other online. For example, metadata could be included to enable different sections of the curriculum to appear online according to the user’s level assessment or enrolment status. The database driving the Web site is programmed to locate these tags and present the data accordingly. Metadata can be added to enhance the online functionality of curriculum. Key words, phrases, and headings can be linked to other online resources.

Finally, this source XML file is transformed to a format suitable for viewing on the Web and a suitable printing format (e.g., PDF) using two separate extensible style sheet language transformations (XSLT). An XSLT script is used to transform the XML to XHTML for rendering on the Web. During this process, each XSLT applies style sheet rules that determine which parts of the source content are appropriate for the output. An online version of the curriculum guide, for example, may include a short video introduction to students that is fully incorporated into the online version of the curriculum guide, but cannot be included in the printed version. The DTD and XSLT script can
Online Curriculum Development

then be applied to other sets of documents, such as other areas of the course or related materials within the curriculum area.

With this process in mind, it is critical that the content undergoes extensive development prior to the markup and transformation. This preparatory process involves careful consideration of five areas: how curriculum is stored; how content will be structured; how curriculum is shared; the visual design of the online version/s; and how curriculum will function as part of an online environment.

XML is promoted by some for use on small projects such as a journal or book (Kasdorf, 2003); however, the single-source approach is more suitable for information that is intended for longer-term use across a range of platforms. Curriculum content can be reused and repurposed across different publications, Web sites, and outputs. (Developing an XML-based framework for a document that will only be used once is not advised. The single source approach described favours a gradual and well-planned curriculum development cycle.)

Storing and Sharing Curriculum from a Single Source

The next step is to map, categorise, and prioritise the parts of the curriculum as a kind of blueprint for how it will be delivered online. This stage of development requires a logical breakdown of the content into its constituent parts, followed by an exploration of thematic links both across and within those parts. These parts become learning objects that can be rearranged in any number of ways. For example, where a curriculum provides for different levels of student assessment, the online version of the curriculum might only show that level of assessment that is of direct relevance to that particular student. When breaking content into smaller objects, care needs to be taken to limit the level of granularity to which the content is chunked; otherwise, the process of marking up and managing these chunks may become unnecessarily complicated and difficult. Following the methodology outlined, these chunks are then prioritised in three ways: firstly, some elements of the curriculum may be prioritised according to the order in which they should be accessed (e.g., on first usage, students may need to start at a welcome page). Secondly, aspects of the curriculum may be tagged according to the type or profile of the user (e.g., according to which elements of the curriculum are relevant to users according to assessment or enrolment type). As a corollary of this, parts of the curriculum may be designed for optional use.

Once curriculum developers have identified generic content for all outputs, it becomes possible to automate the dissemination of curriculum across any number of platforms. Subject guides, for example, typically feature elements that apply across grade level or course frameworks. Unit courses sharing the same subject-level curriculum framework would draw from the same content (and other design elements for presentation if desired). Another example might be syllabi for different subjects within a course that refer to the same curriculum framework or overview of assessment, or it may just be a generic copyright page that is included in all publication outputs of the educational institution. These generic sections of content only need to be marked up once and automatically generated in all versions of the curriculum. Using a single source in this way can reduce unnecessary duplication of content, provided there is a sufficient amount of content and structure within the content to justify the labour-intensive effort necessary to mark up curriculum for multiple platforms of delivery. Storing all content in a single source means that it can be stored in one source for all different media. By maintaining only one source of content, content can be updated or enhanced regularly in ways that are more responsive to its users.

A key strength of marking up content for mass delivery across different platforms can reduce the duplication of labour and data storage (e.g., editing the printed version, then making the changes to the PDF or HTML version, and so on). Rather than separately modify the print and online versions of any given curriculum, it is possible to edit and manipulate one source of content, although the XML document will invariably require some tweaking between versions, online, printed, podcast, or otherwise. However, in the medium-to-long term, this kind of single-source approach can make curriculum dissemination workflows more efficient because all outputs of the curriculum (print, Web, PDA, etc.) are centralised in one source.

Repurposing educational materials using XML offers other benefits. It allows the content to be indexed and cross-referenced in more sophisticated ways that make it easier to search and navigate, and is also a useful way of ensuring that online content is compliant with eLearning and other standards of access. Choosing the right markup or language to describe the data
is important. Developing a common vocabulary (i.e., ontology) is a major challenge experienced by educational institutions seeking to exploit XML (Saini, 2003). As many curriculum review cycles can take years to complete, it is important to future-proof content against technological and organisational change. Languages such as XML are not only useful for data that will be presented in a variety of formats; they can also be used as an intermediate step for transforming one format to another. For interoperative systems to work effectively, a systemic approach to the structuring, marking up, storage, and presentation of any given learning object is required to ensure its conformity to the basic standards of browser handling and interoperability. The use of standards across authoring, designing, formatting, and delivery stages of content promotes a consistent approach. Furthermore, XML can, as an internationally recognised format for data interchange, be converted to other formats relatively easily, so that even if XML becomes obsolete, the source file can be converted to the new standard. More than this, curriculum information can be made more accessible, layered, and dynamic (as opposed, for example, to PDFs, which are cumbersome to edit).

Presenting Curriculum via a Variety of Platforms

The online structure and presentation of curriculum is informed by (i) how the information is organised on the Web (i.e., information hierarchy); (ii) the various linear and non-linear ways by which users will be able to navigate the content; and (iii) the design and presentation of the online interface in service of the first two considerations. A key part of this approach is that the single source of curriculum content is separated from the ways by which it is displayed. Content and presentation are two separate processes. Markup tags indicate how the curriculum should appear and function according to how it is accessed (e.g., via a standard HTML Web page, hardcopy printout, really simple subscription (RSS) post, portable computing device, SMS, etc.). By looking at the relevant XML tags, for example, a back-end server application manipulates the content so that it can be rearranged and integrated with other platforms (e.g., Moodle), and content (such as other course materials), and be made to appear differently according to the platform of delivery (Bradbury, 2001). Different versions can be created as necessary using style sheets that adjust the look and behaviour of the curriculum content depending on who is accessing it (e.g., students of different levels) and how it is being used (e.g., accessed via podcast, intranet, etc.).

This process of prioritising information within the curriculum involves dividing the curriculum content into chunks that function as discrete objects within the online version. Where certain curriculum areas are afforded equal importance, the design of the user interface becomes crucial in visually organising this information on screen in a way that does not overwhelm the user. The Web enables fast navigation of content if it is appropriately designed and organised. Upon entering the site, a user should ideally be able to access the information required in no more than three clicks.

Rethinking How Curriculum Functions in Print and Online

Educational needs and goals must drive technological change. This section examines how online curriculum can function in three ways: firstly, how it can be made more interoperable with other course content and broader online resources; secondly, how it can provide the structural basis for user-generated and other participatory approaches to Web-based learning and teaching; and thirdly, how the curriculum structure itself can be reimagined in three dimensional ways. This mezzanine approach seeks to exploit and build upon existing ways in which curriculum is delivered via the Web and used within a learning-object approach. To repurpose curriculum for multiplatform delivery can be a challenging, but stimulating and rewarding undertaking, because the kinds of modes of delivery outlined not only require educators to look beyond any given media as just a mode of delivery, but also may require non-linear ways of thinking about how curriculum is designed and presented.

Given the scope for flexibility in the structuring of the curriculum, a deeper question arises as to how the structure of the curriculum can be changed beyond the typical linear and static approach inherent to printed materials. To what extent can curriculum be remodelled as a dynamic, organic body of learning objects that can be interconnected, used, and presented in a variety of ways that exploit the possibilities for hyperconnection within electronic environments? One way to approach the content is to imagine it in spatial terms, consisting of the interconnected rooms of its subcomponents.
Online Curriculum Development

This requires fresh, new thinking, and brings with it new challenges and questions, such as: How can curriculum developers imagine content differently? How can students and staff access and use online curriculum differently to conventional approaches, such as print? Could they interact with the Web site in different ways (e.g., via feedback blog, e-mail or by subscribing to an RSS feed)? How can the electronic medium be used to extend/deepen understanding of the curriculum through individual and collaborative activities?

This phase begins by mapping the curriculum; making links between programs and subjects form the “blueprint” of this mezzanine. Building upon the approach to curriculum mapping developed by Wiggins and McTighe (2005), teachers and curriculum developers collaboratively identify which areas of the curriculum are taught and when. When imagined as a space, a typical printed curriculum guide in English typically appears in a standard printed format and has a static structure, featuring a linear “narrative” based on the standard contents page that may be visualised as a foyer into a straight corridor, leading the reader to discreet chapters or rooms within the printed document. For the electronic version, however, it is possible to explore the idea of curriculum as a non-linear space, whose structure offers different pathways to understanding. Developed and integrated with other online teaching materials within, say, the course or institution, the imagined space of the online curriculum features a multidimensional mezzanine area across which users move to different levels of the curriculum, and which enables users to access related materials and resources that intersect the virtual space. At the very least, the curriculum document becomes layered and dynamic; the question of how far curriculum authors adopt this ethos in the development of the curriculum itself is the challenge.

Most curricula have a basic structure consisting of course objectives, assessment, and learning outcomes. A curriculum guide is typically a dry and linear document reflecting the institutional logic of the place in which it was authored. If made available via media such as the Internet, it is not uncommon to find it uploaded as a PDF file from which the hard copy was printed. As both a printed and/or virtual artefact, and as a statement of educational values, approaches, and expectations, this conventional curriculum document is somewhat incongruous to the richly dynamic and collaborative possibilities suggested by the technological and educational developments described. Electronic tools, platforms, and learning environments suggest the possibilities for curriculum to become more flexible, organic, and something that can be negotiated and explored. Reimagining curriculum in this way challenges some fundamental aspects of modern education. The example of the static PDF curriculum guide described is both analogous to, and a literal example of, the tensions between conventional educational approaches to education and the increasing fluidity of modern life that is intensified by ICTs (for better and worse). The dynamic possibilities for curriculum development prompted, and arguably necessitated,– by these shifts present some fascinating challenges and opportunities to rethink curriculum online.

Tagging curriculum chunks as learning objects enables online content to be restructured in richer and more sophisticated ways. The basic hypertext functionality of the Web immediately presents opportunities for fresh rethinking about the variety of ways that curriculum can be negotiated. At a basic level, the user could have the option to access online curriculum content according to educational themes or in terms of one specific area, such as the syllabus or assessment. The presentation of curriculum online can be structured according to the principle that the process of exploring it should assist the user in making sense of the curriculum in various practical and conceptual ways. Implicit in this approach is an educational model according to which the process of accessing and using the curriculum is understood as a key process of knowledge formation, according to which data is converted to information that is then converted into knowledge.

Designing curriculum as a three-dimensional and potentially collaborative space challenges conventional understandings and approaches. Thinking beyond conventional static and linear frameworks requires critical reflection, discussion, and well-paced implementation. Certain components of curriculum remain in place regardless of its mode of dissemination and delivery; the basis of any good curriculum framework is a basic structure that outlines expectations and tasks of students to ensure that teaching and learning take place effectively within established and clearly articulated parameters. This framework is particularly important in an online environment and should be part of the foundation of any curriculum development. Building upon this foundation, the mezzanine approach suggested in this paper has enormous potential for curriculum
content to become dynamic, organic, reusable, and responsive to the preferences of users.

**FUTURE TRENDS**

Broadly speaking, there are at least two popular views as to what the next generation of the Web might look like: Semantic Web and Web 2.0. The first view is that the Web will become a more sophisticated medium of data access, knowledge sharing, and use. Tim Berners-Lee, who in 1989 established the programming language of the Web, suggests that the next development of the Web will be driven by more sophisticated uses of markup language behind the sites, databases and media. He suggests that metadata will be used to enable these components to have more meanings and to be interconnected using a common and agreed set of definitions. (Berners-Lee is a driving force behind the technical standards and policy group, the World Wide Web Consortium.) The result, Berners-Lee suggests, will be enriched cross-referencing in databases across the Web (Shannon, 2006). This shift represents an evolutionary development in the Web from its initial concentration on the interchange of documents, to a universal medium for the exchange of data, information, and knowledge using “common formats for integration and combination of data drawn from diverse sources,” such as XML (W3C, 2007).

A second, and not necessarily opposing view of Web development, focuses more on applications and communication tools seeking to extend the scope for online collaboration, social networking, and sharing among users (Halavais, 2006). In recent years, there has been a marked shift in the use of online software away from the centralised provision of content, and towards applications and services that enable users to take more control over how they access and share information. The rapid adoption and diffusion of user-generated applications, tools, and environments, such as wikis and Web logs, reflect a longer-term trend in Web-use towards user-driven, participatory online environments. Controversially referred to by some as “Web 2.0” (O’Reilly, 2005), this trend is described as more of an “attitude” than a technology (Davis, 2005). Coined in 2004 by open source advocate, Tim O’Reilly, the idea of Web 2.0 was dismissed by critics, such as Tim Berners-Lee, as little more than industry hype (Shannon, 2006). Nevertheless, certain broad developments associated with Web 2.0 provide some indication of the scope and possibilities for online curriculum development in the not-too-distant future. For example, the development of more open-ended, dynamic and user-friendly platforms and applications are enabling relatively easier ways of sharing, organising, and repurposing different kinds of content, such as curriculum and related resources, into granular pieces of microcontent (e.g., blog posts, RSS posts, and wiki nodes) that “may be published, subscribed to, and linked across the network” (Spivack, 2003).

Central to this shift is the active participation of users in generating content. Wiki tools, for example, are designed for collaborative forms of Web publishing. Wikipedia, for example, enables documents to be written, revised, and expanded collaboratively by its users using a Web browser. Wikis offer the inexperienced Web-developer the basic tools to design and share content, with many benefits of the single source approach (e.g., hypertext curriculum mapping, potential for collaborative building, and interoperability with other resources and VLEs) without requiring the same level of training in XML markup. Nevertheless, such an approach may forgo other benefits, such as “enforced” standardisation, future proofing, and other practical benefits of maintaining a single source of content.

With this shift, it is argued that online learning is becoming less about the collection, assemblage, and dissemination of learning objects and more about learning actions and the use of collections of software applications to enhance online teaching and learning environments. Advocates of “E-learning 2.0” favour the use of interoperable applications to foster creative learner-centred environments (Downes, 2005). This approach promotes online learning as more of a platform than a medium, providing the tools for the authoring of content rather than the passive models of e-learning underpinning conventional LMS environments. Critical of the conventional focus on online learning as primarily about the consumption “of content, produced by publishers, organised and structured into courses, and consumed by students,” this approach to e-learning seeks to develop more participatory and user-centred online environments in which the e-learning application “becomes, not an institutional or corporate application, but a personal learning center, where content is reused and remixed according to the student’s own needs and interests” (Downes, 2005).
The use of blogs and wikis in education are neither inherently transformative nor that new; educators have been using them for several years (Halavais, 2006, p. 1228), but by enabling users to become creators of content, wikis can be very effective in supporting processes of knowledge construction and collaboration (Augar et al., 2006). Wikis, for example, can be used to support personal knowledge building (Langreiter & Bolka, 2005). Used in this way to develop an online curriculum document or set of documents, these applications can assist personal knowledge mapping in ways that favour collaborative development. Aside from encouraging curriculum developers to reflect on the thematic links and interconnectedness of curriculum, the curriculum itself can be integrated into broader networks of knowledge sharing and building that engage students, teachers, and curriculum developers in organic and participatory ways. Freely accessible blogging tools enable users to engage in processes of knowledge construction that are more informal and personal than with traditional educational content, forming a network of interactions “much like a social network” (Downes, 2005).

These two views of the second generation Web are not necessarily exclusive, and both perspectives suggest great scope for the development of a dynamic, interoperable and modular mezzanine approach.

CONCLUSION

Development of online curriculum stimulates reflection on how content can be more interactive. Throughout the development process, it is important that curriculum developers remain focused on the core benefits of the technology as they pertain to their particular learning or administrative needs, and in ways that add value to effective existing processes.

The process of rethinking how curriculum can be stored, restructured, and delivered requires close collaboration between curriculum authors, teachers, and ICT support. This more organic approach to content development exploits the power of the Web by approaching online curriculum as more than just a means of disseminating data; but as an environment in which curriculum can be understood and practically engaged as a virtual space in which information can be converted into knowledge. The process of curriculum mapping can be beneficial in itself. Encouraging teachers to make conceptual, thematic, and practical connections between components of curriculum informs their understanding and engagement with it (Morehead & LaBeau, 2005; Wiggins & McTighe, 2005). Beyond any technical benefits, this process of rethinking curriculum can be a fascinating, challenging, and ultimately rewarding experience.

From a cost perspective, it is important to bear in mind that repurposing curriculum will at first be labour intensive and may require technical support and related expenses. Training and licenses for software (e.g., to edit XML) can be expensive. Planning is critical. If the new system is trialled during a standard conventional cycle of curriculum review, any problems during implementation may incur additional costs in time and labour. It is recommended that the online curriculum is developed in parallel with the existing system until the online system has been adequately trialled and refined.

Amidst the trends, challenges, and hyperbole described, the most significant development during the last several years is arguably the shift in attitude; students are seen less as passive consumers of online education, and more as active participants in collaborative learning practices and as creators of content. Access to tools for Web design and online collaboration are becoming more accessible and easier to use. This is consistent with the recent development of applications that are open, interpretable, and encourage end-user generation of content. Advances in search engines and tools such RSS aggregators have enhanced the capacity of users to locate, disseminate, and share content. Open-source software alternatives for online learning, such as Moodle, are challenging the market place of proprietary learning management systems. Initiatives seeking to provide to open source and other efforts to open access to educational resources, applications, and services (BBC, 2006; MIT, 2006) have further challenged proprietary orthodoxies. Educators need to take an active interest in these developments, to the extent that they may impact upon or be usefully applied to service their teaching and learning goals.

The process of repurposing curriculum for multiplatform delivery can stimulate reflection on how curriculum can be more spatial, dynamic, and modular. The mezzanine approach offers a more sophisticated approach to curriculum mapping that, in many ways, reflects the changing ways that we share, communicate, and build knowledge.
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KEY TERMS

**DTD:** Document type definition is a specific syntax and vocabulary for formalising an XML document in a language that enables a computer to interpret it.

**E-learning 2.0:** Promotes online learning as a platform for personal learning through interoperable tools that enable the authoring and sharing of content according to student needs.

**HTML:** Hypertext markup language is used to encode formatting, links, and other features on Web pages.

**Weblog:** A Weblog or “blog” is a frequently updated Web site that is typically published by an individual and that features an informal style.

**Wiki:** Derived from the Hawaiian word meaning “quick,” a wiki is a collaborative tool developed for the Internet in 1994 (Augar, Raitman, & Zhou, 2006).

**W3C:** The World Wide Web Consortium includes product vendors, service providers, publishers, corporations, academic institutions and governmental bodies seeking to evaluate and develop proposed technologies for the Web, such as HTML and XML.

**XHTML:** Extensible hypertext markup language is a stricter reformulation of HTML that is compatible with XML.

**XML:** Extensible markup language provides a set of rules, guidelines, and conventions for encoding, structuring, manipulating, and exchanging data.

**XSLT:** Extensible stylesheet language for transformation is used to transform XML into different outputs for the Web.
Online Discussion Groups

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INTRODUCTION

An online discussion forum is an environment on the World Wide Web for holding discussions, or the Web application software used to enable these discussions. Web-based forums, which date from the mid 1990’s, are also commonly referred to as Web forums, message boards, discussion boards, discussion forums, discussion groups, and bulletin boards. Similar to other elements of the early World Wide Web, online discussion groups were built around common interests, with participants self-selecting membership in a particular online community. These early discussion groups focused on technical aspects of online environments, early self-referential and technical discussions related to the nature, construction, and maintenance of the World Wide Web itself. The content of these early discussions was determined by the nature of these early adopters. As use of the Internet gradually permeated society, the use and content of online discussions evolved as well. A principal area of interest in the current use of online discussion groups is in education. While corporations and other business forms make use of online forums, the evolving and increasing integration of online discussions into educative efforts, enhanced by the proliferation of online education, makes education the area most impacted by this relatively recent development in communication. As Nonnecke and Preece (1999) have described, research in electronic discussion groups has focused on a number of areas, including the nature of online communities (Wellman, 1997), the development of friendship (Park & Floyd, 1996), the role of empathy in group discussions (Preece, 1998), and the differences between men and women (Roberts, 1998). Additional work has been done on specific kinds on online communities, for example, therapy (King, 1994), education (Hiltz, 1993), business (Sproull & Keisler, 1986), and health support (Preece & Ghozati, 1998).

SYNCHRONOUS AND ASYNCHRONOUS DISCUSSIONS

Song (2003) explained the distinction between synchronous (immediate interaction) and asynchronous (delayed interaction) discussions and noted the necessity of understanding the influence of time in the online environment. Synchronous interaction occurs in real time, as in a face-to-face meeting, while asynchronous interaction enables the participant to communicate at different times with the aid of technological mediation. In traditional classroom teaching, interaction is immediate. However, in online environments, interaction can be either immediate or delayed. This distinction between synchronous and asynchronous interaction is significant because it determines the logistics and feel of the distance-learning experience. Educational institutions employ a mixed model of synchronous and asynchronous environments for different purposes.

Asynchronous communication is a form of computer-mediated communication (CMC) that supports information exchange and group interactions through a variety of electronic communication tools such as electronic mail (e-mail), bulletin boards, class listservs, and online discussion forums (Bodzin & Park, 2000; Gilbert & Dabbagh, 2005). In a 2000 National Educational Association (NEA, 2000) survey, 62% of distance learning faculties reported using asynchronous communication tools in their courses to support student-teacher interactions and class discussions.

ONLINE DISCUSSION AND EDUCATION

Currently, university faculty members are being encouraged to develop online courses. Some 1.6 million students were enrolled in 54,470 different distance education courses in 1997-98, and that number is growing each year. Distance education programs, including online courses, increased by 72% between 1994 and
1998, with more institutions planning to add distance education courses in the coming years. The use of Internet resources as part of the syllabi in college classes increased from 15% to 40% between 1996 and 1999 (Moe & Blodgett, 2000).

Ellis and Calvo (2004) have noted that the student experience of learning through discussions is undergoing a transformation through the adoption of new communication technologies for purposes of learning. For campus-based institutions, the adoption of learning technologies for discussions and other activities often results in a blended learning experience, made up of both face-to-face and online aspects. The result of these new communication technologies is that discussions are no longer restricted to the seminar or tutorial and may start before the students meet face-to-face and continue long after the topic-related tutorial has ended.

As Blignaut and Trollip (2003) noted, a growing body of literature has emerged relating to online learning that deals with such topics as:

- The elements of effective online learning;
- The building and sustenance of connected learning communities;
- The interaction of learners in virtual communities;
- The comparison of the critical attributes of traditional and Web-based learning environments;
- The review of the various online communication formats;
- Learner satisfaction with online courses; and
- The role and effectiveness of online discussion groups.

Jonassen (2000, p. 24) summarized that learners use technologies as intellectual partners in order to:

- Articulate what they know;
- Reflect on what they have learned;
- Support the internal negotiation of meaning making;
- Construct personal meaning; and
- Support intentional, mindful thinking.

Research in online discussion forums has evolved from examining their educational advantages and the required associated technology and technical skills for effective delivery to the study of the nature and quality of social interactions occurring in these environments. Research is beginning to develop understanding of the social, cognitive, and teaching roles of instructors in online discussions (Blignaut & Trollip, 2003). Generally, discussion groups are used in a variety of ways: as a place for social interaction between learners and instructors (Kamin, Glicken, Hall, Quarantillo, & Merenstein, 2001), as a platform for cognitive discourse (Garrison, Anderson, & Archer, 2001) between course participants relating to course content, and a mailbox for course deliverables. Strong anecdotal evidence exists that it is more difficult to create and sustain online discussions around content that has a technical or quantitative nature than it is around more humanistic and open-ended topics in business, education, or psychology. Some research also suggests that discussion questions with correct or single answers may inhibit the development of discussions (Blignaut & Trollip, 2003).

As MacDonald and Caverly (2001) described, discussion types are driven by the different purposes of instruction and also by the students’ ability as they become more comfortable with discussion online. Salmon (2000) suggests students grow in their ability to discuss online through a five-step incremental model: (a) access and motivation acquisition; (b) online socialization; (c) information exchange; (d) knowledge construction; and (e) independence development allowing learners to take charge of their own learning. Salmon (2000) also points out that although significant studies have attempted to describe online environments, far less has been written on what teachers, tutors, and learners attempt to accomplish online. Putman (1991) suggests that new users seek guidelines or rules early in the learning process. Online discussions are still developing these protocols. Protocols and processes are appearing in an effort to establish what online tutoring is as well as what it is not. Many schools are establishing guidelines for both faculty and participants to maximize the educational impact of online discussion forums (MacDonald & Caverly, 2001).

### ONLINE DISCUSSION BOARDS AND IMPROVED LEARNING OUTCOMES

Some researchers have found that online discussion forums did not always provide increased learning. Stu-
Students construct knowledge through social interchange that the online discussion forum should furnish, but the online postings in one study had only limited social interchange (Gunawardena, Lowe, & Anderson, 1997). Romeo (2001) found that respondents often merely shared stories and reflections but did not reach higher levels of thinking. Online discussions can serve as a support to the classroom experience when they allow students to discuss course topics, develop understanding through debate, and share different perspectives and interpretations (Light, 2000). It is recommended that educators study the use of such technologies to determine their validity and usefulness for the learning community.

One of the key distinguishing features of online education, as compared with other forms of distance education, is the opportunity for instructors and students to interact via online asynchronous discussion forums. Asynchronous discussion forums are used to a varying degree in different online academic programs, and in widely different ways. They can be used for social interaction only, for discussion of assignments and other assessable work, as a collaborative tool for individual project groups, for tutorial purposes, or as a central part of the teaching strategy. Likewise they may be entirely voluntary, be used as a “hurdle” requirement (compulsory but carrying no intrinsic assessment weight), or as an integral part of the assessment mix.

Student-staff ratios in online courses that use discussion forums may vary widely. Hundreds of students may participate. The mix of student-student and student-instructor interaction in discussion forums also varies widely. Depending on the purpose of the forum, instructors may: (1) limit discussions to one or more instructor-initiated themes; (2) lead more general discussions; (3) assume the role of answering most of the questions from students; (4) moderate the discussions but maintain a low profile in them; or (5) even be entirely absent from the discussions. The educational philosophy underlying the design of an online program is integral to the way in which instructors are expected to participate in online discussions (Mazzolini & Maddison, 2003). Different instructors have different philosophies regarding their role in mediating and participating in online discussion with students. Each approach will have different educational outcomes.

It is generally recommended that instructors play an active, visible role in forum discussions. For example, Paloff and Pratt (1999) state that instructors participate as “cheerleaders”, in an effort to motivate deeper learning through online discussions. It is also recognized that instructor participation may be overdone: too much participation by the instructor may reduce the amount of student-student interaction and create an unnecessary degree of reliance on the teacher (Paloff & Pratt, 2001).

**ADVANTAGES AND DISADVANTAGES OF ASYNCHRONOUS ONLINE DISCUSSIONS**

Lobry de Bruyn (2004) described the following advantages in the literature examining the use of asynchronous computer-mediated communication for supporting online learning activities. These include:

- Connectivity and accessibility: There is increased group interaction since the discussions are open and not limited to face-to-face meeting times (Eastmond, 1994).
- Equitable communication between the students is encouraged as there is no need for “turn taking” (Graddol, 1989), and everyone can be “heard”, including the more reticent students, without being intimidated by more vocal students.
- Student reflection is also fostered through messages being preserved electronically; messages can be revisited and reread; and students having “time for reflection before they can commit their ideas to public scrutiny” (Mason & Kaye, 1990).
- Student conversations using asynchronous computer-mediated communication are *boundless* in time and space, which promotes greater student interaction.

Lobry de Bruyn (2004) also described the many difficulties that may be encountered when using asynchronous computer-mediated communication (Gudzial & Turns, 2000; Harasim et al., 1998; Light & Light, 1999). These originate from lack of student initiative in discussions, limited student discourse on learning issues, and student preference for “face-to-face” learning. Such factors include:
Online Discussion Groups

- Technical difficulties associated with access to computer software or hardware.
- Communication anxiety, accentuated when student/instructor responses are not immediate.
- Lack of social presence, because the medium does not allow for social cues, especially those which are non-verbal and which, if available, would lead to greater immediacy, and hence more intense, affective and immediate interaction between students and teacher (Rourke, Anderson, Garrison, & Archer, 1999; Stacey, 2002).
- Limited student interaction, either because the learning environment does not motivate students to interact as it does not rely on confidence or attention-getting skills, or because of low student confidence in what they may want to say, is not important or contributing anything new to the discussion (Gudzial & Turns, 2000).
- The lack of support for a convergent process (e.g., analyzing and synthesising) (Hewitt, 2003).
- Time management: This is often necessary as the time spent online can easily exceed the time spent in face-to-face classes, since online discussions are boundless (in relation to time and location) and are typically always open.
- Information overload: This can occur as a result of the amount of information, and the additional information to which students are guided by links to other material, thus overwhelming students to the point of torpor.
- Misconceptions: These can occur when students receive no clear feedback to indicate whether their point is clear, and this situation is further compounded by “learner reluctance to push peer thinking and understanding” (Hewitt, 2003).
- Traditional roles: Traditional teacher and student roles are often maintained with the teacher sending and the student receiving. (Light & Light, 1999).

CONCLUSION

Online discussion forums have evolved significantly and their impact on society and on education is an emerging area of interest. As online discussion boards proliferate, their influence will become greater, contributing to changes in the nature of teaching and learning.

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Online Discussion Groups


KEY TERMS

Asynchronous Communication: A delayed interaction; a form of computer-mediated communication (CMC) that supports information exchange and group interactions through a variety of electronic communication tools such as electronic mail (e-mail), bulletin boards, class listservs, and online discussion forums. This model enables the participant to communicate at different times with the aid of technological mediation.

Computer-Mediated Communication (CMC): Forms of communication made possible through the use of computers: e-mail, instant messaging, Webconferencing, and other Web-based forms of communication.

Discussion Groups: Also called bulletin boards or newsgroups; participants post messages on a news server which stores them in directories. Users participate in discussion groups by reading and responding as they choose to messages. In an educational context, discussion groups are used in a variety of ways: as a place for social interaction between learners and instructors, as a platform for cognitive discourse between course participants relating to course content, and a mailbox for course deliverables.

Equitable Communication: Evidence in an online discussion group, usually in an educational setting, of reasonably equal participation by all members.

Information Overload: The result of the amount of information, and the additional information to which participants are guided by links to other material that can be overwhelming.

Lurkers: A member of the computer-mediated discussion who reads materials on the message board, newsgroup, chat room, file sharing, or other interactive system, but seldom offers any contributions.

Online Discussion Forum: An environment on the World Wide Web for holding discussions, or the Web application software used to enable these discussions.

Synchronous Communication: An immediate interaction in real time, as in a face-to-face meeting, telephone call, or computer-facilitated discussion using cameras, microphones, and/or speakers.
Online Interaction and Threaded Discussion

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INTRODUCTION

Human beings are social creatures who habitually communicate with each other and share among themselves. Human interaction is the interchange of suppositions, intentions, and meanings. As a vital thinking and socializing tool, interaction is essential for every human activity and is a complex symbolic process in which meaning is created and negotiated as persons in conversations coconstruct their social realities (as cited in Comeaux, 2002). In fact, “The formation of opinion takes place through conversation of individuals with members of groups to which they belong or through that inner conversation of thought which is outer conversation imported into the mind” (Mead, 1938, p. 616). Mead’s “inner conversation of thought” supports the claim that human beings are meaning driven by not only the result of social interaction, but also meanings reprocessed through interpretation (Blumer, 1969).

In traditional face-to-face instruction, interaction is central to the teaching-learning process because, “True interaction produces a cohesive classroom group where teacher and students share responsibility for the defining, carrying out, and evaluating of the learning experience” (Gorman, 1969, p. 31) in addition to “providing information, expressing feelings, stimulating others, making social contact, controlling others, and functions related to contact seeking and role playing” (Keegan, 1996, p. 117). Hence, interaction, as a crucial means of facilitating learning, is “intrinsic to successful, effective instructional practice as well as individual discovery” (Sims, 1997, p. 158). As instruction shifts from face-to-face toward online learning, interaction is endowed with its capability to interact diversely (i.e., many-to-many, many-to-one, one-to-many, one-to-one, one-to-self). Such nonlinear, multifaceted interaction may not only “provide both teachers and students with a communications environment rich with opportunity for reflection” (Hart & Mason, 1999, p. 153) but also “change traditional classroom interaction patterns, shaping the communicative roles of the teacher and students as participants in a classroom learning community” (Kumpulainen & Wray, 2002, p. 10). Seen in this light, this article focuses on attributes of online interaction and patterns of threaded discussion. Future trends are also discussed so that distance instructors and their learners can achieve satisfactory results through dynamic teaching and learning conversations that focus on guided but socially shared activities by making the most of technologies.

ONLINE INTERACTION

Learning evolves from learners’ interaction with many elements including those of learner-human, learner-nonhuman, and learning environments. Hence, interaction level (communication, participation, and feedback) between the instructor and learner(s), among learners, and with nonhuman resources may have a major impact on the quality of distance learning. To understand the complex instructional online interaction, Yacci (2000) demystified interaction as having four attributes: (1) a message loop, (2) its complete occurrence starting from and back to the learner, (3) content learning and affective benefits as two distinct outputs, and (4) mutually coherent messages. Interaction as a message loop is a precondition for interaction to occur because a circuit of messages between students and instructors must be completed. Interaction as a complete occurrence from and back to the learner is viewed from a learner perspective. For example, asking a question and responding to it is a complete loop from a teacher’s perspective; however, from a learner’s perspective, the interactive loop is not complete because of the instructor’s failure to provide feedback to the learner’s response. Interaction as content learning and affective benefits reflects the idealistic interaction outcomes in the instructional
process. In other words, affective benefits (e.g., emotions) as a result of interaction can be used to promote social presence, sense of community, and mutual engagement among participants. Thus, content learning in mediated online learning situations may be maximized. Interaction as mutual coherence of messages suggests the shared meaning between each circuit of messages can greatly reinforce both cognitive and affective meaning of messages conveyed in the interaction process. Overall, these four attributes are interrelated and each is constructive for online instructors to properly design and successfully manage their online courses.

More thoroughly, Bannan-Ritland (2002) defined online interaction as (1) learners’ participation or active involvement, (2) specific patterns and amounts of communication, (3) instructor activities and feedback, (4) social exchange or collaboration, and (5) instructional activities and affordances of the technology. Bannan-Ritland’s (2002) definition is comprehensive and signifies online interaction as participatory, engaging, pedagogical, managerial, social, collaborative, and technology-dependent. Further, interaction as “specific patterns” is largely indicative of Yacici’s (2000) attributes of interaction. More important, amounts of communication and feedback are noteworthy because they basically serve as the starting point for achieving sustained, two-way communication between and/or among the participants. As a result, distance learning may stay away from the traditional correspondence course model of independent study.

**Interactive Relationships**

Several forms of interactive relationships exist in distance learning such as personal vs. social (interaction context), physically embodied vs. mediated (interaction mechanism), synchronous vs. asynchronous (interaction temporality), and threaded vs. linear (interaction structure). An important contribution made to distance learning is Moore’s (1989) elucidation of the three interactive relationships: learner-to-content, learner-to-instructor, and learner-to-learner. In Moore’s exposition, learner-content interaction concerns the process of intellectually interacting with the content that may bring about changes in learners. The interaction between the learner and the instructor emphasizes the frequency and intensity of the instructor’s influence on the learner as amplification to learner-content interaction. Finally, learner-learner interaction occurs among learners of an online setting with or without the real-time presence of an instructor. Such interaction may enable learners to join and form a learning community to deal with specific course content. However, Hillman, Willis, and Gunawardena (1994) argued that treatments of the interaction concept in distance learning based on Moore’s discussion of interaction are inadequate. Thus, they added the learner-interface interactive relationship, which concerns the interaction between learner(s) and a technological medium that must be comprehensible for him/her to produce any effectively consistent action with content, instructor(s), or other learners.

The interactive relationships among learners, instructors, content, and interface may generate different instructional foci, activities, and functions in distance learning. For example, learner-instructor interaction may be the center of attention in traditional face-to-face instruction while learner-content interaction may be the focal point in computer-mediated instruction. With growing interest in collaborative learning and the use of computer networks, learner-learner interaction may provide an avenue for further support of each other as well as a mediated channel to meet the socially and/or instructionally shared expectations accomplished synchronously or asynchronously. As regard to learner-interface interaction, mastering the learner-interface interaction technique is “a process of manipulating tools to accomplish a task” (Hillman et al., 1994). As a result, learners are likely to participate more in designed activities and effectively communicate with the instructor and peers in mediated online learning environments.

Pedagogically, Paulsen (1995) presented a framework that includes one-alone, one-to-one, one-to-many, and many-to-many interactive relationships. One-alone interaction largely concerns making use of online resources such as information (online databases, online libraries), software (online applications), people (online interest groups, individual experts), and independent learning (reflections, syntheses, evaluations). Hence, this type of interaction is rather traditional, suggesting that the interaction is task-oriented or content-focused. One-to-one interaction involves the use of e-mail communication to support individual interaction within a group. Satisfactory one-to-one learning interaction may result from individualized teaching and learning activities such as learning contracts, apprenticeships, and so forth. One-to-many interaction focuses on presentation (lectures, symposiums) to learners by one or
more individual experts via a conference or bulletin board system. Such interactive relationship is usually instructor-dominated with learners as passive knowledge recipients. Many-to-many interaction indicates that all participants may have an equal opportunity to participate in and contribute to the interaction. Such interaction can be facilitated via computer conferencing, bulletin board, or listserv that may forge a sought-after networked learning community through social and collaborative activities such as role plays, group discussions, debates, simulations, forums, or group projects. Taken as a whole, Paulsen’s interaction framework is practical so that online instructors can design appropriate instructional activities based on specific learning goals and/or standards.

Issues

Many issues may come about when physically embodied communications shift to mediated forms of learning interaction. Thus, both online instructors and their learners are challenged. For example, interaction issues may result from the size of the group, knowledge of other participants, learner experience, clarity about the task, ownership of the task, need for using the system, type of system available, and prior experience of computer-mediated communication (CMC) (Tolmie & Boyle, 2000). Further, Tu (2000) argued that the attributes of CMC with an inappropriate instructional design are likely to inhibit successful online interactions. Accordingly, he presented a list of issues worthy of attention including (a) anxiety and frustration due to less computer literacy, (b) impact of privacy on the social psychology of online communications, (c) de-individuation as a result of being impersonal when anonymity exists, (d) difficulty in maintaining the flow of the discussion content due to longer process of CMC, (e) gender dominance and minority barriers, (f) lower degree of social presence as a result of being unfamiliar with online communications style, (g) uninhibited behavior (e.g., flaming, insinuating, offensive messages), (h) learners’ perceptions of the medium (e.g., listserv) and of its disunities of time, space, or action, (i) misunderstanding due to lack of nonverbal cues and failure to share meanings within system boundaries, and (j) lost in threaded messages as well as heavy workload (e.g., heavier reading load for online learners, time-consuming process of moderating class conferences, daily individual interactions).

From a different perspective, “distance” in distance learning may be an intangible barrier that influences online interaction. For example, physical distance (i.e., separation in time or geography), social distance (i.e., separation by affinity, closeness, or support), intellectual distance (i.e., the degree of gap in the shared knowledge), and cultural distance (i.e., factors of language, class, religion, age, gender, and ethnicity that may affect the communication process) all present potential problems for effective online communication (Hodgkinson, 1991). Moreover, technological distance concerns the extent of comfortableness in technology use with intent to enhance interactivity. Instructional distance deals with the pedagogical aspects such as what to present, how to activate, what to assess, how to provide feedback, and why to evaluate the impact of the instructional event.

Design Approaches

To facilitate interaction in distance learning, interaction must be designed intentionally into an online course (Northrup, 2001) and “delivered as an integral part of eLearning” (Hirumi, 2002, p. 157). Online interaction design and delivery can be achieved from two approaches: framework as the systematic approach and strategies as the instructional approach.

Systematically, Hirumi (2002) presented a three-level framework for classifying, designing, and sequencing online interactions. In this framework, he incorporates learner-self interaction as Level I interactions, learner-human interaction (i.e., learner-instructor, learner-learner, and learner-other) and learner-nonhuman interaction (i.e., learner-content, learner-interface, and learner-environment) as Level II interactions, and learner-instruction interaction as Level III interactions. Holistically, Hirumi’s framework is learner-centeredness with instructional interaction designed to incubate learning. Level I of learner-self interaction is self-regulated as it occurs within each individual learner. Hence, it is cognitive- and meta-cognitive-oriented with intent to internalize knowledge. Level III of learner-instruction interaction is instructionally designed based on learning objectives, learner characteristics, learning context, and instructional strategies to stimulate the reciprocal interactions that go beyond learner-self interaction. Level III of learner-instruction interaction is thus complementary to Level I of learner-self interaction as a result of Level I’s lacking proper self-regulatory
skills to facilitate socio-emotional interaction in distance learning. As such, Level III is a metalevel that externalizes knowledge. Level II interactions, however, are inclusive and may function as various interactive platforms between learner-human and nonhuman resources to enhance Level I of learner-self interaction and Level III of learner-instruction interaction. Overall, Level III of learner-instruction interaction may provide online instructors with an approach to designing and sequencing Level II and stimulating Level I interactions.

Instructionally, online interaction can be designed from various foci. From an online course design perspective, Tu and Corry (2003) discussed design, management, and strategy to generate desirable asynchronous discussions such as examining the discussion cycle, discussion duration, depth of threads, class size, frequency of participations, moderation requirements, learner-learner interaction, number of postings, instruction for discussion, and quality and evaluation criteria. These interaction elements are specific but successfully integrating these elements into online courses can be challenging due to variances in the instructors’ managerial skills, quality of faculty participation, learners’ attitudes toward interaction, and so on. From a social interaction perspective, McLoughlin and Luca (2002) proposed seven strategies for supporting learners by creating environments that value social, experiential, participatory, and interpersonal. These strategies include (1) designing for social activity and interactive learning, (2) fostering intentionality and goal setting in learning, (3) using role differentiation, (4) ensuring that feedback becomes a constructive social experience, (5) fostering metalearning, (6) enabling student autonomy and a sense of ownership, and (7) balancing both personal and interpersonal orientations. These strategies are useful to learners who need environments that provide support for learning through social interaction, engagement, and community building. More important, these strategies focus on what the learners are to achieve as a result of an interaction (Wagner, 1998). In Wagner’s words, participation, communication, feedback, elaboration, learner control/self-regulation, motivation, negotiation, team-building, discovery, exploration, clarification, and closure are the expected outcomes of clearly conceptualized, well designed, and properly developed learning goals.

THREADED DISCUSSION

Threaded discussions, as an asynchronous form of online interaction, are electronic messages on certain topics or themes that are posted, archived, retrieved, and viewed on a Web/course site. Discussion participants can view and respond to the posted messages. Advantages of using threaded discussions in distance learning are evident. These include (a) facilitating ongoing class discussions on a topic/theme, (b) sharing ideas, drafts, and finished projects with each other, and (c) soliciting comments/critical feedback. However, many factors may influence how interaction develops. For instance, the needs and goals of the participants, the requirements of the course, the role of the instructor, and the emergent properties of the discourse itself can influence interaction (Hewitt, 2003). Hence, understanding the structural patterns of threaded discussions is important for both online instructors and learners. For instructors, being aware of the typical discourse features may enable them to design a more participatory learning environment so that outputs of distance learning can be maximized. For learners, knowing the structural patterns may empower them to make the most out of the mediated interaction within the group.

Patterns, Issues, Causes, and Solutions

Hewitt (2003) argued that discussion threads and their growth patterns may reveal a bias in favor of elongated note structures. In other words, participants tend to focus on recently introduced notes, but a reduced tendency to revisit older, more established notes. Hence, the most recent notes in each thread are the ones most likely to drive the next round of responses. In a similar vein, Thomas (2002) found the threaded discussion branches and becomes progressively more fragmented as it evolves over time. Thus, an overall incoherence in online discussion is evident due to the branching structure, the large proportion of messages that terminate branches, and the abstract nature of student interaction. From a different perspective, Pena-Shaff and Nicholls (2004) claimed that the communication patterns and the knowledge construction process of the discussion participants mainly focus on clarification, elaboration, and interpretation, and messages generated seem to move from a social, interactive sphere to a more individual, self-reflective sphere, thus challenging normal or conversational modes of discussion.
In terms of issues, Thomas (2002) claimed that contributions to and quality in an online discussion forum may change over time. In terms of density (connectedness) and intensity (level of participation, ratio of messages sent and received, persistence, and topical progression) of the threaded discussions, even though all participants are engaged, intensity is unequal among individual participants (Fahy, Crawford, & Ally, 2001). Similar findings are also reported in Lobry de Bruyn’s (2004) study that learner participation in threaded discussions was unequal and of varying quality. In terms of quality, Sain and Brigham (2003) found that the use of a threaded discussion alone is not sufficient to generate the participation needed to increase learning, satisfaction, and interaction in a course.

Causes of these issues vary. Technically, the isolated mode of participation, the structural organization of messages, and the conflict between the written and oral function of technology-mediated interpersonal communication are likely factors for variances in participation (Thomas, 2002). Pedagogically, low participation requirement (e.g., one posting per week) and low percentage of the class grade attributed to participation (e.g., 10%) may cause poor interaction in threaded discussions. Interaction activity not explicitly integrated into the course, the unguided nature of the discussions, and lack of strategies to motivate students to participate and interact may also result in issues discussed earlier (Pena-Shaff & Nicholls, 2004).

To minimize unintentional thread abandonment and topic change in threaded discussions, Hewitt (2003) suggested that instructors encourage online participants to pursue key issues more deliberately and systematically. To enhance the quality and quantity of student participation in online interaction, greater instructor immediacy and explicit linking of online discussions to student outcomes or learning objectives are expected (Lobry de Bruyn, 2004). From pedagogical and course management perspectives, appointing a moderator to summarize the discussion, assigning tasks that require group synthesis, using a linear discussion format, and augmenting asynchronous computer-mediated communication with synchronous technologies (e.g., video conferencing) to make group coordination and negotiating group consensus easier are all likely strategies to sustain engagement in online interactions (Hewitt, 2001). Moreover, designing controversial topics may also promote more discussions and/or enhance participants’ critical thinking level.

**FUTURE TRENDS**

Future trends in terms of interaction may reflect distance learning’s path that evolves from passive, to moderately active, and to a highly interactive level. Hence, persistently maximizing interaction in a distance learning environment is always a pursuit. At present, distance learning environments are continuing to improve with advancing technologies. The trend is moving toward a virtual learning environment in which more integrated interaction becomes a possibility that involves discussion board, file sharing, live, two-way interactive audio, video, or both, and synchronous/asynchronous computer-based interactions. However, without understanding why technology is being incorporated into instruction and learning, its potential benefits may not be fully realized. As such, training is an asset to both online instructors and online learners.

Away from technical perspectives, integrated pedagogy may also play a role in minimizing the negative impact of mediated communications on learning outcomes. For example, a process of collaborative model in which the sender and receiver endeavor to “triangulate” upon the meaning of messages to participants’ satisfaction may facilitate more quality interaction (McAteer, Tolmie, & Crook, 2002). The educational value of triangulating messages can be understood from a social constructivist perspective because the coconstructive process per se is socially involved and “through which social relationships are constructed and through which each person acquires a sense of their own identity in the social world of an online learning community” (Hodgson, 2002, p. 234). Such an acquired sense of social identity may serve as the foundation for nurturing a networked learning community, thus reinforcing more connectedness among online participants by exposing them to each other’s ideas, comments, and feedback as well as articulating their own ideas in the established networked learning community.

**CONCLUSION**

In this article, computer-mediated forms of interaction are analyzed from various foci and perspectives, focusing on the pedagogical/instructional, technical, social, and organizational/managerial factors that seem to facilitate sustained, educationally productive
online interactions. Meanwhile, computer-mediated interactions can greatly complement and promote the traditionally established ways of doing things such as ways of communicating, information distributing, learning, and collaborating. However, various challenges are posed. For example, how can the ongoing, reciprocal, and focused mediated interactions be survived, developed, and sustained among online participants? Seeing mediated interactions globally, does cross-culture play a role? Therefore, identifying the approaches that can help sustain educationally mediated interactions is always encouraged.

REFERENCES


Online Interaction and Threaded Discussion


**KEY TERMS**

**Asynchronous Interaction** is online communication that takes place independent of time or location, or at anytime, anywhere. Participants send messages through e-mail, listserv, or newsgroup to a central location (discussion board, forum), read the retrieved or posted messages, and provide comments or feedback.

**Computer-Mediated Communication (CMC)** is the human-to-human communication by adopting networked computer environments and related technology to facilitate interaction for educational opportunities via e-mail, discussion board, or listserv.

**Discussion Board** is a method of asynchronous online communication or an electronic message center. Users connect with the center via a modem or other devices; they can read messages posted by others and respond or leave messages on other topics.

**Interaction** is the exchange of information, ideas, and opinions between and among learners and the instructor. In distance learning, interaction usually occurs through technology with the aim of facilitating learning. Interaction can be written in a threaded discussion or verbal in audio and/or video conferencing. Whatever the format is, interaction is of a mutual, continuous, and reciprocal nature. The reciprocity between learner-instructor, learner-learner, and learner-to-content is a widely accepted concept of interaction.

**Online Interaction** is (1) learners’ participation or active involvement; (2) specific patterns and amounts of communication; (3) instructor activities and feedback; (4) social exchange or collaboration, and (5) instructional activities and affordances of the technology (Bannan-Ritland, 2002).

**Online Learning** is any learning experience or educational material delivered primarily via the Internet to learners at a remote location. This mode of learning may give learners the opportunity to work with course materials at their own convenience or work collaboratively on class projects using tools like e-mail, discussion board, or listserv.
Synchronous Interaction is online communication that takes place independent of location but at the same time (real time). Participants must agree on a time to log into the chat room and messages are received at the moment they are sent. Examples of synchronous interaction are instant messaging, video conferencing, and Web conferencing.

Threaded Discussions are electronic messages on certain topics or themes that are posted, archived, retrieved, and viewed on a Web/course site. Discussion participants can view and respond to the posted messages.
Online Learning Environments

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INTRODUCTION

Online learning, which was defined as a learning environment using computer communication systems for learning delivery and interaction (Harasim, 1990), has been involved into all facets of society’s education. Online learning can be considered as a subset of the category of e-learning because it refers specifically to learning that is occurring via the Internet or Intranet. Online learning environment normally refers to learning via electronic communications, coursework, and/or information posted on the Web, and through other instructional activities by using Internet.

BACKGROUND

Online learning is usually considered a descendent from computer-based training. With the Internet boom from the mid 1990s to the beginning of 2000s, the concept of online learning has spread broadly. Online learning began with the use of course management system (CMS) and asynchronous Internet communication technologies such as e-mail, discussion board, and file transfer protocol (FTP) to provide communication between instructors and learners across distance (Beatty, 2002). With the technologies’ advance, online learning has more various and complex applications and implementation formats. Online learning has changed to include larger repositories of (usually static) information through course Web sites with the emergence of the World Wide Web (WWW) in the early 1990s (Beatty, 2002). The later Internet communication technologies, such as the Stream Media and DSL, have made the online learning environment a complex environment which comprises both asynchronous and synchronous interactive learning methodologies as well as extensive issues and pedagogies.

Compared with traditional face-to-face learning environments, the online learning environment has many advantages such as its inherent features of anytime and anywhere, many to many communication, computer mediated, flexibility, and high-level interactivity. With synchronous technologies, instructors and learners could communicate with each other without being gathered in a same classroom or even in the same hemisphere. Teachers and learners could “see” and “talk” with each other across the distance. With asynchronous technologies, unlike the traditional classrooms, learners and instructors could collaborate and cooperate with each other online, thus ignoring the time limitation.

FORMATS OF ONLINE LEARNING ENVIRONMENT

At the beginning of online education, the education methods were text-based. With the developments of network-based software and computer technologies, more and more multimedia formats fit into the online learning environment. Students not only can read the instructional materials, but also hear the content or watch them. These formats meet the needs of the students with different learning styles. A well-designed online course should be wisely combined with the text and graphics, animations, video clips, audio files, and interactive activities. Online learning environments contain different communication formats as described below:

- **Personal e-mail and listserv:** Many online classes use mailing list to keep the class up-to-date. Some of them use a specific mail server to house the listserv for online communications. Others just simply use the function of sending mail to multiple recipients (Cc: and Bcc:) in the e-mail.
Online Learning Environments

- **Online conferencing**: Online conferencing has plenty of implementation purposes in today’s online education environment because it could easily establish a virtual conference with simple facilities like digital video camera, computer with Internet connection, and a microphone. By setting the video and audio communication among participants via Internet, online conference could simulate a face-to-face demonstration or a collaborating environment. Online conferencing could be implemented with professional online conference software or free tools such as Microsoft NetMeeting, Skype, MSN Messenger, and AOL Instant Messenger.

- **Chatting**: Online classes could use chatting to facilitate the synchronous communication among students and between students and the instructor. There are many online chatting formats such as text-based, audio, and video chatting. Some online chatting use single format, but others use two or more combined formats to realize the synchronous communication. Online chatting could be Web-based, telnet based, or by using software (e.g., Skype, Google Talk, Microsoft Messenger, Yahoo Messenger). Many free Instant Messengers (IM) can also support multiformat synchronous chat including video, audio, and text-based formats.

- **Discussion board (online forum)**: Online classes usually use the discussion board to facilitate the asynchronous communication among the students. Both the instructor and the students could initiate a “poster” as a thread of a specific topic or problem related to the instructional materials. Everybody can reply to this thread to share his/her own opinions with others. As an asynchronous communication method, discussion boards allow students to think more elaborately before they make responses to others’ posters.

- **Blogs**: Some online instructors ask their students to maintain a blog to reflect their learning in a class. As a new online application, blogs provide a place for enhancing students’ self-learning and reflection.

Currently, many schools and institutions adopt CMS (Course Management System) software as the tools to conduct their courses and instructional delivery. WebCT and Blackboard are two widely used Web Course Management Systems. Blackboard provides a clean and efficient course template, which benefits those who have minimal or no html experiences. However, the customization options are limited for the overall look and feel. In contrast, WebCT gives designers more flexibility to extensively customize the desired look and feel in addition to its basic course template. WebCT merged with BlackBoard on February 28, 2005, and they will have a new product standard for the software.

Another popular CMS software is Moodle (modular object-oriented dynamic learning environment). Initiated by Martin Dougiamas in 1999, it is an “open source” CMS software. It could be freely downloaded from Moodle’s Web site and could be customized by programming staff according to the instructor and students’ demands. It has a very large user base with 11,830 registered sites over 150 countries with 3,896,712 users in 366,955 courses (as of May 17, 2006, from http://moodle.org/stats/).

Except for the above three CMS software types, there are still many other CMS tools such as ANGEL, Sakai, eCollege, Claroline, ATutor, and so forth. CMS software usually supports instructors to make their course plans, manage course materials, present course information, make announcements, provide online testing and grading, and manage students’ records without extra HTML knowledge requirement. They usually support both synchronous and asynchronous communication among instructors and students by threaded discussions, internal e-mail system, and chatting functions. Although CMS software has many functions in common, they do have a big difference in price and specific functions. For example, there are many free CMS software packages such as Moodle, Claroline, and ATutor. But others need to be paid, usually yearly, to keep the license. A license of a WebCT Campus Focus platform for 6000 students costs $15,000 U.S. dollars (http://www.e-teaching.org/technik/produkte/webctsteckbrief). Likewise, in their specific functions, ANGEL6.3 and BlackBoard 6 supports video streaming while other CMS software does not support video services currently. WebCT allows instructors to specify multiple paths through a course for different skill levels or job functions, which is hard to obtain in other CMS software.

CMS software could be efficiently and easily used as course management tools. However, instructors and researchers need to explore the most sufficient approaches to foster the learners’ performance because these course management packages make it too easy for teachers to transfer their courses from traditional
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classrooms to an online environment without carefully thinking of the backdraws for using these packages and other possibilities of online instruction. For example, although current CMS software is very efficient in improving the virtual interaction, the software usually does not provide an emphasis on self-reflection. There are still a lot of other applications outside of CMS platforms such as Blogs and e-portfolios that could be used to foster students’ reflective thinking. When the instructor relies too much on the CMS packages, they may neglect these possibilities that may help improve students’ knowledge construction.

ISSUES OF ONLINE LEARNING ENVIRONMENT

Pedagogies and Models

Pedagogies and models used in online learning environment inherit many characteristics from traditional classrooms with a lot of evolutions according to online learning environment’s constructivist feature. During the period of online learning, students actively take part in the learning process and collaborate and cooperate with peers and the instructor to construct their own knowledge individually from their online learning and social interaction experience (Siat, 2003). Because of this feature, pedagogies utilized in online learning environment are more learner-centered and focus more on collaborative and cooperative learning with authentic activities. Pedagogies and models of collaborative learning, authentic activities, problem-based learning, and higher-order thinking questions and their teaching strategies will be introduced briefly.

Collaborative Learning

Collaborative learning involves a group of students’ or both the students’ and the instructor’s collaborative effort by sharing, discussing, and interacting to achieve the consensus to construct their knowledge during the process of understanding a concept, fulfilling a learning task, or creating a product. In contrast to the traditional classroom environment, collaborative learning is especially effective and necessary in an online learning environment because it improves interaction, which is an extraordinary help to transfer the online learning from isolated to communicative, from autonomous to peer-interacted. The instructor’s role is not important in this learning pattern because the biggest voice will be from the learners and not from an authority.

Authentic Activities

Authentic activities have been used broadly and successfully within online learning environments. There are many instances that online courses utilize authentic activities as the core of the online learning environment. Herrington, Oliver, and Reeves (2002, p. 1) claimed that:

*Instead of providing academic, de-contextualised exercises that can be used primarily to practice a skill, there are many instances of courses where authentic tasks create the core of the online learning environment, and the completion of the tasks effectively comprises the entire student commitment for the course.*

By designing a program, developing a product, or engaging in other authentic activities, students will be immersed in the problem-solving. They need to define and analyze the task by themselves. Some authentic activities require group work. In this case, students need to identify, separate, and allocate the subtasks to collaboratively complete the task. Authentic tasks also require students to collect and select all materials that can help them finish the task by themselves. Authentic activities should also give students a chance to make a selection and reflection on their learning. Authentic activities assessment fit well with realistic world’s assessment with authentic context and task requirements (Herrington et al., 2002).

Problem-Based Learning

In problem-based learning, the instructor designs challenging and open-ended problems that demand students’ critical thinking, problem-solving skills, self-regulate strategies, and metacognitive strategies as well as collaborative working skills. Similarly with the collaborative learning, the instructor’s role in the problem-based learning is not a “teacher” but more of a “facilitator.” It is also a learner-centered learning pedagogy. The most crucial element for the success of a problem-based learning curriculum is the problem selection. For online learning environment, it is especially important to consider the technical
support, online learning environmental format and the students’ multisocial characteristics when selecting the problems.

### Higher-Order Questions

Questions are useful to foster students’ high-order thinking and promote interaction. Because of the asynchronous feature of online learning environment, students could have a longer time to process information with higher cognitive level questions before they respond to the instructor’s questions. According to Blanchette’s (2001) study of questions in Online Learning Environment, 75% of the instructors’ questions required higher cognitive level thinking, the opposite of the result from Barnes’ (1983) study, which showed that 80% of instructors’ questions in the traditional classrooms were at lower levels and needed little or no thought on the part of the student. By initiating questions in an appropriate way, students will be led to discussion. However, inappropriate questions such as having too many questions at one time or ambiguously worded instructions can lead to less discussion and interaction.

Although several online learning pedagogies and models are introduced here, it is not easy to clearly state which one is the best or should be used because in most cases they intertwine with each other. Similar to traditional classroom learning environments, there are still many other pedagogies and models used in online learning environment.

### Social Dimensions of Online Learning Environment

Although there are diversified models or strategies of facilitating online learning as described above, all these strategies involve social factors at each facet. With the popularization of online learning, more emphasis has been placed on creating a social online learning environment. Online social interaction and cultural issues in online learning environment will be discussed here.

### Online Social Interaction

Social interaction refers to a dynamic sequence of social actions between individuals or groups that makes those individuals or groups adjust their actions and thoughts through their interactions with their counterparts. Online social interaction refers to the social interaction that occurs in an online environment. The participants usually do not interact within a same location or at the same time, but conduct their social interaction via Internet with multiple network technologies. Online social interaction is one of the most frequently studied issues, although there are many different definitions of interaction.

Yacci (2000) defines four major attributes for interactivity: (1) the existence of the message loop—students, instructors, computers, and any other media compose an interactive loop, in which each entity could be either the message’s target or origin; (2) the interactivity occurs from the learner’s perspective—the instructor must not only give the students information and ask for response but also give feedback on the students’ response; (3) the distinct effects of content learning and affective benefits—the effect of content learning refers to the effect of learning instructional goals and the effect of affective benefits refers to the effect of amplifying the student’s attitudes and values toward the instructional objects, and (4) mutually coherent messages in each interaction, which means that when an interaction process is analyzed, messages should not be isolated. Both going and returning messages should be considered and analyzed. Northrup (2001), from a different perspective, offers another set of interactivity attributes, that encompass five interaction attributes of content, collaboration, conversation, intrapersonal interaction, and performance support.

### Cultural Issues

Another social issue about social online environment is cultural issues. With the boom of a global civilization and the growth of demands the learning community and school cooperating projects, cross-cultural online learning attracts more and more researchers’ attention. Instructors and course designers must be responsive to the learners with diverse cultural backgrounds. Culture usually has a strong influence on the online learning communication. Cultural background influences learners’ learning by shaping the way learners participate in discussion, the way learners understand the world, and the way learners approach problems (Geer, 2001). The lack of shared meaning can make inefficient communication.
Based on these points of view, many other researchers such as Wang (2001), Brown and Hedberg (2001), Lim (2004), and Wang (2004) contribute to the online learning environment research related to diverse cultural backgrounds. Wang (2001) found that to encourage effective communication and collaboration among learners with diverse cultural backgrounds, the instructor should pay attention to the cultural sensitivity and flexibility. Brown and Hedberg (2001) found that cross-cultural differences existed vastly between Western and Chinese online learning Web sites when they studied cultural recognition in interface acceptance and interface design. Lim (2004) compared both Korean and American online learners’ learning motivation and found that (a) their motivation are influenced greatly by cultural achievement-relevant beliefs, goals, and values, and (b) other variables like gender and academic status could also result in the diversity of cross cultural difference. Wang (2004) found that Asian students who were taking online courses in the U.S. usually felt nervous when they needed to present their ideas because they were worried about their language proficiency.

Motivational Issues

Motivation could simply be defined as the degree of the choices made by people and the degree of the effort they will exert (Keller, 1983). According to Keller (1983), motivation has four components: (1) attention, which captures the students’ interest and stimulates the curiosity to learn; (2) relevance, which meets the student’s individual needs/goals and effects a positive attitude; (3) confidence, which helps students’ to believe that they will succeed and self-control their learning progress; and (4) satisfaction, which reinforces students’ accomplishment with internal/external rewards. Kim (2004) and Kinzie (1990) claimed that intrinsic motivation and continuing motivation are the most significant components in education. Intrinsic motivation refers to students’ engagement for not just the separable and extrinsic consequence, but inherent satisfaction. Continuing motivation is one type of intrinsic motivation that emphasizes the education aspect and reflects the student’s willingness to learn.

In online learning environments, cultural factors are often considered when motivation is studied (Clem, 2004; Lim, 2004). According to Kim (2004), the lack of motivation is one major reason for student drop-outs of online courses. Researchers (Hoskins & Hooff, 2005; Kim, 2004) suggested several methods and strategies to improve student learning motivation in online learning environment such as using interaction and dialogue to create a motivating online learning environment and using authentic settings to motivate and encourage student participation by facilitating learners’ willing suspension of disbelief (Hrington, Oliver, & Reeves, 2002). Laszlo and Kupritz (2003) reported that course relevance was the strongest factor as an online learning motivation. However, because of the diversity of the styles and types of online learning environments, there are still a lot of strategies that need to be explored to motivate students’ learning in an online learning environment.

CHALLENGES, BARRIERS, AND SUGGESTION

Challenges and Barriers

Online learning has been accepted by all of the developed countries and some of the developing countries. From K-12 to higher education to postgraduate, from discussion boards to video-conferencing, from college online courses to adult professional training, online learning environments have been inevitably embedded into the education environments of the society. However, there are still critical issues that need to be taken care of by online learning environment researchers, educators, administrators, and governments.

The first issue is to train teachers and students for the online environment. According to Hamel and Stickler (2005), online course teachers usually spend more time in an online environment than in a traditional face-to-face environment to prepare and distribute course materials, provide student feedback, and prompt discussions to achieve the instructional objectives. At the same time, students of online courses also often spend more time discussing, collaborating, and completing their assignments than their traditional classroom counterparts. Insufficient technical skill is one of the main reasons. By improving their technical sufficiency, the barriers of technical operation will be eliminated. Meanwhile, confidence with technology will help improve students’ motivation. Teachers’ operating and designing competencies will also improve students’ perspectives toward the teachers’ ability.
Online Learning Environments

The second issue is the increasing expenses for the supporting technology. Because of the command on interaction and communication, more and more telecommunication technologies have been used in an online learning environment, which makes online learning more expensive than traditional learning methods. Although educators, researchers, and administrators prove that online learning environment is effective on time and material saving, the increasing cost for distance telecommunication still need to be taken into consideration.

Ethical issues also receive a lot of notice. Because of the intellectual property law, copyright, and fair use, a lot of uncertainties are created (Crosta, 2004). Many online instructional strategies adopt collaborative learning and encourage feedback from peers and instructors. These strategies usually make learners’ artifacts or ideas available to their peers and may be available to the public, which causes students to use online resources freely. But are there some limitations of these artifacts? How can one protect these authors’ intellectual property in an online learning environment?

The other types of ethical issues are about the ways teachers and learners respond to those marginalized and excluded students such as minorities, people with physical disabilities, and so forth (McCormack, 2005; Zembylas & Vrasidas, 2005).

Online learning environments need to be studied according to their various and divergent contexts and course materials—different courses may have different performance outcomes and students from different cultural and knowledge backgrounds may have different perspectives and performance in online learning.

TRENDS AND SUGGESTIONS

With the flourish of Web 2.0, more and more online learning courses have begun to adopt blogs and RSS aggregators to facilitate the communication and collaboration among learners and instructors. Bandwidth’s expanding makes the flow of media a strong and meaningful medium in improving and facilitating the online interaction. Online learning environments rely much more on technologies than traditional classrooms. This dependence partly determines the success or failure of an online learning process. For instance, it is impossible for a student majoring in dentistry to watch an online dentist’s surgery video clip with a 28k speed modem dialing to the Internet. Today, network and Web technologies allow people to communicate both synchronously and asynchronously without the limitation of time and location. Noticeably, however, technologies are not the decisive part for the success of an online course. Instructional designers, administrators, and instructors should comprehensively take into account all factors related to the context, the course’s own characteristics, the features of the students, and right instructional methodologies.

Although the faster developing technologies provide numerous possibilities to simulate the authentic “face-to-face” communication, there are still plenty of problems and opportunities to be explored in taking advantage of online communication and avoiding the shortcomings. Based on the formal research, it is obvious that online learning environments need to improve the quality of interaction. Cooperative and collaborative learning could be efficient methods to foster learners’ and teachers’ interaction. Meanwhile, with the globalization of online education, many sociocultural factors need to be taken into account for the future of education in an online learning environment.

REFERENCES


KEY TERMS

**Bcc:** Bcc is the abbreviation of blind carbon copy. It is similar to that of Cc except that the e-mail address of the recipients specified in this field do not appear in the received message header and the recipients in the To or Cc fields will not know that a copy has been sent to these addresses.

**Blog:** Blog is the short form of the term “Weblog.” It is a Web-based publication consisting primarily of periodic articles (normally in reverse chronological order). Blogs can be hosted by dedicated blog hosting services, or they can be run using blog software on regular Web hosting services. The activity of updating a blog is “blogging” and someone who keeps a blog is a “blogger.” Blogs are typically updated daily using software that allows people with little or no technical background to update and maintain the blog.

**Cc:** Cc is the abbreviation of carbon copy. It means that the addresses after the “Cc:” header would receive a copy of the e-mail. Also, the Cc header would appear inside the header of the received message.

**CMS (Course Management System):** A course management system is a tool that allows an instructor to post the course content and other information on the Web without Web page programming. The instructor and students could access the online course via a Web browser, usually with controlled access to materials, dynamic class lists, inner e-mail system, grading system, online management of assignments and tests, and synchronous and asynchronous communication tools such as chatting rooms, discussion boards, and so forth.

**Discussion Board:** A discussion board is an application on the World Wide Web for holding discussions. A sense of virtual community often develops around forums that have regular users. Discussion Boards are also commonly referred to as Web forums, message boards, Internet forums, discussion forums, discussion groups, bulletin boards, or simply forums.

**IM:** IM is the abbreviation for “instant messaging.” It is the act of instantly communicating between two or more people over a network such as the Internet.

**Listserv:** It is also called an electronic mailing list. It is a special usage of e-mail that allows for widespread distribution of information to many Internet users. Software is installed on a server to process incoming e-mail messages according to their content. The process could either distribute the e-mail to all subscribed users or just process it inside the server. Some popular tools of mailing list software are GNU Mailman, LISTSERV, and Majordomo.

**RSS Aggregator:** RSS refers to RDF Site Summary, or Rich Site Summary, or Really Simple Syndication—A XML format for distributing news headlines and other content on the Web. A RSS aggregator is a software application or remotely hosted service that collects RSS feeds from dispersed sources and provides a single consolidated view.

**Web 2.0:** Web 2.0 generally refers to the second generation of services available on the World Wide Web. In contrast to the first generation, its main features are collaboration and interaction. The term may include blogs and wikis but it is also incorporating whatever is newly popular on the Web (such as tags and podcasts), and its meaning is still changing.
Online Mentoring in Education

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INTRODUCTION

Mentorship between new and experienced education professionals is a laborious task. Senior educators assume the responsibility of teaching rules, codes of conduct, relevant information, content knowledge and skills, and so forth to newer colleagues as a way to help them transition into the new role of an educator. This form of mentorship can also exist between professionals and students who are learning about their fields of study. Finally, older students can mentor younger students to help them progress academically, personally, physically, and psychologically. Hence, mentoring is one of the more effective processes for supporting and improving professional development in education (McCampbell, 2002). Because mentorship can be arduous in terms of time and commitment, other mentoring alternatives are available such as using online communications. This overview discusses the importance of using online modes of communication as a form of mentorship between educators and students. When distance and time are factors impeding effective mentorship, online tools can help improve the teaching and learning processes.

BACKGROUND

Definition

Mentoring is a one-on-one relationship that requires mutual trust, openness, encouragement, respect, and a willingness to learn and share ideas, advice, and constructive criticism between an experienced individual and a novice (Treasury Board of Canada Secretariat, 2000). A mentor is a wise and trusted advisor and assistant to someone who is inexperienced. The structured one-on-one relationship concentrates on the needs of the mentored participant that is generally sustained over a long period of time (Educational Technology Center, 2004). Thus, mentorship is commonly used for self-development, career/academic development, and knowledge/skills development. Furthermore, in most cases the mentor has voluntarily committed time toward mentoring inexperienced individuals. In education, mentorship is primarily used as a tool for teachers to obtain professional development. For students, mentoring is mainly provided as career development to help students prepare for graduation and provide them with an understanding of the workplace and the challenges that come along with the profession (Career Mentor Scheme, 2005).

Characteristics

A good mentor embodies several characteristics that makes the mentor an effective adviser. Because mentors teach through sharing, modeling, guiding, advising, supporting, and networking, certain qualities need to be present. According to James Rowley (1999), a good mentor for entry-year programs in K-12 schools should possess six basic, but essential qualities: (1) committed to the role of mentoring, (2) accepting of the beginning teacher, (3) skilled at providing instructional support, (4) effective in different interpersonal contexts, (5) a model of a continuous learner, and (6) communicates hope and optimism. Other general characteristics that distinguish good mentors include (Education Technology Services, 2004; Soaring to Excellence, 2004):

- High standards and proven experience
- Trustworthiness, care, and empathy
- Dedication toward the commitment
- Self-confidence and the ability to affirm others
- Strong people and communication skills
- Positive outlook and possessing a sense of humor
- Ethical standards and behaviors
- Flexibility and being open to new ideas, methods, and so forth
- Willingness to be an advocate and supporter
- Good management of time and resources
- Life-long learning with an aptitude for teaching
Benefits

A mentoring relationship fosters caring and supportive contacts that encourage individuals to develop toward their full-potential and produce a vision for the future. With this in mind, mentoring has several benefits to the mentors themselves, to the students/mentees, and to the community/school.

Mentors can experience many benefits as they serve as mentors to those who are less experienced. A few of these include increased involvement within the community, realizing that they can make a difference in someone’s life, discover a new friend that would later provide support, and gain new experience and knowledge about the environment in which the mentee/student is coming from (Dubuque Community School District, 2003). In addition, mentors can experience news ways of thinking that may prompt reflection upon one’s own career (Staff & Educational Development Unit, 2005). Finally, mentoring can help the person develop leadership skills as part of the experience (Treasury Board of Canada Secretariat, 2000).

To students, mentoring helps increase self-motivation, critical thinking, and more independence as they acquire life-skills. Often times, students who are mentored become mentors themselves in the future after experiencing the benefits that they have gained (Education Technology Services, 2004). Furthermore, mentoring increases personal knowledge and an understanding of one’s role in the organization/school. Mentorship helps develop an environment that supports constructive criticism that includes wisdom, advice, assistance, and encouragement. In addition, the relationship itself provides an effective learning tool that cannot be obtained through written documents and allows networking opportunities to occur that may help future employment options (Treasury Board of Canada Secretariat, 2000). If mentoring is performed as part of a school mentorship program, K-12 students can benefit by receiving support from a caring adult and assistance with academic endeavors, experiencing encouragement to stay in school and to refrain from drugs and alcohol, and increasing students’ self-esteem and their interpersonal relationships with teachers and family (Dubuque Community School District, 2003).

School and organizations can also benefit from mentorship programs. In the professional workplace, mentorship enhances service delivery and professional development, networking opportunities, better communication, and identifies a pool of qualified candidates to meet future recruitment needs (Treasury Board of Canada Secretariat, 2000). In addition, mentorship within an organization can ensure that all employees have acquired the same set of knowledge and skills, that includes an understanding of the organization’s shared goals and vision. In schools, mentorship can help improve student performance, attendance, and retention (Dubuque Community School District, 2003).

Strategies for Effective Mentoring

Once a mentor has been identified, there are certain tasks or steps that should be undertaken to create an effective relationship between the mentor and mentee (Johnson, 2000). The first task that should be performed is to establish a relationship. The mentor should create a safe environment in which the teaching can take place. In addition, clarifying expectations and goals of the relationship can help set the boundaries for matters such as meeting length and frequency, time, place, purpose, and level of accountability. Once the mentoring sessions begin, the mentor should ask probing questions that stimulate self-reflection among the mentee. The mentor is not the “answer station” for all questions, but can help promote thought and self-contemplation when the mentee experiences complications. Furthermore, the mentor should push the mentee towards paths that are unfamiliar or that the mentee does not feel competent in pursuing. The idea is to encourage the mentee to develop and prepare for unexpected turns in an academic career.

Other strategies for ensuring effective mentor relationships include the following principles that involve monitoring and encouraging progress (Office of Mentoring and Service Learning, 1995). First, mentors should demonstrate their true-selves and encourage the mentees to do the same. Being a good listener and not betraying confidential information are important to establish trust. Goals and accountability should be encouraged throughout the mentor process and mentors should follow-up on commitments that have been made. Availability of the mentor during times of difficulty is also important. When situations arise in which the mentor is not qualified to handle the matter, the mentor should not assume responsibility. Instead, the mentor should refer the mentee to a qualified expert that can resolve the problem.
ONLINE MENTORING AND LEARNING SUCCESS

Online mentoring in education can take many forms. Mentor relationships can expand from a single student who is matched with an adult mentor to a group of students in one classroom matched with a group of mentors from one company. In addition, online mentoring programs cover different time frames from a few weeks to an entire school year depending upon the purpose of the program. Research has shown that students who are involved in mentoring projects had higher levels of college enrollment and higher educational aspirations than nonparticipants who receive comparable amounts of education (Dennis, 1993). With this result in mind, establishing mentor relationships in education will only create opportunities and support for individual students.

The primary reason why a traditional face-to-face mentor relationship may go toward an online format could be due to time and distance constraints. For instance, in a *Business Week* article entitled “No Time to Mentor? Do It Online” (Field, 2003), Karlene Rogers wanted to volunteer time to help kids learn about her job as a litigator. However, her tight schedule prevented any face-to-face obligations to occur. Thus, she turned to an online mentoring program called icouldbe.org that matched high school students with adults working in careers of interest. Without this online opportunity, Karlene would not have been able to serve as a mentor. Many mentoring programs like these are available and online communication tools are allowing such interaction to occur. In addition, educational institutions are also sponsoring their own online mentoring projects to help improve teaching and learning. Pairing students with teachers/parents/professionals in an online mentoring program can create a collaborative environment that furthers student motivation and professional preparation. The following sections address these programs and opportunities in which online mentorship can transpire.

### Online Mentoring Resources

The following list offers a few online mentoring resources that could help mentees find mentors or vice versa. Each resource is described in terms of purpose and what it offers to students, educators, and the community. This list is not exhaustive because there are hundreds of online mentoring programs available. However, here are a few topic-focused sites that one can visit and explore (Perez, 2001):

- **MENC (National Association for Music Education):** Online members can find support with topics pertaining to the areas of band, chorus, and general music (http://www.menc.org/mentors). This service is available to mentors during the school year (Fehr, 2005).
- **MentorNet (E-mentoring Network for Diversity in Engineering and Science):** Nonprofit e-mentoring network that addresses the retention and success of those in engineering, science, and mathematics (http://www.mentornet.net).
- **Mentor Youth:** A faith- and community-based network that pairs Christian adults with youths (http://www.mentoryouth.com/).
- **International Telementor Program:** The International Telementor Program provides experts from around the world to assist in science, math, medicine, and more (http://www.telementor.org).
- **Girls to Women Mentoring Project:** Designed around themes that would help girls become aware of themselves, how they believe they fit into the world around them, and to help them realize they are not alone (http://www.mentoringproject.com/).

There are also traditional programs that have joined school-based programs such as Big Brothers and Big Sisters of America. Religious institutions have also taken a leadership role in mentoring youth, and some corporations and social organizations like One Hundred Black Men, Inc. now promote employee involvement in the community (Dennis, 1993). Thus, if someone is interested in becoming a mentor or mentee, one just has to look.

### Programs and Case Studies

There are several projects that use online mentoring or e-mentoring as a method for professional development of educators or to enhance students’ preparedness for instruction and/or careers. The following summaries are only a few of the e-mentoring projects that have been successfully used in education. Other case studies do exist. However, these few will provide a general descrip-
Online Mentoring in Education

The use of online communication tools to foster a working relationship between individuals who are just learning the content area and those who are more accomplished. In education, online mentoring has provided an avenue in which students, teachers, and community leaders can interact and discover new facts from one another. Finally, as demonstrated in the case studies, participating in mentorship programs often lead to continued communication and support, and the actual application of the skills/knowledge obtained.

FUTURE CONSIDERATIONS

As online tools and the presence of the Web continue to grow, new applications and methods will develop in terms of mentoring. One method will be videoconferencing. As the Web and Internet networks continue to improve in speed and strength, along with greater access to the World Wide Web and video technologies among individuals, videoconferencing may take precedence over e-mail and/or bulletin boards. Videoconferencing, in a sense, may become a surrogate over the more traditional face-to-face communication. Because some individuals learn better with visual interaction, videoconferencing is a better alternate than using nonvisual mediums such as e-mail.

Another trend of online mentoring will be the access to and advances in mobile technologies. As personal digital assistants, blackberries, and other forms of
mobile technologies become more abundant, online mentoring will become more readily accessible as well. Increased access to mobile technologies can help improve the availability of mentorship relations that are not just delegated to desktop computers. As such, mentoring strategies may change due to this increased access; a trend that future mentors and mentees can take advantage of in education.

CONCLUSION

Online mentoring is a useful tool in teaching concepts, ideas, information, and practical knowledge and skills to students/mentees. In addition, online mentoring can help promote self-motivation and increase confidence and independence among students/mentees. Mentoring online can also help mentors develop leadership skills and help them become more involved in the community. Schools can also benefit from e-mentoring by allowing teachers to obtain professional development and in improving student motivation and retention. Hence, online mentoring is a process that both sides (mentor and mentee) can gain an advantage; a process whereby all individuals can and will learn.

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KEY TERMS

E-mentoring: Another term used for online mentoring. It is an online community of networked individuals that consists of mentors and mentees.

Mentee: The novice or a person seeking professional development or content knowledge/skills from a more experienced person.

Mentor: A person who agrees to help teach and guide another person. A mentor is someone who encourages, shares, interacts, supports, and communicates with a novice about certain matters.

Mentoring: A structured one-on-one relationship (or partnership) that concentrates on the needs of the mentored participant. A supportive relationship that is sustained over a period of time between a novice and expert.

Online Mentoring: Takes the aspect of mentoring to an online format generally via e-mail or bulletin boards. Mentors are paired with a novice online that would foster the relationship further.
Organizational Data Warehousing

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INTRODUCTION

A data warehouse (or smaller-scale data mart) is a specially prepared repository of data created to support decision making. Data are extracted from source systems, cleaned/scrubbed, transformed, and placed in data stores (Gorla, 2003). A data warehouse has data suppliers who are responsible for delivering data to the ultimate end users of the warehouse, such as analysts, operational personnel, and managers. The data suppliers make data available to end users either through structured query language (SQL) queries or custom-built decision-support applications, including decision support systems (DSS) and executive information systems (EIS).

During the mid-to-late 1990s, data warehousing became one of the most important developments in the information systems field. It has been estimated that about 95% of the Fortune 1000 companies either have a data warehouse in place or are planning to develop one (Wixon & Watson, 2001). Data warehousing is a product of business need and technological advances. The business environment has become more global, competitive, complex, and volatile. Customer relationship management (CRM) and e-commerce initiatives are creating requirements for large, integrated data repositories and advanced analytical capabilities. More data are captured by organizational systems or can be purchased from the third party.

Even though there are many success stories, a data warehousing project is an expensive, risky undertaking (Beitler & Leary, 1997). Organizations are spending millions each year on data warehouse development, but the majority of all initial data warehousing efforts fail (Chenoweth, Corral, & Demirkan, 2006). The most common reasons for failure include weak sponsorship and management support, insufficient funding, inadequate user involvement, and organizational politics (Watson, Gerard, Gonzalez, Haywood, & Fenton, 1999).

Conventional wisdom holds that having a management champion with a tightly focused (data mart) design and restrictive tools will lead to success. However, Chenoweth et al. (2006) found that the reverse situation can be just as successful. If the users see the potential of the data warehouse to deliver value to the organization, they can be the champions and convince management to adopt the technology. Furthermore, if users understand both the technology and the organization’s business processes, a single data repository may actually be more satisfying for them.

BACKGROUND

In today’s business environment, every business owner dreams of having the ability to know what is happening in all aspects of his or her operation and of being able to use that information to better the market and increase profit. In order for an organization to achieve competitive advantage, voluminous data need to be managed, analyzed, and fed into the decision-making process. The introduction of data warehouses, which provide decision support to organizations with the help of analytical databases and analytical applications like online analytical processing (OLAP), answers this need (Gorla, 2003). The technical definition of a data warehouse is a subject-oriented, integrated, time-variant, and nonvolatile collection of data that supports managerial decision making (Inmon, 2002). Typically, a data warehouse is housed on an enterprise’s mainframe server, but it can reside with a storage service provider. Data in an OLAP data warehouse are extracted and loaded...
from various online transaction processing (OLTP) applications and other sources using extract, transfer and load (ETL) tools. Analytical applications such as online analytical processing (OLAP) tools, data mining, statistical modeling, geographical information systems (GIS), DSS, and other user queries are then applied to the repository (Jones, 2001).

There are five major elements of data warehousing including: data acquisition, data modeling and schema, metadata, data management, and data analysis (Inmon, 2002; Jones, 2001). Data acquisition involves identifying, capturing, and transforming data in operational systems so that the data can be loaded into a data warehouse or data mart. Data acquisition is a complex, time-consuming, and costly phase of building and managing a data warehouse, but if this phase is not correctly carried through, the data warehouse will not be effective. During data acquisition, data are extracted, transformed, transported, and loaded. Data modeling is the analysis of data objects used in a business or other context and the identification of the relationships among these data objects. A data model consists of objects (for example, a product, a product price, or a product sale) and expressions of the relationships between each of these objects. The activity of data modeling leads to a schema, which is the organization or structure for a database. Metadata is a definition or description of data, and it is the glue that holds together all components and views of a data warehouse. Data management includes the access and storage mechanisms that support the data warehouse. This is usually a relational, multidimensional, or other specialized database designed to facilitate complex queries. Data analysis applications enable end users to access and analyze data stored in data warehouses or data marts. There are many variants of data analysis software. The main types of data analysis software include data mining tools, OLAP tools, enterprise business intelligence suites, and DSS.

There has been little empirical research on the implementation success of data warehousing projects. Wixon and Watson’s (2001) empirical investigation suggest that management support and resources help to address organizational issues that arise during warehouse implementations. Furthermore, resources, user participation, and highly-skilled project team members increase the likelihood that warehousing projects will finish on-time, on-budget, with the right functionality. The implementation’s success with organizational and project issues, in turn, influence the system quality of the data warehouse.

There are several issues of interest in the data warehousing literature. In this article, we focus on three issues. The first is data warehousing methodologies that organization may choose, the second is the management of the data warehouse through its operational life cycle, and finally the security of the data warehouse. The later issue is of importance because we believe that organizations must protect their valuable information asset.

MAIN FOCUS

When a small business decides to install a network for the first time, it must choose the operating systems, hardware, network, and software components. The same applies when an organization decides to build a data warehouse because there are several methodologies to choose from. Data integration technologies have experienced explosive growth and a large number of data warehousing methodologies and tools are available to support market growth. Furthermore as the business environment changes rapidly, management of the data warehouse through its operational life, and securing the data, become important because of the costs involved. In this section we present our thoughts on the choice of data warehousing methodologies, managing the data warehousing through time, and data warehouse security.

Choosing Data Warehouse Methodology

With so many data warehousing methodologies to choose from, a major problem for many firms is which one the company should utilize for its situation. We believe that when a technology is in its growth stage there is going to be a variety of methodologies and very little standardization. In such a case, we expect that an organization would use different criteria to evaluate the different options and select the one that meets their need. To confirm our thoughts, we researched recent empirical studies on data warehousing methodologies (Sen & Sinha, 2005). In general, data warehousing methodologies can be classified into three broad categories as follows (Sen & Sinha, 2005): (i) Core-technology vendors are those companies that
sell database engines, such as NCR’s Teradata-based methodology, Oracle’s methodology, IBM’s DB2-based methodology, Sybase’s methodology, and Microsoft’s SQL Server-based methodology. These vendors use data warehousing schemes that take advantage of the nuances of their database engines. (ii) Infrastructure vendors, which are companies that sell database systems independent methodologies such as SAS’s methodology, Informatica’s methodology, Computer Associates’ Platinum methodology, Visible Technologies’ methodology, and Hyperion’s methodology and information modeling companies. These infrastructure tools are the mechanisms used to manage metadata using repositories, to help extract, transfer, and load data into the data warehouse, or to help create end-user solutions. (iii) Information modeling vendors, which includes ERP vendors (e.g., SAP, and PeopleSoft), a general business consulting company (Cap Gemini Ernst Young), and two IT/data-warehouse consulting companies (Corporate Information Designs and Creative Data). These vendors focus on the techniques of capturing and modeling user requirements in a meaningful way.

Several attributes have been used to evaluate the various methodologies including: core competence, modeling requirements, data modeling, support for OLAP queries, architecture design philosophy, easy of implementation, meta data management, scalability, adaptability to changes (Sen & Sinha, 2005). Based on Sen and Sinha’s (2005) qualitative evaluation of the various methodologies, it follows that none of the methodologies has achieved the status of a widely recognized standard, consistent with our hypothesis on technologies in the growth stage. The results from Sen and Sinha (2005) suggested that the core vendor-based methodologies are appropriate for those organizations that understand their business issues clearly and can create information models. Otherwise, the organizations should adopt the information modeling based methodologies. If the focus is on the infrastructure of the data warehouse such as metadata or cube design, it is best to use the infrastructure-based methodologies. We anticipate that as the field of data warehousing moves to the mature stage, there could be a convergence of the various methodologies.

Managing Data Warehouse Operational Cycle

Every business goes through changes in strategy, as changes occur in the external and internal environment in which it operates. Organizations constantly assess their strengths, weaknesses, opportunities, and threats in formulating and implementing new strategies. Because the business world is characterized by frequent changes, data warehouses must be adapted to these changes in order for them to continue to be relevant. Management of data warehouse through these changes is a new area of research called data warehouse lifecycle management (DWLM) (Longman, 2004). This enables the organization to align information systems with the changing business operations they are designed to support.

Given the need to respond to internal and external changes, the design of the data warehouse must be flexible enough to adapt to changes in the business cycle. Without this flexibility, there will be additional high costs because any major change will require IT experts to hunt through large systems and identify what needs to be altered and then make complex changes in the relevant places. One characteristic of an adaptive data warehouses is the use of generic storage rather than set a physical storage structure to meet predetermined business goals (Longman, 2004).

A second characteristic of adaptable data warehouse is that it should allow the business users to manage the changes needed in the data warehouse, thus eliminating the need to have the IT function take charge of every little alteration needed. This is important because miscommunication between the business users who know what they need and the IT function who try to implement the change can lead to errors and costly translation process. Thus, it makes sense for a financial manager to change the definition of net profit and add some new budget data to the data warehouse.

A third characteristic is consistency in the master data management. In a global corporation, for example, the same product can be referred to in different ways in different places, and this means that the transactional systems will not be sufficient to manage the master data to produce the desired analytical results for management. One recommendation is that adaptive warehouse
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design use a scheme that will give the business owners of the data the tools to improve, enrich, authorize, and publish master data in a form acceptable to the several systems used to run the business (Longman, 2004). Without well-managed master data, data warehouses will produce questionable results, which will significantly diminish their utility in running a business.

Finally, adaptive data warehouse must be able to capture the history of an object of data in storage over time. This will allow the data warehouse to provide information about the behavior of these objects in the past, making it possible for the business to compare changes over time (Longman, 2004).

In our opinion some of these characteristics are quite ideal, and in most cases a piecemeal implementation would be required to transform the data warehouse into an adaptive one. For example, it would not be 100% possible for business users to manage changes in the data warehouse themselves, meaning that there will always be a need for the IT function to be included in the transformations required. Furthermore, tracing historical changes in data objects, while ideal, should be done selectively within the master data structure.

Data Warehousing Security

In the IT world, protection of IT systems against virus and spyware and protecting customers data are just a few of the security worries IT specialists face on a daily basis. Many of the basic requirements for security are well-known and apply equally to a data warehouse like they would for any other system. We believe that these requirements are perhaps even more important in a data warehouse because a data warehouse contains data consolidated from multiple sources and thus from the perspective of a malicious individual trying to steal information a data warehouse can be one of the most lucrative targets in an enterprise. Therefore, the application must prevent unauthorized users from accessing or modifying data, the applications and underlying data must not be susceptible to data-theft by hackers, the data must be available to the right users at the right time, and the system must keep a record of activities performed by its users.

There are further security provisions, in our opinion, that could be implemented in the data warehousing environment. First, an enterprise where data warehouse that is widely used by many divisions and subsidiaries in a company needs a security infrastructure that ensures that the employees of each division to only view the data that is relevant to their own division, while also allowing for employees in its corporate offices to view the overall picture. Second, when the data warehouse stores personal information, privacy laws that govern the use of such personal information must be strictly implemented. Furthermore, companies that sell data to their clients must ensure that those clients only view the data they are entitled to (Edwards & Lumpkin, 2005).

Recent research on data warehousing security and privacy suggest that organizations should ensure the security and confidentiality of customer data in a data warehouse by: the establishment of a corporate security policy, logical security (such as the use of passwords and encryption technology), physical security, and periodic internal control reviews (Elson & LeClerc, 2005). Because in some cases the data warehouses were built with little consideration given to security during the development phase, proactive security requirements of data warehousing, a seven-phase process, can be implemented (Warigon, 1997). These seven phases include: identifying data, classifying data, quantifying the value of data, identifying data security vulnerabilities, identifying data protection measures and their costs, selecting cost-effective security measures, and evaluating the effectiveness of security measures (Warigon, 1997).

FUTURE TRENDS

Organization’s business intelligence and data warehousing technology is rapidly expanding in the business industry globally especially in the U.S. market. Data warehousing has several trends that are getting worldwide attention from organizations such as active data warehousing and integration of CRM and data warehousing. These two trends are discussed briefly in this section.

One of the important trends in the data warehousing industry is that an active data warehouse provides an integrated information repository to drive strategic and tactical decision support within an organization (Brobst & Ballinger, 2003). Enterprises face competitive pressures to increase the speed of decision making so active data warehouses are designed to hold accurate, detailed, and integrated data from operational
systems within an organization. Active data warehouse are becoming important for two key reasons. First, daily customer activities are supported by active data warehousing because all levels of decision makers can manage customers information on a day-to-day basis. Businesses can manage customer relationships by real time analysis such as responding to customer’s interactions, behaviors, and changing business conditions. Strong customer relationships are important to any information-driven business because direct interaction with customers will empower employees with information based decision making. Employees will have the knowledge and experience to assist customers based on accurate information stored on their organization’s data warehouse. Second, active data warehouses are the next generation decision-support systems because they are one-to-one relationship oriented. The next generation of data warehousing manages the customer relationship at any and all touch points and in understanding customers as an individual.

The next important data warehousing trend is the integration of data warehousing and CRM. In the business world today, many organizations are implementing a business strategy that supports their customers. Building and maintaining beneficial long-term customer relationship is critical for the implementation of CRM (Knight, 2001). The integration of data warehousing and CRM is essential because they both allow organizations to capture, analyze, and disseminate the proliferation of customer information to drive business decisions (Bull, 2002). A key success factor of any CRM strategy is the ability to make use of the available information on customers in order to understand the characteristics of the customer base and to influence the ways in which customers and the organization interact (Imhoff, Loftis, & Geiger, 2001). To achieve this integration, the organization should be able to use the data warehouse to recognize the different types of customers, their expectations, diverse requirements, and preferences. This will allow the organization to anticipate their customer’s needs by analyzing their buying habits. Effectively analyzing customer wants and needs through sales and marketing technologies will give customer-driven organizations a global competitive edge among rivals. Finally, understanding the value of each customer will positively affect a strong customer relationship because customers want to be recognized as loyal consumers. Therefore, the data warehouse must be accurate and up-to-date for this integration to be successful.

CONCLUSION

Every organization needs a view of its performance across all its operations. Many enterprises use data warehouses to store a copy of data drawn from operational systems so that they can be extracted for analysis. Such data warehouses present data on demand to business users and analysts via business intelligence, reporting, and analytical tools. By acting as a central source for management information, a data warehouse delivers a single version of the truth that spans multiple operations. This gives executives visibility of business performance, improving the organization’s ability to react to competitive pressures.

Data integration technologies have experienced explosive growth and a large number of data warehousing methodologies and tools are available to support market growth. Because the data warehousing is in its growth stage, there are several methodologies and none of these methodologies have achieved the status of a widely recognized standard. As the business environment changes, managers must think about adaptive data warehouses that could be easily aligned with the business or industry lifecycles. Finally, the security and privacy of the information in the data warehouse must be protected because data warehouses are often very large systems, serving many user communities with varying security needs.

REFERENCES


KEY TERMS

Business Intelligence: A corporation’s ability to access and employ information usually contained in a data warehouse. With the information, the corporation can analyze and develop insights and understanding that lead to improved and informed business decision making.

Data Base Management System (DBMS): Computer system software that manages the physical data.

Data Mart: A subset of a data warehouse that focuses on one or more specific subject areas. The data usually is extracted from the data warehouse and further denormalized and indexed to support intense usage by targeted customers.

Data Warehouse: A database built to support information access. Typically a data warehouse is fed from one or more transaction databases. The data needs to be cleaned and restructured to support queries, summaries, and analyses.
Data Warehouse Lifecycle Management (DWLM): The creation and ongoing management of a data warehouse throughout its operational life. DWLM delivers enterprise-scale data warehouses that adapt efficiently to change, at lower cost than traditional software development methodologies.

Geographic Information Systems (GIS): A computer system designed to allow users to collect, manage, and analyze large volumes of spatially referenced information and associated attribute data.

Metadata: Data about data. Metadata includes the attributes of and information about each piece of data that will be contained in the data warehouse.

Online Analytical Processing (OLAP): A database designed to support analytical processing such as decision support.

Online Transaction Processing (OLTP): A database designed to support transactional processing.
Pedagogical Agents in Online Learning

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## INTRODUCTION

Lack of personalization and individualized attention are common issues facing distance education designers and instructors. This is a particularly important deficiency as research has shown that personalization can increase learning greatly in comparison to nonpersonalized, information to student, linear instruction (Clark & Mayer, 2003). Advocates of personalization cite cognitive learning theory as the basis for such an approach; when humans communicate with one another they are continuously processing information, either assimilating or disregarding data and forming an understanding of the information in context of the environment and of the person with whom they are interacting. This is a natural learning mechanism that cognitive learning theories state is the foundation for all deep and lasting instruction (Hein, 1991). Through an engagement of the natural learning mechanisms, or cognitive structures, an individual should be capable of learning efficiently and form a more thorough understanding of a topic. Personalization of text through the use of informal speech and the inclusion of virtual coaches known as pedagogical agents are used as personalizing devices. These are particularly relevant options in the design of nonmoderated e-learning, as personalization is meant to fill the void where the instructor once stood. There are exclusions however, as pedagogical agents have been used in “traditional” online classrooms as well. This article focuses on the use of pedagogical agents in e-learning that:

- Provides information on pedagogical agents strengths and weaknesses
- Provides research relevant to pedagogical agents instructional role
- Provides examples of current use
- Discusses possibilities of future implementation.

## THEORY, STRENGTHS, AND WEAKNESSES

Human beings tend to interact with technology in much the same way as they interact with living people or real places (Reeves & Nass, 1996). The expectations that people assign to people and places are naturally transferred to objects that virtually represent real people and places. This relationship can be seen as one of information exchange and transfer. Media is normally used as an information disbursement modality similar to that of a human relationship where information is exchanged between one or more individuals and is either assimilated or disregarded. Technology-based information distribution can not assume all of the nuance and complexity of human interactions. Still, it is a powerful way that many engineers and programmers have attempted to harness in order to create more effective and efficient designs, programs, and learning.

This natural inclination to personalize technology can be used by instructional designers through the implementation of pedagogical agents. Pedagogical agents are computer-generated virtual mentors and are commonly created to represent real people, animals, or objects. Agents can be created by graphic artists/animators and utilized by instructional designers as virtual e-learning mentors. Pedagogical agents are commonly designed with the characteristics of a living, autonomous being; a pedagogical agent can have a voice, personality, emotional affect, and any other characteristic that can be found in a living or nonliving object. The instructional designer’s intent is to use the individual’s tendency to interact with the machine or training as though they were receiving one-to-one tutoring. One-to-one tutoring has been shown to be one of the most effective instructional modalities (Bloom, 1984); the pedagogical agent allows every learner the opportunity to interact with an instructor one-to-one.
Pedagogical Agents in Online Learning

When the computer acts as an instructor, virtually representing a living being, this would theoretically transform the person-to-machine relationship and create an environment that was as close as possible to an actual one-to-one instructional environment. Lester, Converse, Kahler, Barlow, Stone, and Bhogal (1997) have demonstrated that through this one-to-one engagement pedagogical agents can increase enjoyment of learning, increase self-regulation and efficacy, and motivate students to continue to learn about a topic or subject.

Other learning theories that are commonly cited to encourage implementation of pedagogical agents include a constructivist learning theory (CTL) and a social learning theory (SLT). Proponents of CTL would state that through the use of pedagogical agents, learners are able to interact with a more meaningful and realistic environment and thereby construct knowledge through realistic experience (Hein, 1991). CTL is centralized on the learner rather than the instructional material; this is an ideal approach for implementing a pedagogical agent as it is a one-to-one interaction focused on the learner. Pedagogical agents also allow for the creation of virtual environments that can be highly reflective and almost identical to the actual situation in which learners will utilize the information/knowledge being studied. For example, a pedagogical agent can be created to assume the role of a customer which would interact with the learner just as a living being in a customer service program, or a virtual student can be created to assist educators in honing their tutoring skills.

Social learning theories (SLT) focus on the social relationships in learning interactions; learning can occur through observation or modeling/imitation and learning does not require an observable change in behavior (Ormrod, 1999). Pedagogical agents can demonstrate tasks and procedures as well as actively involve the learner in the process, allowing for social and virtual physical involvement in learning. Social learning interactions are easily observed in an instruction utilizing pedagogical agents as it is a socially-based activity involving the learner and virtual instructor.

Instructional role has direct application to both CTL and SLT as the manipulation of pedagogical agent characteristics can affect the environment/experience as well as the social relationship of the student to the agent respectively. The pedagogical agent’s instructional role can be dissected into feedback and affect components; the two primary components can be further separated into auditory and visual categories. The combination of these characteristics creates a more believable agent and theoretically more effective one as the student would be more open to learning with a virtual tutor that seemed to be alive.

Regardless of the benefits and theoretical advocacy, pedagogical agents rely heavily on programming and many on visual technologies, making them expensive to implement. This is a major obstacle and a possible reason that they have not been implemented in mainstream instruction. Other weaknesses include issues related to the digital divide. Also, many instructors and designers may be slow to adopt such a new technology even if it is accessible. Cognitive overload is also commonly cited as a weakness, as the agent may be distracting or relaying too much information for a learner to process.

Instructional Role

It should be noted prior to reviewing the following three studies that the pedagogical agent field is still in its infancy and there is much research to be done. This is especially true for the use of pedagogical agents in adult education in contrast to childhood e-learning (Knowles, Holton, & Swanson, 2005), where there are numerous examples of pedagogical agents in use. Currently, the majority of available studies on pedagogical agents have focused on childhood to undergraduate, college-aged adult populations.

In nonmoderated e-learning, as well as some moderated online classrooms, the role of instructor is usually at least partly delegated to the learner, who manages their own learning. Pedagogical agents can virtually represent the instructor, however, it is not possible for technology to fully replace the function of a living instructor. Students must still manage themselves in a virtual learning environment that is moderated by a pedagogical agent who simply provides a learning gauge or compass to steer learners in the correct direction. Therefore, an agent would not create a limited environment, but merely a more understandable one and thus would be in alignment with andragogical theory and practice.

As a virtual representation of a living being, pedagogical agents can demonstrate the behaviors and characteristics attributed to their living counterparts. In the
research available on instructional role, the majority focus on agents assuming one or more of three roles (Baylor & Kim, 2003):

- Expert
- Motivator
- Mentor

When the expert is merely an information portal, the motivator an instructional coach, and the mentor is a combination of both the expert and motivator.

In a study of learner perceptions of pedagogical agents, Baylor and Kim (2003) attempt to determine whether or not learners actually perceived the intent of the separate roles that pedagogical agents may play in a computer based instruction. If learners are aware of an agent’s purpose and intent they should be capable of utilizing it to their own purpose. This control and understanding of the instructional event, which is discussed in constructivist learning theory and andragogical learning theory as an important facet of effective learning (Hein, 1991), allows the learner to fully utilize the instruction to further their individual learning goals as it is useful, nonlimiting, and allows self-direction.

Baylor and Kim (2003) conclude that the learners were capable of identifying the agent’s role and purpose; this is beneficial as students who are capable of identifying an agents role in an instruction that utilized a variety of agents could chose an agent based on the type of information they wanted to receive. Visual learners may wish to learn with a highly interactive agent, while auditory learners may choose an expert-like agent as they could limit the type and amount of information they receive. This study has proven valuable as a design instrument used to create and measure agents with particular instructional roles, and their effectiveness in fulfilling that role.

What Role is Most Effective

Because the field is new it is difficult to determine what role is the most effective. Lester, Converse, Kahler, Barlow, Stone, and Bhogal (1997) conducted a study with 100 middle school students, which focused on the type of feedback each instructor gave and what effects this had on learning retention and transfer. The agents were similar to those created for the Baylor and Kim (2003) study: expert, mentor, and motivator. Five clones of the pedagogical agent were created and each exhibited specific behaviors and instructional roles; the five agents were classified into the following categories:

1. Muted: agent provides no advice
2. Task-Specific Verbal: Expert
3. Principle-Based Advice: Motivator
4. Principle-Based Animated/Verbal: Animated Motivator
5. Fully-Expressive: Mentor

The task specific verbal agent can be compared to the expert agent in the Baylor study. The principle-based agent is similar to the motivator agent, and the fully-expressive is similar to the mentor agent who exhibits the behaviors of both expert and motivator. Regardless of the agent’s instructional role, all learners who interacted with a functioning agent scored higher on learning measures than those who were in the control group.

The study revealed that there were no significant differences in learner performance on simple questions; no differences were found between agents. However, a significant interaction was found between agent type and problem difficulty, demonstrating students who interacted with the agent were able to solve more difficult problems with less errors. Learners who interacted with the fully expressive agent or the task-specific agent were found to commit fewer errors than either the control group or the principle based agents. Although the learners who interacted with the principle-based agents did not score as high as the task-specific/fully expressive agents, their scores were found to be significantly higher than those of the muted agent. Further, it was found that learners who interacted with the fully expressive (mentor) or the animated task-based advice (motivator) agents scored significantly higher on complex problems demonstrating that agents can increase deeper understanding and retention.

Online Classroom Agents

The definition provided at the beginning of this article stated that pedagogical agents are virtual learning mentors, with many being given the façade of a living being or object; however, there are pedagogical agents that have no visual presence and work behind the scenes much like an online classroom facilitator.
Thaipupathump, Bourne, and Campbell (1999) conducted a study of such agents called KnowBots in an asynchronous course: *Getting Started Creating Online Courses*. The agents automated various online tasks that are usually the facilitator’s responsibility, such as giving reminders of various due dates, providing instant feedback after work submission, answering simple questions, checking computer code, and so forth. The agent acts as an autonomous assistant to the facilitator; rather than a tool that can be manipulated.

Thaipupathump, Bourne, and Campbell (1999) found that when the Knowbots were introduced there was a significant increase in the amount of participants who completed the course. It was also found that following the introduction of the agents, participant’s satisfaction levels increased as well as the number of assignment returned, thereby making the course more effective and productive. The researchers concluded that their hypothesis was correct: for an online course to be most effective, students should receive feedback often and quickly.

Interestingly, and corroborating the previous research, mentor agents are correlated with significant performance increases. Although the Knowbots could not be seen, they provided factual information as an expert and motivational support through immediate feedback. This is significant in terms of traditional education as well, as instructors can learn what is most important to learners and how to create the most effective instruction.

**Other Research**

The research on pedagogical agents is increasing, with the majority of studies citing benefits to their inclusion in e-learning. Researchers are attempting to pinpoint those agent characteristics that are responsible for learning benefits; studies on gender, realism, feedback, and sound are increasing.

There are researchers that believe that the positive effects seen in agent instructed courses are due to the novelty of such a program; the novelty of the agents increase attention and therefore learning is increased. However, there are measured affects that go beyond an agent’s ability to gain attention. An interesting study by Baylor, Shen, and Warren (2005) conducted a study to determine the effects of agent emotional and motivational support on learner anxiety. Baylor et al. (2005) found that agents were capable of alleviating anxiety by providing motivational support, which also increased learner’s self-efficacy. The researchers studied a group of young adult students in a GED math course, who were identified as having a high level of math anxiety. The research demonstrated that agents can positively affect learning beyond that of gaining attention. If agents can alleviate mental and emotional stress, it may be possible to create virtual counselors that advise students in their education.

**Agents in the Real World**

Although not mainstream, pedagogical agents are becoming more popular in training and education. Children’s e-learning software, such as *Reader Rabbit*, commonly uses pedagogical agents as means of instruction. In adult education, pedagogical agents are becoming popular in the design of corporate training, as well as in software help systems. Microsoft has created a programmable software agent that can be coded into Windows based programs and provides guidance to software users. Microsoft Word popularized the notion with cartoon animated characters such as the Paperclip office assistant or Merlin the Wizard.

In academic settings many institutions may be slow to adopt the technology as it is expensive and complex to implement, as well as the infancy of available research. The Knowbots study cited previously is an example of the use of pedagogical agents in an academic setting; however, the majority of agents are restrained to university research labs. As the technology becomes more accessible, and research demonstrates solid learning increases, many institutions may be willing to invest in it.

**Discussion: Implications for the Future**

Although there are limitations, which were addressed earlier, pedagogical agents seem to have a bright and unlimited future. Agents continue to evolve and are being programmed with artificial intelligence, voice comprehension, and other “smart” technologies. The agent is becoming more life-like, helpful, and seemingly more effective. Agents may even be capable of individualizing instruction to a specific student’s needs. Through collecting of a student’s participation and performance data in an e-learning training program, the agent can identify the type of learner the student is and instruct accordingly.
As technology becomes more accessible to all areas and people, many will use it to learn and the question poses itself: How can we teach so many diverse people effectively? Pedagogical agents may be the answer. One Laptop per Child (OLPC) is an initiative that hopes to deliver laptop computers to children in rural locations around the world. In many of these areas electricity is not available and the computers provided by OLPC will be equipped with a hand cranked battery. In impoverished and unindustrialized areas where there is a lack of qualified educators, it would be a great benefit to use pedagogical agents as tutors, who provide one-to-one attention to each learner who otherwise may lack any formal individual education.

Aldrich (2004) demonstrated the importance and power of simulations as a teaching and learning tool and its growth in the future. Pedagogical agents will play a key role as the virtual personas a learner or trainee would interact with in these simulated learning environments. Corroborating both CLT and SLT learning theories as accurate descriptions of learning and indicating that pedagogical agents will continually grow and become more prominent in e-learning design.

Software, both Web and computer based, would also benefit from implementing agents to create more user friendly help systems. It may be far easier to ask an agent a question than clicking or searching a database for the relevant information. As agent technology, such as Microsoft’s Software Agents, advances it may become more popular in mainstream computing.

CONCLUSION

Pedagogical agent technology is an exciting and burgeoning field that has great promise as an instructional tool. Research to date demonstrates that agents are a beneficial tool to instructional designers. The weaknesses of the technology will become a smaller concern as it evolves and becomes more accessible and as understanding and popularization of e-learning in general increases.

Pedagogical agents are powerful tools that can affect learners in many ways, including emotionally, which can be a barrier to learning. This is especially true for adults, who bring a wealth of experience to the instructional environment. Some of these experiences may be deterrents to learning performance while others may increase a learner’s ability. Agents as proxy instruc-

tors are not programmed with experience, although they may be capable of understanding how a specific student learns and provide material and advice based on student performance. Pedagogical agents have the potential to create personalized learning experiences that approach the student as an individual and to reach farther than any living instructor.

REFERENCES


**KEY TERMS**

**Constructivist Learning Theory:** States that through the use of pedagogical agents, learners are able to interact with a more meaningful and realistic environment and thereby construct knowledge through realistic experience.

**E-learning:** Learning that is accomplished over the Internet, a computer network, via CD-ROM, interactive TV, or satellite broadcast.

**Knowbots:** Independent, self-acting computer programs that know how to search a specific database of information on the Internet on behalf of a user, possibly replicating itself on other hosts on the network. As the Knowbot performs its task, it sends reports back to the user.

**Pedagogical Agents:** Computer generated virtual tutors used in e-learning that can provide individualized instruction, learning motivation, and a more interesting and effective learning environment.

**Personalization:** In this context, it is when humans communicate with one another they are continuously processing information, either assimilating or disregarding data and forming an understanding of the information in context of the environment and of the person with whom they are interacting.

**Social Learning Theory:** Focuses on the social relationships in learning interactions; learning can occur through observation, modeling, or imitation. Learning does not require an observable change in behavior.
Pedagogical Characteristics Affecting Student Learning

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INTRODUCTION

Student in today’s undergraduate level classrooms often display widely varying characteristics that extremely affect learning outcome. Although student characteristics have been widely studied in the more traditional teaching and learning environments, educators have just begun exploring the applications in interactive multimedia and its associated technological techniques. This article first describes some pedagogical characteristics that could affect students in their learning and than discuss some student learning styles.

BACKGROUND

In recent years, approaches to teaching have shifted considerably and have led to a greater differentiation between teaching and learning. While studies on improving teaching have been ongoing for many years, only recently have studies on improving learning been initiated. More and more researchers today are looking into what characteristics affect a student’s learning curve given that the teaching techniques are close to optimal.

A variety of student characteristics impact a student’s performance and ultimately individual achievements in the classroom. Huit (2002) lists six main characteristics as follows:

• Intelligence, achievement, and prior knowledge
• Learning style
• Cognitive development
• Gender
• Race
• Moral and character development

As a case study the experiments under research have focused on a first year undergraduate level classroom that teaches engineering mechanics subjects. Considering that many first year undergraduates have different level of knowledge in science and mathematical subjects, the student characteristics list of learning as stated above can be extended as follows:

• Basic knowledge background: The characteristic represents the basic science and mathematics knowledge of the student. On a given scale, it shows whether, and how much, basic science and mathematics knowledge the student has. The scale is however multidimensional, showing not only the background knowledge in science and mathematics, but also knowledge of other categories required for a better understanding of the selected engineering mechanics subjects. Engineering mechanics subjects are better understood if the student has an intermediate knowledge of topics such as calculus, science, mathematics, and physics.

• Academic performance: A student’s prior academic performance is often a factor that is overlooked in a student’s current academic achievements. A good or bad performance often affects a student positively or negatively particularly during test or quizzes.

• Exposure to modern educational technologies: This represents the experience that students already have in using modern technological learning aids such as computer and learning packages that students use in their learning. The use of computer packages is more easily understood if students already have some elementary computing skills.

• Learning style: Student learning styles are probably one of the most researched factors affecting
student cognition and learning rate. Many studies have been performed on student learning styles with many different categorizations made available.

Learning styles are most often targeted in elementary education. A number of researchers have tried to categorize learning styles in different manners. Some of these are discussed in the next subsequent sections.

**HISTORY OF LEARNING STYLES**

There have been several learning style questionnaires (instruments) and models developed to categorize the way learners take in and process information. Some most quoted and popular ones found in the literatures include, the Myers-Briggs type indicator (MBTI), Kolb’s learning style model, Herman brain dominance instrument (HBDI), McCarthy’s 4MAT model, Dunn and Dunn learning style model of instruction, Felder-Silverman learning style model, and Honey and Mumford learning styles evaluation. In general research conducted with engineering students using any of these learning styles mentioned is reported to provide a positive involvement.

The issue of how to help people to learn effectively has been an active research area over the last decade (Mumford, 1982). Most individuals have different learning styles, which indicate preference for particular learning experiences. Witkin’s (1976) work on field dependent and field independent cognitive styles concentrates on the differences in the way individual structures and analyses information. Pask and Scott (1972) identify holist and serialist strategies in problem solving. Pask argues that the holist and serialist strategies are the manifestations of the underlying differences in the way people approach learning and problem solving. Miller and Parlett (1974) describe cue-consciousness and identify two distinct groups of students. The first group is respective to, and actively seeks out, clues and hints from their tutors regarding forthcoming examinations, these they termed as clue-seeking; whereas the second, who have less sophisticated strategies and do not pick up on available hints, are termed clue-deaf.

Dunn (1979) points out a person’s learning orientation is perhaps the most important determinant of educational attainment. Logically, the greater its congruence with the teaching method used, the greater the chance of success (Allinson & Hayes, 1990). Consequently, some instruments are available which seek to measure learning styles. In past years, a number of researchers have examined the concept of learning styles (Delahaye & Thompson, 1991). Marton and Saljo (1976a) believe that students’ approaches to learning tasks could be categorized into two broad areas that they labeled as “deep approaches” or “surface approaches.” Deep approaches involved an active search for meaning underlying principles, structures that linked together different concepts or ideas and widely applicable techniques. Surface approaches, on the other hand, rely primarily on attempts to memorize course work, treating the material as if different facts and topics were unrelated.

Further studies by Marton and Saljo (1976b), and Svensson (1977), demonstrate that most students were somewhat versatile in their choice of learning approach. The students’ choice depended on such factors as their interest in the topic, the nature of their academic motivations, the pressure of other demands on their time and energy, the total amount of content in the course, the way in which a task is introduced, and their perceptions of what will be demanded of them in subsequent evaluations or applications of the material (Kinshuk, 1996). Recent work in the field is more expansive (in those issues are assessment, instruction, personality, and evaluation) as they relate to learning styles and strategies are comprehensively addressed (Ginter, Brown, Scalise, & Ripley, 1989; Green, Snell, & Parimanath, 1990; Weinstein, Goetz, & Alexander, 1988). However, the Kolb (1976) learning style model has motivated most researchers and is used widely to measure student-learning style.

**Kolb’s Learning Style Model**

Kolb developed the learning style inventory (LSI) in 1976 and revised in 1985 (Tendy & Geiser, 1998). The LSI was a nine-item self-report questionnaire in which four words describing one’s style by which respondents attempt to categorize their learning style. One word in each item was used to correspond to one of four learning modes as shown in Figure 1. The four stage cycle of the learning modes in the figure are identified as Type-1: concrete experience (CE), Type-2: reflective observation (RO), Type-3: abstract conceptualization (AC), and Type-4: active experimentation (AE).
According to Figure 1, the concrete experience mode describes people who feel more than they think. Individuals in this mode tend to be very good at relating to others and tend to be spontaneous decision makers. Their characteristic question is “Why.” To be effective with Type-1 students, the instructor should function as a motivator.

The reflective observation mode describes people who would rather watch and observe others than to be an active participant. Individuals in this mode tend to appreciate exposure to differing points of view. Their characteristic question is “What.” To be effective with Type-2 students, the instructor should function as an expert.

The abstract conceptualization mode describes people who think more than they feel. Such people tend to have a scientific approach to problem solving as opposed to a more artistic approach. Their characteristic question is “How.” To be effective with Type-3 students, the instructor should function as a coach, providing guided practice and feedback in the methods being taught.

Lastly, the active experimentation mode describes individuals who take an active role in influencing others as well as situations. These individuals welcome practical applications rather than reflective understanding as well as actively participating rather than observing. Their characteristic question is “What If.” To be effective with Type-4 students, the instructor should pose open-ended questions and then get out of the way, maximizing opportunities for the students to discover things for themselves.

Most studies of engineering fields on the Kolb model find that the majority of the subjects are Type-2 and Type-3. For example, Bernold, Bingham, McDonald, and Attia (2000) found that of the 350 students in their study, 55% were Type-3, 22% were Type-2, 13% were Type-4, and 10% were Type-1. Sharp (2001) reported that 64 out of 1,013 engineering students that were tested, 40% were Type-3, 39% were Type-2, 13% were Type-4, and 8% were Type 1. Spurlin et al. (2003) reported on an ongoing study comparing freshman-engineering students using the four Kolb model. Their preliminary results showed that Type-2 and Type-3 students did better, and they are conducting further studies intended to pinpoint reasons for the relatively poor performance and high risk of attrition of the Type-1 and Type-4 students.

However, critics of the application of Kolb’s LSI suggest that its application for education research purposes was premature in the sense that the instrument’s psychometric properties had not been sufficiently assessed.

As such, Honey and Mumford (1992) proposed learning styles questionnaire (LSQ) as an alternative to Kolb’s LSI. Although LSQ has been criticized by some researchers for failing to construct validity and has correlations among its four learning styles (Goldstein...
& Bokoras, 1992; Tepper, Tetrault, Braun, & Romero, 1993), this has been the most favored learning style instrument in the literature for evaluation of CAL modules (Allinson & Hayes, 1990; Furnham, 1992; Hayes & Allinson, 1988). Generally, the LSQ has also been used for students in engineering courses.

**Honey and Mumford’s Learning Styles Questionnaire**

The Kolb model is the theoretical background to Honey and Mumford’s (1986) learning style questionnaire, which has four styles, that is, theorists, activist, reflector, and pragmatist. The questionnaire directly assesses the four basic types of style in Kolb’s model as shown in Figure 2. This analysis has been used widely through business and education and most recently as a basis for selecting undergraduate engineering courses (Halstead & Martin, 2002).

According to the theory, the hypothesized learning cycle can be entered at any stage but must be followed in sequence. A person could start, for example, at Type-2 by acquiring some information and analyze it before reaching some conclusions (Type-3), and deciding how to apply it (Type-4).

The LSQ is designed to assess the relative strengths of four different learning styles: activist, reflector, theorist, and pragmatist. These four styles correspond approximately to those suggested by Kolb’s (1976) LSI.

Each style is associated with a stage on the continuous learning cycle. People with activists preferences, are well equipped for experiencing. People with the reflector approach, with their preferences for deliberating over data, are well equipped for reviewing. People with theorist preferences, with their need to tidy up and have “answers,” are well equipped for conducting. Finally, people with pragmatist preferences, with their liking for things practical, are well equipped for planning (Honey & Mumford, 1986). Whilst Honey and Mumford (1986) found Kolb’s four-stage learning cycle acceptable, they were less satisfied with the LSI, questioning the use of one-word descriptors as a basis for attributing style, and expressing concern over the face validity of the styles themselves. The LSQ is a self-administered inventory consisting of 80 items, with which respondents are asked to tick, indicating agree, or cross, indicating disagree, respectively. The 80 items comprise four subsets of 20 randomly ordered items, each subset measuring a particular learning style. The vast majority of these items are behavioral and the aim is to discover general behavioral trends. The LSQ is scored by awarding one point for each ticked item and no item carries more weight than another. The items describe an action that someone might or might not take. Occasionally, an item probes a preference or belief rather than a clear behavior.

Figure 2. The experiential learning model (after Kolb, 1984, p. 21) with the linked Honey and Mumford (1986) learning styles in bold
Felder-Silverman Learning Style Model

The Felder-Silverman learning style model classifies students along four dimensions: sensing/intuitive, visual/verbal, active/reflective, and sequential/global as shown in Table 1. According to these dimensions, a student’s learning style may be defined by the answers to four questions:

1. What type of information does the student preferentially perceive?
   - Sensing learners retain information obtained through their senses, while intuitive individuals are more likely to retain information obtained through their own memory.
2. What type of sensory information is most effectively perceived?
   - Visual learners prefer pictures, while verbal learners prefer the written and spoken word.
3. How does the student prefer to process information?
   - Active learners learn by experimenting, while reflective learners learn by thinking about a concept.
4. How does the student characteristically progress toward understanding?
   - Sequential learners learn in small incremental steps, while global learners need a strong understanding of the big picture (Felder, 1996). A study of over 800 students at the University of Western Ontario (UWO), London, Canada, found that engineering students have strong sensing, visual, active, and sequential preferences (Rosati, 1998).

Structure of Index of Learning Styles

The index of learning styles is a 44 question instrument developed in 1991 by Richard Felder and Barbara Solomon to assess preferences on the four dimensions of the Felder-Silverman model. The index of learning styles is a self-scoring instrument that assesses preferences on the sensing/intuition, visual/verbal, active/reflective, and sequential/global dimensions. The ILS is available at no cost to individuals who wish to assess their own preferences and instructors or students who wish to use it for classroom instruction on research.

Scoring and Interpreting the ILS Questionnaire

Scoring the questionnaire is quite straightforward. When an individual submits a completed ILS questionnaire online, a profile is instantly returned with scores on all four dimensions, brief explanation of their meaning, and links to references that provide more detail about how the scores should and should not be interpreted.

Each learning style dimension has associated with it 11 forced-choice questionnaires, with each option (a or b) corresponding to one or the other category of the dimension (e.g., visual or verbal). For statistical analyses, it is convenient to use a scoring method that counts “a” responses, so that a score on a dimension would be an integer ranging from 0 to 11. Using the visual-verbal as an example, 0 or 1 “a” responses would represent a strong preference for verbal learning, 2 or 3 a moderate preference for verbal, 4 or 5 a mild preference for verbal, 6 or 7 a mild preference for visual learning, 8 or 9 a moderate preference for visual, and 10 or 11 a strong preference for visual. This

Table 1. The four dimensions of Felder and Silverman’s learning styles

<table>
<thead>
<tr>
<th>Sensory/Intuitive</th>
<th>Sensors prefer facts, data, experimentation, sights and sounds, and physical sensations and are careful and patient with detail, but may be slow. Intuitions prefer concepts, principles and theories, memories, thoughts, and insights and may be quick but careless.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual/Verbal</td>
<td>Visual learners prefer pictures, diagrams, charts, movies, demonstrations, and exhibitions. Verbal learners prefer words, discussions, explanations, discussions, written and spoken explanations, formulas, and equations.</td>
</tr>
<tr>
<td>Active/Reflective</td>
<td>Active learners learn by doing and participating through engagement in physical activity or discussion. Reflective learners learn by thinking or pondering through introspection.</td>
</tr>
<tr>
<td>Sequential/Global</td>
<td>Sequential learners take things logically step-by-step and will be partially effective with understanding. Global learners must see the whole picture for any of it to make sense and are completely ineffective until they suddenly understand the entire subject.</td>
</tr>
</tbody>
</table>
method was used in the statistical analyses reported in this thesis. The method used to score the online version of the instrument subtracts the “b” responses from the “a” responses to obtain a score that is an odd number between – 11 to + 11.

Studies Utilizing the ILS

A number of studies have collected the response data for the index of learning styles. Some investigators simply measured and reported response profiles and drew conclusions from them regarding appropriate teaching methods for their classes, and others used the profiles to examine various aspects of student performance and attitudes. A summary of learning styles profiles reported in various studies can be found in Felder and Spurlin’s “Applications, reliability and validity of the index of learning styles” (2005).

CONCLUSION

In conclusion, this article discussed some pedagogical characteristics affecting student learning and reviewed some extensively used learning style measurement instruments and their efficacy in the evaluation of computer-based learning/instruction. The vast majority of research conducted with engineering students using any of the learning styles questionnaires and models mentioned in this article is reported to provide a positive intervention whereas students require greater flexibility in assessing a variety of learning preferences.

REFERENCES


Pedagogical Characteristics Affecting Student Learning


KEY TERMS

**Cognitive:** The mental processes of perception, memory, judgment, and reasoning.

**Learning Styles:** A composite of the cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. Included in this definition are perceptual modalities, information processing styles, and personality patterns.

**Multimedia:** Is media that uses multiple forms of information content and information processing (e.g., text, audio, graphics, animation, and interactivity) to inform or entertain the (user) audience.

**Pedagogy:** Literally means the art and science of educating children that embodies instructor-focused education.
Piaget’s Developmental Stages

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Robert Morris University, USA

INTRODUCTION

Jean Piaget (1896-1980) was a Swiss psychologist whose cognitive-developmental theory left a lasting impression on how child development is viewed. He felt that children are not simply empty vessels into which adults pour knowledge (Piaget, 1952). Piaget based much of his theory on his masterful observations of children, and demonstrated many experiments that study how children adapt and react to their world (Vidal, 2000).

One of the main points of his theory was that of adaptation (Piaget, 1971). The child’s mind adapts from infancy to childhood to adulthood to achieve a better fit with external reality. Piaget sensed that children construct knowledge actively as they manipulate and interact with their environments. Many of his thoughts and ideas were influenced by his background in biology. This document will provide insight into Piaget’s Stages of Development as well as look at technology that meets the needs of children at specific times during their life.

BACKGROUND

Piaget’s Terminology

The framework that exists in a person’s mind to organize and interpret information was termed “schema” by Piaget. Schema can be thought of as the mental file folders that we have in our minds for different topics.

“Adaptation” is equivalent to learning and happens in two ways: through assimilation and accommodation. For example, a baby girl knows how to take a pacifier and thrust it into her mouth. It is a schema that has been mastered. She will then try to assimilate this concept by taking the mother’s necklace and thrusting it into her mouth. Piaget called this “assimilation” because the child is assimilating a new object into an old schema.

When this same infant comes across another object, she might accommodate an old schema into a new object. If that child is handed a soccer ball, she may realize that it will not fit into her mouth and simply just drool on it as she puts it to her lips because it will not work the original way. Hence, she practiced what Piaget called “accommodation.”

THE DEVELOPMENTAL STAGES

Piaget determined that there is a sequence of four major stages of a child’s cognitive development. Each stage is age-related and involves distinct ways of thinking. He believed that adults could not force the training and teaching to accelerate a child through the developmental stages. Rather, children need to directly experience and initiate the transformation.

Sensorimotor Stage (Birth to Two Years of Age)

The first two years of a child’s life are considered to be the sensorimotor stage (McCormick & Pressley, 1997). The word “sensorimotor” alludes to the use of senses (e.g., hearing and seeing) and motor skills (e.g., reaching and touching) to gain understanding about one’s environment. Infants begin by reflecting and imitating what they experience.

If infants cannot see or touch an object, they tend to stop thinking about it. For example, if the mother puts a ball behind her back, the child believes that the ball is truly gone because the child cannot see it. The game of Peek-A-Boo helps the child to understand “object permanence” which is the idea that although the object or person is no longer seen by the child it still exists. The company Brainy Baby has a DVD on the market called Peek-A-Boo™ that incorporates music, rhymes, and visuals to teach important skills. Such tools for learning help to teach skills such as object permanence, communication skills, and cause-and-effect.
Preoperational Stage (Two to Seven Years of Age)

Children in the preoperational stage begin to use symbols such as language to represent objects. For example, the child understands the word “bird” although a real bird is not seen. During this stage, the child learns from concrete evidence whereas adults can learn in an abstract way. Children tend to be highly egocentric in their viewpoints and perspective during this stage. Children work on intuitive instead of logical thought and reasoning.

Drawings at this stage are often colorful and inventive scribbled designs without the need for a realistic portrayal of the subject matter. The symbolism is strong but very simple. Words and images begin to represent the world around them at this stage.

At this point in development, children lack understanding of conservation, which is the concept that a characteristic of an object stays the same even if it changes in appearance. For instance, if a child is in the preoperational stage, it may not occur to the child that a puddle of water is from the ice cube that was left on a plate in the sun.

Creating interactive storybooks online that incorporate visuals and sound such as All About Me (on http://www.starfall.com) can help children to learn to read while filling in information about themselves. This can satisfy the requirements of learning language while also focusing on self-awareness.

Concrete Operational Stage (Seven to Eleven Years of Age)

During this developmental stage, children can engage in hands-on (concrete) activities in a logical order such as classifying and sequencing objects. Children can then take this task a step further by considering their interrelationships. At this stage children can manipulate numbers (Boudourides, 2003). Questions for which they have no personal frame of reference and abstract thoughts are too difficult at this stage.

In the concrete operational stage children comprehend the law of conservation. Piaget demonstrated this task when he presented children with two beakers that were identical and filled each to the same height with a liquid. He asked a child if both contained an equal amount, to which the child answered in the affirmative. Piaget took the liquid from the first beaker and poured it into a thinner and taller third beaker. When asked if there was still the same amount of water in the new beaker, the children under eight years old said that there was not the same amount and justified their answers by pointing out the width or height. The children who were older than eight years of age, who were in the concrete operational stage, explained their response by correctly stating that pouring it back into the original container shows that it is the same amount (Santrock, 2004).

Since a child at this stage can manipulate numbers, a variety of software packages can be utilized for children to learn and demonstrate their knowledge in this area. For example, at Education by Design (http://www.edbydesign.com/maths/), children can use Java and Flash created games to visually categorize numbers using Base Ten Count, and practice their number skills in addition, multiplication, subtraction and division using Automaths, or test their skills using Number Cruncher.

Formal Operations Stage (Eleven Years of Age and Beyond)

This is Piaget’s final stage in his theory of child development. It includes the early adolescent and follows them into their adult years. During this time, the person can solve abstract questions and problems in a logical and scientific manner. The person can recognize and identify a problem. The person can then brainstorm multiple solutions prior to solving it. Piaget called the concept of developing an educated guess about the best way to solve a problem “hypothetical-deductive reasoning.”

During the formal operations stage a person’s identity in relationship to social issues becomes a new focus (Tomei, 2005). People begin to determine qualities that they want to strive for in their lives. Formal operational thinkers can also plan ahead and set goals. Because individuals in the beginning of this stage have a need to establish their own identities, online blogs can give them a voice to express themselves.

Piaget acknowledged the importance of peer relationships in a child’s development (Piaget, 1932). Today’s technology offers a wealth of opportunities for this cognitive stage. Instant Messenger and chat rooms on the World Wide Web (De Lisi, 2002) can provide opportunities to engage in social relationships.
Piaget’s Developmental Stages

CONCLUSION

Piaget’s developmental stages give parents and teachers a framework of cognitive development. The theory outlines the flexibility and level of abstraction that a child can manage at the individual stages. Piaget’s theory can suggest guidelines for types of technology that would be appropriate to meet the needs and ability levels of children at various stages.

REFERENCES


KEY TERMS

Accommodation: The act of comprehending new experiences by integrating old schema into a new object.

Adaptation: Adaptation is learning that takes place through assimilation and accommodation.

Assimilation: Changes in existing ways of thinking that are in response to encounters with new stimuli or events by integrating a new object into an old schema.

Concrete Operational Stage (Seven to Ten Years of Age): A child in this stage is able to complete hands-on (concrete) activities in a logical order such as classifying and sequencing objects. The law of conservation is also comprehended at this point.

Formal Operations Stage (Eleven Years of Age and Beyond): A child in this stage is able to solve abstract questions and problems in a logical and scientific fashion. They also begin to think about an identity in relationship to social issues.

Piaget, Jean: The Swiss psychologist (1896-1980) who created the cognitive-developmental theory which has four main levels of child development: sensorimotor, preoperational, concrete operational, and formal operational.

Preoperational Stage (Two to Seven Years of Age): A child in this stage is egocentric and is beginning to learn the concepts of language. The child is able to think through operations in a single direction.

Schema: The framework that exists in a person’s mind to organize and interpret information.

Sensorimotor Stage (Birth to Two Years of Age): A child in this stage is an infant who is just beginning to utilize object permanence, wherein the child knows that an object does not stop existing because it is not seen. The child tends to think through doing and this is often in the form of imitation.
Plagiarism and the Classroom: The Faculty Role in Awareness and Education

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INTRODUCTION

Recent news reports ranging from national network broadcasts to traditional academic research journals have reported on the growth and ease of cheating in America’s classrooms. While teachers at all levels should become more knowledgeable on how to recognize plagiarized work, higher education can take a lead and educate future teachers, current teachers, and college faculty on plagiarism detection and prevention. In fact, some scholars challenge faculty to better understand plagiarism and how and when it occurs and further, to pass on that understanding to students through better constructed assignments which discourage plagiarism (Jeffes & Janosik, 2002; Kennedy, 2004).

The following provides an overview of plagiarism in today’s classrooms and discusses the important roles awareness and education must play in plagiarism detection and prevention. Advice for educators is included along with recommendations for plagiarism detection resources based on actual testing by graduate students and use of those resources.

BACKGROUND

The Center for Academic Integrity (CAI), in a 1999 study across 21 college campuses, found that about one-third of the students surveyed had cheated on tests and half had cheated on written assignments (The Center for Academic Integrity, n.d.). In a later study (2005) by CAI, with 60 campuses involved, 70% admitted to cheating. Plagiarism is not a new problem, however, and with the proliferation of the Internet and its vast array of services from online paper mills to multiple database access, a student can, with a few keystrokes, plagiarize an entire paper or portions of one. And, in today’s online world, plagiarism may occur because students misunderstand what is public domain on the Internet and what is not. Further, students may not understand how to properly paraphrase or cite information in their individual work (Bates & Fain, 2003). To that end, educators must have a full understanding of plagiarism, its detection, and its prevention.

INCREASING AWARENESS AND EDUCATION

Understanding Student Abuse

From dictionaries to university honor code statements, included are common definitions of plagiarism are phrases such as to copy ideas or words of another, and, present as new a work of another (e.g., Dictionary.com, n.d.). While most universities include honor codes or statements regarding plagiarism policies, we must spend time on educating students on what plagiarism is and how it can be prevented. Further, while universities publish an honor code it may not always be enforced; therefore detected plagiarism goes unpunished, contributing to the cycle of student abuse. Other contributors to plagiarism should also be examined, such as students’ lack of knowledge of what plagiarism means, student laziness, sloppy note taking, boredom with a subject, students’ lack of necessary skills to complete an assignment, and difficulty managing time (Muha, 2000; Moeck, 2002; Harris, 2000, as cited in Jeffes & Janosik, 2002).

In many cases, students may, through unintentional plagiarism, not cite sources properly or may paraphrase incorrectly, thinking that simply changing a few words or phrases is okay. The Center for Academic Integrity, in its 2005 report, noted that most students believed that using a “direct sentence or two,” without citations, was okay. The adage, “if it is on the Internet, it must be free,” must be overcome through proper education. For students who intentionally plagiarize, as noted ear-
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lier, multiple conditions may lead the student to make a decision to intentionally plagiarize. For instance, the student may be overburdened with assignments or may plagiarize out of mere laziness (Bate & Fain, 2003). The Internet and its available resources (such as the infamous paper mills) can become a quick copy and paste outlet for students. How an assignment is structured may help avoid plagiarism. Consistent feedback from the instructor can encourage improvement throughout the writing process (Moeck, 2002) and deter the need to plagiarize, as can the requirement of writing process documentation from initial note taking through the final draft.

Some Tips for Educators

First and foremost, educators must be aware of how students can cheat (and, then, let the students know we are aware!). And, we must be willing to emphasize academic integrity in every class, throughout the year. Baron and Crooks (2005) encourage faculty to “clearly indicate their position on academic dishonesty via verbal discussion and in writing” (p. 42). To further help prevent plagiarism, assignments may need adjusting as noted earlier. McLafferty and Foust (2004) comment, “When students are instructed appropriately and given certain types of assignments, plagiarism is minimized or rendered virtually impossible” (p. 186).

Further, in today’s technological world, we must be familiar with the paper mills and how multiple, even customized topical papers, can be obtained. We must also realize that such “resources” are not going away; therefore, we must educate ourselves on prevention techniques and be fully aware of the “potential” in these resources. Simply doing an Internet search for “paper mills” and researching those available online is a start. There are also some great educational resources online that have links to paper mills, along with other links to tips on correctly citing sources, understanding copyright and fair use, how to paraphrase properly, and other useful educational resources for students and faculty. For example, visit the University of Alberta, Canada library (http://www.library.ualberta.ca/guides/plagiarism/index.cfm) or The Center for Academic Integrity (http://www.academicintegrity.org/), both excellent online resources. Harris (2004) also provides excellent materials for strategies of awareness and strategies for detection.

While at one time students could be “caught” with minor mistakes, such as copying and pasting information where the font style changes and the Internet address is listed in the header, today, students are more sophisticated with technology and may not make such common mistakes. Therefore, instructors need to be more astute than ever. Some common advice includes: explain your institution’s plagiarism policy clearly in the course syllabus; discuss academic integrity with your students; explain and demonstrate proper citation principles; require outlines several weeks in advance and compare the final paper to the outline; give written quizzes in class or in a timed online environment; search for Web addresses on the printout in the header and/or footer; spot check references for verification; ask students to provide copies of cited material; let students know you are aware of paper mill sites; and finally, go one step further and start using a plagiarism detection resource.

Use Plagiarism Detection Resources

Many institutions are turning to plagiarism detection software or Internet based detection services to identify similar or copied text. In the implementation of one plagiarism detection resource (turnitin.com) at Hofstra University, Burke (2004) surveyed faculty who used the resource and found an overall satisfaction among users. Burke further reported that the incidence of online plagiarism at Hofstra decreased from 34% the first year to 12% at the end of the second year the resource was used. Using such a detection resource and either involving the students in the process of identifying similarity, or making students aware that a detection resource is being used can help deter plagiarism (Auer & Krupar, 2001; Bates & Fain, 2003; Burke, 2004; Hamlin & Ryan, 2003; Jeffes & Janosik, 2002; Scanlon & Neumann, 2002).

There are many plagiarism detection resources available and since they change and develop as dynamically as other Internet resources, it is in the educators’ best interest to investigate each to determine which resource may meet student and faculty needs. One of the ways to do this is to incorporate the investigation of plagiarism detection resources into an assignment. This author actually incorporated such an assignment into her educational technology class during two consecutive semesters with one semester having 9 graduate students enrolled and the other having 7 enrolled. Of these 16
Plagiarism and the Classroom

graduate students, most were also currently teaching and later expressed appreciation for the opportunity to learn of resources they, themselves, could use in the classroom. For this assignment, students were to identify and test (by submitting their own work from a previous abstract assignment) two plagiarism detection resources available online. Several plagiarism detection resources are presented here; however, it is recommended that pricing and availability be investigated to fit your institutional needs, as well as any new resources which may have emerged since this writing.

In presenting the following resources, the author chose to incorporate what her students found to be the most reliable and those that were available either as a trial or by what was deemed by the students as “affordable.” There were four plagiarism detection resources that were most and consistently mentioned in the students’ search and testing sequences: Turnitin.com, Glatt Plagiarism Self-Detection Service, MyDropBox.com, and EVE2. These four are presented with general information and with some student comments regarding their test of the resource.

**Turnitin.com**

One online plagiarism detection service is http://www.turnitin.com. With this service, individual instructor licenses to campus licenses are available. Assignments can be posted to individual classes and originality reports are often generated within a few hours. Submissions are cross-referenced with the service’s databases, library databases, and the Internet is also searched for possible matches. While many of the students indicated ease in using this resource, one graduate student did note, “When I first entered the site, I felt as if I was on a mystery hunt. I had to use the ‘help’ function to find out how to submit my paper.” The same student indicated, “I was very confused with all the colors.” Another student noted that the similarity report included citations that were properly cited, however, she was impressed with the service’s “reliability” and plans to “use the resource” in her class.

**Glatt Plagiarism Self-Detection Test**

This plagiarism self-detection test from Glatt Plagiarism Services (GPSD) is available at (http://www.plagiarism.com). One student described this program as one that “removed every fifth word from a paper and replaced it with a blank,” forcing the students to replace their original work. While one student felt this was a deterrent, another student met this challenge, submitted and replaced her work as instructed, and noted:

> Once I did this and resubmitted my work, a score (60%) quickly appeared based on a simple percentage matching the new submission with the original text. (A score of 50% or higher is thought to indicate that the piece is original.) Some of the difficulties I encountered were: a) being unaware of the need to include punctuation when filling in the blanks, and b) missing a match due to misspelling a word (no spell check available).

**Mydropbox.com**

This online service, available at www.mydropbox.com, offers fee-based services where users can submit a paper and have it checked against an extensive database of papers and Web sites. In comparing with another service, a student wrote, “I found it to be much more user-friendly. It was more graphic friendly.” Another wrote that in comparing to another service, the “turn-around time on receiving the report was longer.”

**EVE2 (Essay Verification Engine)**

Available at www.canexus.com/eve, EVE2 does require downloading of a program. While one student found this to be cumbersome, another found the EVE2 service to be “highlight happy,” highlighting general phrases such as “technology alone is not the answer.” However, one student found the flexibility of the search strength in EVE2 to be helpful, “You can set EVE2 to perform a quick, medium, or extra strength search. Extra strength takes longer but does a better job of detecting plagiarism.” Another student found the medium strength search to highlight random words which did not “constitute plagiarism.”

**Other Reflections**

While comparison of plagiarism detection resources was certainly an appropriate assignment for an educational technology class, the assignment also informed current teachers of ways to more readily detect plagiarism in their own classrooms. In reflecting about turnitin.com, a student wrote:
Overall, the site was informative and helpful. I would definitely use it again. My only wish is that I had known about it when grading my research papers on political parties last semester. I had so many children I suspected of cheating. Some of the plagiarisms were easy to prove, because they actually attached their sources; however, the others were not so easy.

Another student noted how helpful online tip sheets, such as those posted at Cheating 101, were to her:

I also went to the other websites for the assignment. The Cheating 101 checklist was fabulous. I had never thought about some of the ideas that were on this list. For example, pronouns not agreeing with the gender of the writer or references to graphs that are not there.

An English teacher in one class noted how she found many students are “too lazy to put the textual resources into their words” and believed using a plagiarism prevention service would assist her in holding the students “accountable.” Finally, a computer teacher recognized how he could use a similar activity in his classes in an effort to raise awareness of plagiarism detection, writing, “Seeing this procedure and getting results back would help set the importance in their minds of NOT plagiarizing.”

CONCLUSION

Encourage all faculty members to include a statement on plagiarism; what it is and how it will be dealt with at the institution. Every class should include training on what academic integrity means and furthermore, every class should strive to train students on proper citation and paraphrasing techniques. If possible, include an assignment that involves the students in plagiarism detection discovery.

Cheating is not a new problem and while we cannot offer an easy copy and paste solution to plagiarism, as educators, we do have new approaches on how to deal with this issue. We, as educators, should strive to be more astute in our delivery of instruction and in our method of detecting student plagiarism. Finally, when considering plagiarism detection resources through software use, educators should fully investigate options that meet institutional needs and they should be aware of potential problems in the software. Plagiarism will continue to exist, but, hopefully, new approaches through more effective awareness and education programs can offer creative ways to better detect and prevent plagiarism.

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**KEY TERMS**

**Academic Honor Code:** A set of rules and/or standards that exemplify an institution’s ethics and ideals. The code includes expectations that the rules/standards be followed; violating the code can result in suspension or expulsion from the institution.

**Academic Integrity:** The moral and ethical expectation that any person(s) at an institution uphold that institution’s rules, ideals, and standards, including but not limited to upholding integrity through honesty, behavior, and work.

**Copyright:** Protection for original works of authorship including literary, dramatic, musical, and artistic works.

**Fair Use:** Allows limited use of copyrighted works without the permission of the owner for certain teaching and research purposes. Criteria, including consideration of purpose, amount used, and intent of use, must be met in order to meet fair use.

**Plagiarism:** The act of copying words, ideas, and works of another and claiming such as one’s own work; a form of cheating.

**Plagiarism Detection Software:** Software which may be off-the-shelf, an Internet download, or Web delivered, which assists in detecting similarity in text, repeated words and phrases, and copied works.
IntrodUction

“The Voice of the People,” “Democratization of the Media,” and “Radio on Demand,” are some of the titles podcasting has earned since emerging on the public technology scene in 2004. The original podcast movement started with Adam Curry, a former host on cable television’s MYV, and much of the movement was focused on music. Podcasts enabled people to be “instant disc jockeys” and create their own radio shows, albeit Web-based, RSSfeed, and mobile.

As one podcaster, Rob Walch of Podcast411, who has been in this field since early on, describes it, “What was just a handful of audiobloggers on Labor Day of 2004 turned into a group of a few hundred podcasters by New Year’s eve 2004” (personal communication, June 7, 2006). Now we know that over 5 million people have downloaded a podcast listening program (podcatcher) as of Spring 2006.

Furthermore, just as far as the usage of the word “podcast,” Walch shares, “In the beginning a Google search for the term podcast would have given you less than 30 results... By May 2005, a search in Google for podcast yielded over 10 million results” (personal communication, June 7, 2006).

What increased in podcasting content during this time was first “talk show” programming. Much of that content was casual and “adult-oriented,” some of it worked toward being professional incorporating elements of radio broadcasting such as background music and formally structured segments. Emergent streams of podcasting are what the podcasting field terms “microniched,” which includes educational, specific business markets, and inspirational content.

“Democratization of the Media” is the theme that basically refers to the fact that “big corporations” do not own the “air waves” (sic) of podcasting. In podcasting, a $10 microphone, free or inexpensive software, and Internet space can make anybody a DJ or talk show host. There is no FCC control of podcasting, at least as of this writing in 2007, and the chosen topic, as much bandwidth as is affordable to pay the Internet host for (limited if for free accounts), and time are the only constraints. After all, because the services of a broadcast station or sponsors are not needed, podcasters do not require the assurance of listeners. However, in reality, most podcasters would seem to want to have listeners; that is why they are sharing their views through this media.

A primary document of this perspective can be seen in the self-described mission of Odeo.com, a podcasting directory and feedreader (Odeo, 2006). Notice the grassroots development and success of the principles in the company. The missionary commitment and zeal to the values of democratization of the media, founding values of the podcasting movement, are evident in the following excerpt:

Odeo is a small company based in South Park, San Francisco, California.

We were founded in December, 2004 by Noah Glass and Evan Williams. Noah had been helping individuals publish audio to the Web for over 2 years with his company, ListenLab, which provided a service called AudBlog (now part of Odeo). Evan was most recently with Google, where he ran their personal publishing service, Blogger, which he cofounded in 1999 and sold to Google in early 2003....

As a company, we believe strongly in the democratization of media. We think that giving more people powerful tools for the creation and distribution of media will result in more knowledge, ideas, art, truth, and amusement available to all. This, we see, is one of the most important roles (if not the most important) that the Internet is playing in society today.

And we think that the potential for new forms of audio content is particularly exciting, as it is one of the most ubiquitous mediums possible, yet also one that has lacked options for so long. See http://www.odeo.com/about.
Today, a tour of some of the major podcast directories of current content reveals the breadth and variability of both topics and broadcasting expertise. In December 2007, these directories include iTunes, Zune.net, Podcast Alley, Podcastpickle.com (http://www.podcastpickle.com/), and about 100 others. From politics to tech talk, dating to music, animal talk shows to psychics, and history to class projects, you can find the full spectrum of interests in all varieties of views, expertise, and polish in the world of podcasting.

BACKGROUND

What is a Podcast? The most complete answer is that a podcast is a series of audio files which are stored and available on the Internet, but also published via an RSSfeed which enable the most recent episode of the series to be “pushed” to subscribers. Or, as Geoghegan and Klass (2005, pp. 5-6) describe,

*a podcast is audio content available on the Internet that can be automatically delivered to your computer or MP3 player. Strip away all the upcoming potential confusion of feeds, aggregators, subscriptions, and so on, and what's left? Audio on the Web.*

*So what's the big deal? We've had "Internet radio" on the Web for over a decade....Why is podcasting different? To summarize quickly, podcasting is automatic, it's easy to control by the listener, it's portable, and it's always available.*

A dissection of these definitions reveal that the audio series is either a music/and or spoken word MP3 file that is from the same source, organization, podcaster, or as you may think of him or her, “broadcaster.” These files are digitally recorded to be compatible for most current Internet browsers and MP3 programs (such as iTunes, Windows Media Player, Real Player, Music-Match, etc.) and MP3 players such as iPods, Sandisk MP3 players, or any other brands.

Because these files will end up being shared and passed along to many people, they usually have descriptive text tags (ID3 tags) and/or metatags, and image files attached to them before they are uploaded in order for them to be identified at a later time. Once prepared, the files are uploaded to an Internet server.

An RSSfeed has to be created for a podcast. This file is usually named feed.xml and is written in XML scripting language. The feed can be written in XML code or by feed creating software, or podcasters can use all-in-one Web sites which automate the recording and publishing process. However in order for a podcast to be created, an RSSfeed has to be developed somewhere along the way.

The RSSfeed is rather like a specialized table of contents which starts off with specific identifying information about the associated podcast and then refers to each episode one section or “item” at a time. It is in the “item” section that all the details of the individual podcast resides: the creator’s name, an e-mail address, podcast title, episode title and number, date, description, and any other comments that may have been included, along with the all important “enclosure” information. The “enclosure” information has the audio file’s name, size, location, media type, and publication date and time. More detailed information on creating RSSfeeds by code or automatically can be found many places on the Web, but also in Herrington’s book (2005, p. 222ff).

The RSSfeed is the essential technology that puts the “power” in the audio file. Without this file one would just have a Web cast (an audio file posted on a specific Web site, accessible only by visiting that particular site and downloading or playing the file from there) but with the RSSfeed the podcaster has an audio file that people can sign up for (subscribe) and which is “delivered” to their “RSS readers” whenever it updates or they open the program. This dynamic format is called a “push” technology that sets RSSfeeds and podcasts apart significantly from files which are solely posted on a Web site.

Podcatchers (Herrington, 2005) are specialized “RSS readers” that will index and make it easy for users to search podcasts for topics of interest. At that time they can then electronically subscribe, in most cases at no charge, and the podcatcher will then “check” that podcasts’ RSSfeed frequently to see what the current listing of episodes and programming is. Any new episodes are immediately added to the index for the subscriber and downloaded, ready to be listened to at their convenience. There are no “hide and seek” games involved with the RSSfeeds and podcasts once the user subscribes because the feeds push the podcasts directly to the subscriber’s desktop. Going two steps further, if the user has a portable media device (such as an Ipod or other MP3 player) configured with the computer, the podcasts can be synchronized (synched) and downloaded automatically and made mobile.
Podcasts

Not only does the listener receive updates as soon as possible, but they are “time shifted!” That is, users decide when they want to listen to them—they shift the schedule. Hence the nickname “Radio on Demand.” In many ways, users can “cut the electronic cord” and take their podcasts away from the computer and make them mobile using the portable media player. In this way users can decide when to listen to their favorite podcast, anytime, anywhere.

Examples of programs that can be downloaded and used to index, search, and collect podcasts, podcatchers, include, but are not limited to iTunes (http://www.itunes.com), Doppler Radio (http://www.dopplerradio.net), and Odeo.com (http://www.odeo.com).

MAIN FOCUS OF THE ARTICLE

Copyrights

One of the major issues which has emerged in podcasting include copyright law. Specifically, music copyright has taken on new importance with the wave of music downloading that swept the globe beginning in 2004 and with podcasting (Geoghegan & Klass, 2005). Because people cannot legally reproduce or broadcast copyrighted music publicly without permission and/or royalties, in relationship to podcasting, “podsafermusic” has risen on the seen as a result of this controversy.

Podsafermusic is music which is available to be played on podcasts; that is, it can be downloaded, copied, and distributed along with the broadcast. The musicians who identify their work as podsafermusic have given permission for this form of distribution. In fact whole collaboratives and Web sites have been created to support podsafermusic. Examples of podsafermusic directories include Garageband (http://www.garageband.com/) and Podsafe Music Network (http://music.podshow.com/).

Creative Commons (www.creativecommons.org) ownerships, rights, and usage of materials are another popular way that podcasters have dealt with intellectual property. The Creative Commons framework provides a means for authors of audio, images, video, text, or educational materials to make and communicate their choices about property use and rights through a series of designations. For instance, an author may choose to place their content in the “public domain” and thereby provide free use to everyone with acknowledgement of authorship. Or an author might indicate a “standard Creative Commons license,” which provides for the author to keep their copyright but allows people to copy and distribute their work provided they give the author credit—and only on the conditions the author specifies in the license. The Creative Commons Web site makes the choices as easy as possible in what is the complex world of intellectual property, through tutorials and menus of choices to lead one to the selection that fits the author’s decisions.

This is all a collaborative process, developed to encourage sharing of content, and yet recognizes authorship and preserves authors’ choices. Creative Commons was created as an alternative to U.S. copyright law which would be more appropriate for Internet use and those independent content producers so active in its day to day development; however one should still examine the U.S. copyright laws (http://www.copyright.gov/circs/circ1.html#cr) for a comparison (Lafferty & Walch, 2006). Given the nature of podcasting as broadcasting the voice of the populace, as it were, Creative Commons is not a surprising phenomenon to see occurring in many podcasts and related endeavors.

Teaching and Learning

The outstanding characteristics of podcasting for teaching and learning are in the dimensions of the choices it provides in instructional methods, delivery, and scope. In terms of instructional methods it is a stark study in contrasts from K-12 to higher education. In K-12 education, podcasting has served primarily as a platform for collaborative student projects, creative development, and learner-centered curriculum. In higher education, we have seen a vast proliferation of a pattern of coursecasting (Gura, 2006; King, 2005), as the early stages of podcasting in colleges and universities has mirrored the early days of online learning where professors posted their lectures notes on the Web. Herein, also, we hear the shuffle of feet and hear the same lecture that is given at 8 a.m. now recorded and posted to the Web perhaps at 10 a.m. that same day or a week later, however it remains, unchanged, unedited, with no value added. Indicators of innovation are evident demonstrating that podcasting can be used to transform teaching and learning into new dimensions and forms (King, 2005, 2006a; King & Gura, 2006). And as time has progressed and more educators are using podcasting, gaining feedback from learners and reflecting on their
work, this medium is experiencing new developments. In this way, podcasting is again demonstrating that distance learning and mobile learning have not reached points of completion.

Issues of content and purposes focus the examination of podcasting in educational settings to the principle of “delivery.” Flexibility and mobility for teaching and learning are key aspects of podcasting which will awaken great possibilities once educators understand the instructional implications of this new medium (King, 2006b). Audio and video podcasts on a small device that can be taken with teachers and students at different times and to different locations to consume and create and to interact with content and one another presents the potential to radically alter the way teaching and learning occur. Thinking about traditional education with the advantages of distance education is a paradigm shift, the next phase of change currently underway is the result of the shrinking of time and space created by the immediacy of content and the flexibility provided by handheld devices (King & Gura, 2007). It may well be that younger students and teachers are the ones who will lead the way in developing understandings of these possibilities. More experienced teachers and learners, conditioned to acquire knowledge and interact with content in more traditional ways, may be at a disadvantage if they do not acquire expertise with emerging media technologies. Teachers in both K-12 and higher education settings are being transformed from educators to content providers and the location and creation of knowledge has become more egalitarian, moving from libraries and print media to video and audio formats.

Finally, for those who create their first podcasts and then hear back from someone on the other side of the earth, the impressive global aspects of podcasting cannot be adequately described. In our case, at our professional development center we started podcasting in the summer of 2005 and, because we had designed our podcast feeds in such a way that we could track the statistics, we knew that by January of 2007 we had reached over 2 million listeners (King & Gura, 2007). When an educational podcaster records a 30-minute recording and then sends it out over a digital feed, the fact that hundreds of people are “catching” it, archiving it, and then listening to it within days is a scale that distance learning has not achieved previously.

Working with this technology raises questions as to how this form of distribution can be used for accountable learning. However, at the Fordham RETC in Bronx, NY, we have used it precisely for professional development and in coordination with the development of a selection host of companion resources. Additionally, we are developing innovative hybrid and mobile distance learning methods and formats, our Community podcasts, and our PFT Virtual Seminars, which are examples of some of these formats (King & Gura, 2006; King & Gura, 2007; http://www.retc.fordham.edu; http://www.podcastforteachers.org/; http://www.podcastforteachers.org/pftseminars.html).

**FUTURE TRENDS**

What is the precise, final impact on teaching and learning from podcasting? Years from now we will be in the midst of another wave of innovation, but podcasting is providing new dimensions for instructional methods, flexibility, mobility, and scope of reach in teaching and learning. It is at one the principles we are continuing to learn, those of innovation, stretching our minds with yet a new technology, and capturing it for teaching and learning, that this technology is offering to teaching and learning.

The future of podcasting will no doubt include a greater role of video (videopodcasting, vodcasting, vlogging) even as we are seeing emerging now. However, the combination of podcasting with other technologies and instructional methods will likely be a powerful trend. Hybrids and blended instruction will continue to provide the flexibility and personalization of learning that 21st Century learners expect in order to accommodate learning into their complex and harried 21st Century lives.

A significant future impact of podcasting is in the construction of knowledge. The trend of emerging communication technologies, especially the Internet, has had significant implications for notions of expertise and knowledge. The egalitarian nature of the Internet and Web-based content like podcasts is resulting in a destabilization of traditional knowledge providers. Currently, the news media are experiencing this kind of destabilization, facing competition from Web sites, bloggers, and podcasters. In a similar way, educators are being confronted by a generation of students who are increasingly digitally literate, connected to each other in ways that are wholly supported and possible through the use of some kind of technology. This new
Podcasts

generation has an evolving and complex understanding of knowledge and authority as well as issues of source quality and integrity of information.

In the past, educative efforts have focused on the ability to access and retain information. The current and evolving environment is rich in information, requiring the current generation to develop skills in critiquing and evaluating information rather than accessing it.

The word podcast entered the English dictionary in the year 2005. Since that time “diffusion of innovation” has certainly been in play. Just searching out the data is a study in itself because one has to consider motives and sources. For this reason, we present some slices of data from spring and summer of 2006 for your review, and to consider what is happening with this technology development. Notwithstanding the exact numeric decision, the trend is clear: since early 2005, podcasting has risen as an independent voice in the media, powered by the Internet and carried forward no doubt by the popularity iPods, music downloading, and file sharing. Take a look at the trends and then see what is happening at the point in time when you read this article. The sands of time will not stand still; this is a dimension of distance learning that illustrates dynamic relationships. In 2005-2007, we have lived through a revolution of democratization of the media, and as it spreads beyond the young and the more well-heeled, the future is difficult to predict.

Overview 2004 to Spring 2006

In late 2004, less than 75,000 people had downloaded a podcatching program. However, today over 5 million people have downloaded a podcatching program that would enable them to find and subscribe to a podcast (Lafferty & Walch, 2006). Dateline 6/2006, Data Points:

- **Listeners: Podtrac** (www.podtrac.com): A podcasting marketing firm and service provider, announced on May 31, 2005, that podcast awareness has grown rapidly from late 2005 to the beginning of 2006, that is from 32% to 41%. The study is based on a worldwide database that is the largest on podcasting and has over 55,000 detailed demographic profiles, representing more than 22 million U.S. podcast listeners and viewers (Podcastingnews.com, 2006b).
- **Awareness:** Furthermore, according to this podcasting-related study, podcasting continues to grow as 41% of U.S. online adults were aware of term “podcasting” at the end of 2006 vs. 32% the end 2005 (Podcastingnews.com, 2006b). However, if one looks at data from the radio broadcasting industry (Arbitron) in April 2006, 27 million Americans are listening to podcasts and “22% of Americans have heard of podcasting, … 11% have tried podcasts” (Podcastingnews.com, 2006a).
- **Habits:** The previous study (Podtrac) indicates that 56% of podcast listeners and viewers (videopods) use their computers, 46% a portable devices. Additionally, rather than just listening or viewing portions of episodes, these findings indicate that 88% listen to or watch entire podcast episodes (Podcastingnews.com, 2006b).
- **Predictions:** The widely quoted and oft-misquoted, “Forrester Report” projected that 700,000 households in the U.S. in 2006 would use podcasts, and that by 2010 12.3 million households in the U.S. would be listening to them (Forrester Report, 2005).

Summary

In 2004 there was less than a 1,000 podcasters compared to today where there are over 54,000 podcast feeds on Feedburner.com. In late 2004, there were less than 75,000 people who had downloaded a podcatching client (iPodderX, Juice and Doppler were the most popular in late 2004). But today there are well over 5 million people who have used a podcatching client (iTunes mostly) to subscribe to a podcast listeners.

CONCLUSION

But much more than the statistics, podcasting represents another example that distance learning is not completely defined. As technologies and user interfaces change (in this case, sound editing software: RSS feeds and XML scripting language, for instance) distance learning can evolve in new directions. A persistent critique of distance education is its lack of personal contact and connection, described as integral parts of an educational experience. Yet younger learners have broad experiences initiating, developing, and sustain-
ing relationships through technology in the areas of personal Web sites, newsgroups, discussion boards, listservs, and gaming. These developments are leading to a reconsideration of the definition of personal relationships. Younger people are more comfortable operating in a virtual world and the distinction between worlds—virtual and personal—is blurring. Educators and educational institutions will have to adapt to the emerging nature of personal, business, and educational interactions. In the future, a “place” called school, may no longer be a place at all; instead, lifelong learning may find more of its potential through new definitions, paradigms, and innovations.

REFERENCES


KEY TERMS

**Enclosure**: A section of information used in an XML file to refer to a media file’s name, size, location and media type.

**Feed**: The URL address which “pushes” the most recent digital publication of a podcast or other enclosure on an XML script. For instance The Teachers' Podcast feed is http://www.teacherspodcast.org/feed.xml. (This is the second generation of the Podcast for Teachers series).

**Podcasts**: Combination of the words iPod and broadcast to represent the technology of distributing an audio file over the Internet via an RSSfeed.

**Podcatcher**: A specialized RSS reader which indexes, allows searching, polls, and collects podcasts. Examples include iTunes (http://www.itunes.com), Doppler Radio (http://www.dopplerradio.net), and Odeo.com (http://www.odeo.com).
**Podcasts**

Podsafe Music: Music which is available to be played on podcasts; that is, it can be downloaded, copied and distributed along with the broadcast. Often found in podsafe music directories such as Podsafe Music Network, Music Directory at Podcasting news.com, and Garageband.

**Rssfeed:** RSS is a group of Web feed formats, specified in XML and used for syndication of Web-based information. This content can be broken down into individual items which can be syndicated and is used by (among other things) news Web sites, Weblogs and podcasting. Once information about each item is in RSS format, an RSS-aware program can check the feed for changes and react to the changes in an appropriate way by making them available to subscribers.

**Timeshifting:** To watch or listen to a video or audio program at a later time by having recorded it when it was broadcast.

**XML Scripting Language:** XML Script allows for the creation, storage and manipulation of variables and data during processing. XML is a markup language for documents containing both content (words, pictures, etc.) and some indication of what role that content plays (for example, whether it is in a section heading or a footnote, etc.). The XML specification defines a standard way to add markup structure to documents.
Promoting Cooperative Learning for Preservice Teachers Through Information Technology

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INTRODUCTION

Cooperative learning means students working together to accomplish shared learning goals and to maximize their own and their group members’ achievements (Johnson & Johnson, 1999), and stresses the importance of shared dialogue and inquiry (Littleton & Hakkinen, 1999). The concept of cooperative learning has been around for a long time. Sometimes cooperative and collaborative learning are used interchangeably, but Lehtinen, Hakkarainen, Lipponen, Rahikainen, and Muukkonen (2007) have suggested that cooperative work involves dividing work among the team members, whilst collaborative work means all the team members tackle the problems together in a coordinated effort. In a traditional setting, cooperative learning occurs when there is human interaction, but cooperative learning can transcend cooperation from someone that you know to virtually everyone in the world if they have a Web-connected computer. Does information technology foster or stifle cooperative learning?

BACKGROUND

David Johnson and Roger Johnson are probably the most consistent advocates of cooperative learning. They found that social skills and competencies tended to increase more within cooperative situations, as working together increases students’ abilities to provide leadership, build and maintain trust, communicate effectively, and manage conflicts constructively (Johnson & Johnson, 1989). Similarly, a study conducted by Slavin (1996) showed that when students were engaged in student interactions and activities when working in small teams and the activities frequently required high-order thinking and critical reflections. Johnson and Johnson (1999) further elaborated that those cooperative efforts promote positive relationships among group members. They had higher morale, were more likely to commit effort to achieve educational goals, and were more willing to endure pain and frustration for their learning, as well as to listen to and be influenced by classmates and educators. Johnson, Johnson, and Stancee (2000) conducted a meta-analysis of cooperative learning and confirmed that there are over 900 research studies supporting the use of cooperative learning over competitive and individualistic learning. However, the question remains: What specifically is the role of information technology in supporting cooperative learning?

Using information technology as a collaborative learning tool has stemmed from work by Scaramalia and Bereiter who developed computer supported intentional learning environment (CSILE) in the early 1990s. The purpose of the system was designed to support learning in a purposeful, intentionally and collaborative learning environment. With the rapid development of the Internet in the mid-1990s, information technology has presented a new arena for learning and teaching. Specifically, various communication channels such as e-mails, wiki, online chat, and discussion forums provide a simple and convenient arena for a single or multiple user(s) to discuss asynchronously or synchronously. The Internet exchanges are highly flexible and convenient when compared to other means of communication such as face-to-face or telephone communication. Furthermore, messages can be stored and retrieved easily at the discretion of users without requiring sophisticated software. Learners from different background and diverse locations can share their personal and team experience, and construct their ideas together in order to solve problems in the learning process.

The effectiveness of online collaborative learning has been confirmed by various studies. For instance, students were able to discuss in greater depth and their critical thinking skills were enhanced (Tan, Turgeon, & Jonassen, 2001) and learners’ levels of involvement and incentive to learn have also increased significantly.
with a wider and more complete understanding of the subject knowledge (Eleuterio & Bortolozzi, 2004). Lipponen (2003) has summarized how information technology can enhance learning (1) by removing the physical and temporal barriers of schooling by eliminating time and space constraints, (2) the delay of asynchronous communication allows time for participants to reflect, (3) it makes thinking visible by allowing students to represent their own and others’ ideas and share their expertise, (4) the shared discourse spaces and distributed interaction can offer multiple perspectives for students with varying knowledge and competencies, which can offer greater opportunities to share and solicit knowledge, and (5) the database can function as a collective memory for a learning community that allows the knowledge to be revised for future reference. Indeed, a number of researchers (Applefield, Huber, & Moadllem, 2000; Muukkonen, Hakkarainen, & Lakka, 2005; Scardamalia, 2002; Scardamalia & Bereiter, 1994; Stahl, 2004; Woodruff, Brett, MacDonald, & Nason, 1998) have proposed using the information-technology-supported learning environments to facilitate student-centred learning so that they are able to construct knowledge in authentic and collaborative settings.

PROBLEMS

There are a number of published successful cases of using the technology to support cooperative learning, although some of these are focused on K-12 school context (Barron, Vye, Zech, Bransford, Goldman, et al., 1995; Collins, Brown, & Newman, 1989; Scardamalia & Bereiter, 1996; Stahl, 2004; Turvey, 2006), some are related to business studies courses, especially in Information System discipline (Lee, Vogel, & Limayem, 2003; Martin, Hatzakis, & Lynch, 2004; Rutkowski, Vogel, Genuchten, Bemelms, & Favier, 2002; Vestal & Lopez, 2004), and some are for teachers as professional development (Parr & Ward, 2005; Treweren & Lai, 2001) but there is not much research in the specific area of student teachers education. The community of teachers (CoT) is one of the few communities for preservice teachers at Indiana University (Barab & Duffy, 2000). Indeed, a number of studies have indicated that preservice teacher education does not adequately prepare teachers to teach with technology (Pope, Hare, & Howard, 2002; Selinger, 2001), and it was suggested to integrate content, pedagogy, and technology (Hughes, 2005; Koehler, Mishra, & Yahya, 2005).

THE MAIN FOCUS OF THIS ARTICLE

“An irony is that, within teaching, much learning aimed at extending teachers’ pedagogical content knowledge has been taken outside the workplace rather than within the logical venue” (Parr & Ward, 2005). Koschmann (2000) suggested that teacher-educators have an obligation “to make explicit our theories of teaching and learning … that motivate our work and that are embedded in our designs.” In view of the current needs, this paper will discuss how to use information technology, in particular, the discussion forum of a learning platform, to support various cooperative activities for student teachers. At the same time, whether information technology can enhance learning proposed by Lipponen (2003) is also examined. There are three underlying rationales when designing such learning activities. Firstly, there is a need to infuse technology into our module design so that information technology provides a supportive environment for learning and teaching rather than just as an add-on tool. Secondly, the different cooperative practices can be easily implemented and sustained with few resources. Lastly, there is a need to relate assessments with different learning activities so that students are informed of their learning process and to improve learning.

The study was conducted at the Hong Kong Institute of Education, which is the largest teacher education institute in Hong Kong. Participants included both undergraduate and postgraduate students studying an information technology module concerned with how to use IT to support learning and teaching. There were about 70 students enrolled on the undergraduate course and about 10 studying on the postgraduate course. The respective modules have similar content, but the levels of expectation are slightly different, and the activities are modified in order to cater for the level of study and the number of participants enrolled. Due to the time constraints of a three-credit module, it would be impossible to put all the elements into one module. Both levels of students conducted student-led discussion, but the undergraduates had online debate and communication with student teachers of an Australian university.
Promoting Cooperative Learning for Preservice Teachers Through Information Technology

Figure 1. Using information technology to foster cooperation

whilst the postgraduates were using a self-designed assessment rubric for evaluating their peers.

**Online activities.** Apart from standard face-to-face learning and teaching activities, a number of online activities were organized so that student teachers could experience the advantages and disadvantages of using information technology to support cooperative learning. Examples have been drawn from these two groups for 2 years because there was not enough authentic quotations from the participant’s work since most of them typed in Chinese, even though they could type in either Chinese or English. Figure 1 depicts the range of activities that were in place for fostering multiple levels of collaboration, ranging from intragroup cooperation to global cooperation using information technology as the pivot.

**Intragroup cooperation.** Preservice teachers were required to form groups and took turns to present any critical issues relating to the module content that they had learnt in the previous weeks. Due to the class size, teams of a larger size, four to five people per team for undergraduate students and smaller team size, two to three people per team for postgraduate students, were formed. They formed groups with members of their own choice. Each group of learners cooperated to select a topic by providing background information and raising questions so that the class members could learn from each other. For example, undergraduate Group A presented the background information of their chosen topic “The impact of online learning.” They formulated some questions such as “1) What are the components of online learning? 2) Is it feasible to carry out online learning? 3) How do we monitor the quality of online learning?” and so forth. (see Figure 2). They used the convenience of the learning platform to note down discussion materials, questions, and leading questions in order to make it easier for other classmates to explore issues and ideas and be prepared to discuss during class time. Each group member led one group of student to discuss one to two questions and then summarized the discussion, including their own opinions on the discussion forum. Figure 3 shows that the facilitating group posted a summary during discussion, so that all other teams could be informed of other’s opinions. The facilitating team was also granted moderator rights to facilitate the follow-up online discussion.

Postgraduate students were also asked to do similar tasks as the undergraduate students, but they were to come up with assessment rubrics to assess student-led discussion based on Bloom’s Taxonomy (Bloom, 1956), which is a widely accepted framework of the educational process. Each group of learners was asked to delineate two levels of Bloom’s Taxonomy and come up with an assessment rubric. The six different levels
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**Figure 2. Using the discussion forum to prompt discussion before classes**

<table>
<thead>
<tr>
<th>Staff Information</th>
<th>Course Material</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion Board</td>
<td>Groups</td>
<td>External Links</td>
</tr>
<tr>
<td>Tools</td>
<td>Course Map</td>
<td>Control Panel</td>
</tr>
</tbody>
</table>

Topic: Impact of online learning

Discussion material:
1. Article (1 page).
2. Online video (5 mins).

Questions:
1. What is the component of online learning?
2. Is it feasible to carry online learning?
3. How to monitor the quality of online learning?
4. What are the advantages and disadvantages of online learning?
5. How to create a virtual learning community through online learning?
6. Can you suggest any future developments for online learning?

Lead Discussion Run-down:
1. 2 mins introduction.
2. 3 mins video watching.
3. 3 mins review article.
4. 5 mins discussion.
5. 2 mins conclusion.

**Figure 3. Using the discussion forum to post and share classroom discussion**

<table>
<thead>
<tr>
<th>Course Information</th>
<th>Staff Information</th>
<th>Course Material</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Groups</td>
<td>External Links</td>
<td>Tools</td>
</tr>
<tr>
<td>Course Map</td>
<td>Control Panel</td>
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</tbody>
</table>

4. Someone in charge(A)
   where to find the source, e.g., teacher provide information(A)
   do report after project(K)
   do assessment in the web(S)
   cannot only depend on the web, because the students may not concentrate on learning in the web(A)

5. Student participation(K)
   Cultural aspects(K)
   habit to visit the virtual learning community(A)
   interesting, attractive context with pictures, with some tips to attract students(S, J)
   e.g., each visit the forum before the school block the part(K)
   counter(S, incentive K)

6. School need to support IT(S)
   teaching training, especially for the senior teacher(A)
   Culture(K)
   hardware, more training course, for own interest(K)
   increase more information in the web(K)
   may be trouble to use the web, need to be user-friendly(C)
   cannot give up the original teaching method, e.g., blackboard, they think using computer for teaching is trouble for them(K)

are 1) knowledge, 2) comprehension, 3) application, 4) analysis, 5) synthesis, and 6) evaluation. All of them were very polite and did not have any objections to their classmates’ self-designed rubrics. To facilitate learning, each group of learners had to evaluate other group’s presentation on the background information and discussion facilitation. Table 1 shows that one group of postgraduate students evaluated another group that came up with a topic, for example, “the role of computers in teaching and learning.” Peer assessment is accepted as a meaningful process to foster learning effectiveness and to develop learners’ sense of ownership and control over their work (Boud, Cohen, & Sampson, 2001; Oldfield & MacAlpine, 1995; Orsmond, Merry, & Reiling, 2000).

**Intergroup cooperation.** To strike a balance between group and individual work, each group of learners not only commented on the other groups’ student-led discussion, but each individual also commented on the particular reflections of members of other groups. Dewey (1933) was frequently cited as an early advocate of practicing reflection in learning, and he suggested “While we cannot learn or be taught to think, we do have to learn how to think well, especially acquire the general habit of reflecting.” Reflection has been put into practice for initial and continuing education,
especially for professionals such as teachers, nurses, and social workers (Boud & Walker, 1998) over the past 10 years. They suggested “It is important to frame reflective activities within the learning context in which they are taking place” (p.193). Macdonald, Weller, and Mason (2002) further suggested that networking opens up possibilities for enhancing formative feedback to students through peer review. Therefore, students were asked to reflect on their understanding of the topic that they put forward for student-led discussion at the end of the semester.

To facilitate interaction, peer assessment circles that consisted of one member of each group were formed, as shown in Figure 4. The peers were able to present multiple perspectives on the assessed peer’s reflection, which they could revise before they finally submitted to the educator. Table 2 shows a student teacher’s assessment of other groups member’s reflection on the topic that was submitted at the end of the semester. It was encouraging to note that student teachers thought their peers had attained at least level 3 (application), and some activities attained level 6 (evaluation) on their assessment scheme.

**Interclass cooperation**. To foster critical thinking skills and cooperative skills, undergraduate student teachers were asked to have interclass online debate among the three classes. Two volunteers from each of the three classes were gathered to form two teams. They conducted a straw poll to decide if they joined the “for” or “against” team. The debating team had to come up with an ill-structured debate topic, which was “Teaching approaches are more important than information technology resources.” The debating team members had to cooperate to decide on the sequence and the content of the debate prior to the actual online debate. The debate was made possible by using either Flash Communicator or Windows Live Messenger, which is free software, as shown in Figure 5. During the online debate period, each team member was stationed in their own class. The rest of the class’ constructed knowledge together by watching the debate on screen, and were able to express their opinions by participating in the discussion forum (Figure 6).

There were a total of 74 messages, with most messages “for” the motion at hand. A few of respondents thought that information technology and pedagogy are

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**Table 1. Inter-group assessment based on self-developed rubrics**

<table>
<thead>
<tr>
<th>Assessed Group: 2</th>
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<td><strong>Topic</strong></td>
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of equal importance, and none of them were “against” the motion. Basically, students thought that it is the teacher who designs and selects IT resources, and IT is merely a tool. For example, one student “for” the motion said “If IT resources are more important, there is no need to study teaching methods.” Those who thought that IT and teaching approaches are of equal importance considered that they complement each other and are especially effective when immediate feedback is required.

Communication can be independent of time when using technology. As such, there was continuous discussion until December 12th, when the module ended, even though the debate was held on October 3rd. In agreement with Lipponen’s (2002) suggestion, more perspectives were generated in this way. There were a few interesting points stemming from the debated topics such as whether having questions and answers via live broadcast could be as effective as face-to-face; how to manage the class if there was no face-to-face communication; and whether the teacher as role model is only for subject knowledge, or includes attitudes towards life.

**Global cooperation.** In order for our student teachers to understand the power and flexibility of information technology, they were offered an authentic experience to cooperate with student teachers of an Australian university. Groups of our undergraduate student teachers were randomly matched with groups of Australian counterparts. Our student teachers were required to find online materials, and to summarize and post questions for group members to discuss in order to anchor knowledge. Figure 7 shows that our student teachers had put a summary of an article related to online courses and three questions for discussion. All the participants were positive about online courses due to its flexibility and convenience. However, there are some disadvantages such as “some students preferring person to person contact. Another disadvantage is being at home and being easily distracted by other things.”

**LEARNERS’ COMMENTS**

We observed that students enjoyed a variety of cooperative online activities. The enormous number of hits
Promoting Cooperative Learning for Preservice Teachers Through Information Technology

Figure 5. Synchronized debate

Figure 6. Asynchronous debate

and messages posted also provided concrete evidence of ample shared dialogue and inquiry. However, we were also interested in determining students’ thoughts and comments on different activities so that we might expose some uncovered ideas. Thirty-three undergraduate student teachers were asked to fill in an open-ended questionnaire, and nine postgraduate students were asked to participate in a focus group meeting regarding their opinions on cooperative learning.

**Comments from the questionnaire.** Twenty-five undergraduate participants returned the questionnaire, with a response rate of 75%. When they were asked about how they shared the group workload, 48% said that it depended on fairness, 36% said it depended on each individual’s strengths, whilst 16% included other reasons, such as some groups tackling most tasks together, and one response said that it would depend on how much time a particular team member has. When they were asked if it was important to share their workload equally, most of them (72%) believed so, 20% did not believe it was so important, and 8% showed no comment. Those who considered that it was not important to share their workload equally gave the reasons 1) outcome rather than the fairness was more important, 2) it depended on the expertise of individual; and 3) each member was willing to give a share of the effort.

When they were asked to comment freely on using cooperative learning strategies, 23 out of 25 made a comment, which is unusually high. The comments included 1) more ideas were generated and their horizons had been broadened; 2) they were able to learn
from each other, they could even learn about some knowledge that was not available in books; 3) there was discussion and feedback on their ideas during the group work, which helped them to rethink their ideas; 4) mutual support and reminding each other was important; and 5) there were better learning outcomes as they could consolidate different ideas from group members. One learner opined that he/she did not learn much, as each team was responsible for one part’s work and the group was formed only for putting team members’ work together.

Comments from the focus group meeting. Seven out of nine postgraduate students attended the focus group meeting. All of them agreed that cooperative learning was useful, even though it was the first time that they actually used information technology to support cooperative learning, as they mainly cooperated on group projects. They shared their responsibilities according to their strengths and they discussed the ideas together. When asked about using information technology to support learning, one participant said that “we had more time to think and to prepare responses before we posted anything on the discussion forum. Therefore, the information was more accurate than on face to face discussions.” One said that the discussion forum enabled them to tackle the discussions that were not finished during class time. Another stated that “the cooperative learning is more relaxing as we are more open in our communications. We could gain benefit from receiving feedback and more information from postings from classmates.” One said that he would like all postings on the discussion forum to be saved in a file so that he could refer to them later on.

CONCLUSION

This chapter discusses different cooperative learning activities that can take place easily with the support of information technology. Preservice teachers participated in a number of cooperative online activities, such as online debate, with their fellow classmates from different tutorial groups, whilst other participants were able to express their opinions via the discussion forum, and have online discussions with classmates and their Australian counterparts. Comments from a questionnaire and a focus group meeting confirmed that our preservice students agreed that information technology supports cooperative learning. It was found that the five advantages of using information technology to enhance learning proposed by Lipponen (2003) were realized. Furthermore, information technology also promoted the different dimensions of cooperative learning, and helped participants to understand how to integrate technology into learning, teaching, and assessment.

We are mindful that our student teachers participated in only the first step of fostering cooperative and deep learning. The future direction of this research will include cooperative activities into different modules of the teacher education program so that momentum can be maintained. Longitudinal research is needed to examine whether the information technology is a good medium for fostering collaborative learning, and in particular, to investigate if learning outcomes are related to cooperative effort. Cooperative activities such as discussion forums and conferences should be organized so that educators can continue to share and stimulate good ideas and practices. Last but not least, there is also an urgent need to reexamine current assessment methods and criteria. Specifically, public examinations should include cooperative skills and information technology competency so that teachers, students, parents, and employers at large, are able to grasp the value of cooperative effort rather than just individual effort and achievement. We certainly believe that the variety of cooperative activities offered by research supported information technology can be used appropriately in order to foster a more harmonious and supportive learning environment.

ACKNOWLEDGMENT

The author is very thankful to all learners for participating and giving insightful comments for this study; and thanks her colleagues, Kong Siu Chueng, Ada Ma, and Alison Yeung for fruitful discussions.

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KEY TERMS

Assessment: An ongoing activity that is intended to improve and inform the quality of instruction and student learning. Assessment should be designed to support learning rather than to select learners.

Assessment Rubrics: A set of assessment criteria or standards that delineate the level of competency.

Collaborative Learning: Collaborative learning refers to methodologies and environments in which learners engage in a common task in which each individual depends on, and is accountable to, each other. Learners working together to accomplish shared learning goals and to maximize their own and their group members’ achievements.

Cooperative Learning: Students interact to support the learning of one’s self and other group members.

Computer Supported Learning Environment: Information technology supported learning environment. A suite of computer software that enhances teaching and learning. A learning platform is commonly used to provide digital resources, discussion forums, and related links to present the information systematically.

Computer Supported Intentional Learning Environments (CSILE): This is a networked computer program developed by Marlene Scardamalia and Carl Bereiter at the Ontario Institute for Studies in Education, University of Toronto. This networked multimedia environment enables users to explore different ideas of interest by creating “nodes.” Discussion can be presented in graphical format, which enables users to follow the discussion systematically.

Reflection: An activity in which individuals are engaged in examining their experiences in order to lead to new understanding and appreciation.
Reexamining the Digital Divide: Aesthetic Choice and Tech-Nos

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INTRODUCTION

The concept of the “digital divide” refers to perceived differences in opportunity and achievement caused by economic and social disparities that limit access to technology. In general, the concept represents that as technology advances, some groups within society gain greater access to more efficient technology while other groups that are unable or unwilling to participate in the use of technology are left behind. This lack of participation in the digital world is considered to place these individuals or groups at a disadvantage relative to their more connected peers. The term “digital divide” also describes information technology disparities between nations and technical accessibility disparities within smaller societal groups. Although this issue has been researched for over a decade, both the concept and proposed solutions to problems related to technology access are controversial. As the concept of a digital divide moves beyond economic issues, conflicts between technology and aesthetics are emerging as potential factors in the debate over the adoption of new technologies.

BACKGROUND

The term digital divide developed in the early 1990s and was popularized in a series of studies by the National Telecommunications and Information Administration that examined telephone and computer usage (NTIA, 1995, 1998, 2000, 2002). The first of these studies “Falling Through the NET: A Survey of the ‘Have Not’s’ in Rural and Urban America” (NTIA, 1995), described disparities in computer and telephone access by age, race, geographic location, and income. In general, it was found that individuals who lived in central cities or rural areas, were less educated, were members of a minority group, and had lower income levels were less likely to have access to technology resources than individuals who were Caucasian, were better educated, and who enjoyed higher incomes. This report influenced a series of studies that focused on identifying who had access to technology and who did not. Technology use was examined in terms of income, geographic location, gender, race, education, and age.

Income

Initially the cost of computer equipment and Internet access were significant barriers to the participation of lower income groups in the digital economy; however, the problem proved to be more complex than counting computers since computer ownership and computer use are not equivalent (NTIA, 2004). Although the cost of computers has decline in the last ten years, associated costs such as Internet subscription fees can still be a burdensome cost for low income families. Many individuals who access computers use resources available at schools, workplaces, and public access points such as libraries. For all ethnic groups, computer ownership is likely to increase as income increases (Hoffman & Novak, 1998).

Lower income individuals are more likely to use computer resources for seeking specific information and as an aid in seeking employment (NTIA, 1999). Individuals in the lower income levels are more likely to access technology at a public resource center such as a library or school (NTIA, 1999). Individuals who have access to computers in their homes are more likely to use computers as a recreational device. For all users, e-mail is the most common activity engaged in online (NTIA, 1999, 2000, 2004).

Computer access outside the home is an important resource for many users and school-based computer access is an important introduction to information technology. A little more than 8% of the population lacks Internet access at home and uses Internet services
Reexamining the Digital Divide

at another location and 75% of these users access the Internet at least once a week (NITA, 2004). Although there were initial differences in computer access in certain geographic areas and in poverty areas, these differences have not existed since 1999 (Williams, 2000). According to Wells and Lewis (2006), by 2005, nearly 100% of public schools in the United States had Internet access and 97% of these schools had broadband connections. Ninety-four percent of this access was in instructional environments (Wells & Lewis, 2006).

Geographic Location

Geographic location affects the quality and cost of technology resources. Historically rural individuals were less likely to use computer technology than urban individuals because supplying information technology to sparsely populated rural areas was not economical (Malecki, 2003; Parker, 2000). Rural residents still lag behind urban residents in Internet use. Rural residents have fewer choices for Internet connection types and were more likely to be older and to have lower incomes than urban Americans, characteristics that are common in late adopters of information technology (Bell, Reddy, & Raine, 2004; NTIA, 2004).

Social culture may play a part in the extent and rate of use of information technology. Bulik (2006) notes that rural users lack the social peer pressure that may motivate urban users to adapt new technologies. The relevance of the technology is an important participation factor for these users. Once rural users connect to the Internet they were found to be quicker than other groups to use the Internet daily (Bell, Reddy, & Raine, 2004).

Gender

Although there has been a significant number of studies examining the role of gender as a factor in computer ability, early impressions that females were at a disadvantage in the digital age has not been supported by more recent work. What gender differences exist appear to be attitudinal rather than skill based (Durnell & Haag, 2002). In a controlled study that tested the ability of users to effectively and efficiently use search engines to retrieve specific information, no gender differences were found (Hargittai, 2002). Women are less likely to discuss their computer activities than men and are less familiar with computer terminology than men (Enochsson, 2005). Internet usage rates are similar for both men and women with women surpassing men in Internet use in August of 2000 (NITA, 2000).

It is clear that males and females use technology in different ways. According to Fallows (2005), men are more likely to use the Internet for recreation and are more confident in their computer abilities and are interested in technical advances. Women are more likely to use the Internet as a communication tool and to research topics of personal interests such as religion or health. Women between the ages of 18-29 are more likely to be online than their male peers, as are African-American women (Fallows, 2005).

Ethnic Groups

When controlled for household income level, Asians lead all ethnic groups in the percent of households online; they are followed by Hispanics, Caucasians, and African-Americans (Walsh, Gazala, & Ham, 2001). Income for all groups is highly related to computer and Internet access. In families that earn above $75,000 a year, computer use and Internet access is high for both African-American and Caucasians (NTIA, 2004). As income levels decline, differences between ethnic groups is significant even when income level effects are controlled. Currently 61.8% of all American households own computers and of these households 87.6% have Internet access (NTIA, 2004).

Although African-Americans lag behind other ethnic groups in using Internet technology, (NTIA, 2000), African-Americans who use the Internet are more highly educated than other user groups. Seventy-five percent of all African-American users are women. African-American users are also more likely to participate in chat rooms than other ethnic groups (“African-American Internet Users,” 2001).

Age

Like all psychomotor and cognitive skills, the ability to successfully use computer technology is affected by age. Older users are slower to complete specific tasks and are less likely to be successful at specific tasks. The effects of age are progressive and increase with the age of the user (Hargittai, 2002). Twenty-two percent of Americans 65 years of age or older use the Internet regularly and these individuals are likely to use information technology on a regular basis (Fox, 2004).
two demographic groups that are least likely to own home computers are senior citizens and young adults. For both of these groups lack of computer ownership may be tied to economic concerns.

**FUTURE ISSUES AND CONSIDERATIONS**

There is considerable debate on the usefulness of the term “digital divide” and the extent to which this problem currently exists. Although it was considered a serious social problem in the 1990s, there are researchers who believe that due to advances in software design and reductions in hardware cost, the digital divide no longer exists. Other researchers see this problem as evolutionary and believe that as physical access issues are addressed, the problem of equitable access shifts toward more subtle differences such as technical literacy and quality of access. As access to technology rapidly expands across the industrialized world, this debate has splintered into multiple approaches to the problem. Although the number of categories varies, three areas of concern appear to be common; gaps in technology, gaps in literacy, and gaps in psychological readiness. In this article these perspectives are described as the technical divide, the literacy divide, and the psychological divide.

The technical divide perspective promotes that physical access remains a significant issue since there are inequalities in the quality and location of access (Fallows, 2005, Hassani, 2006; Wilson, 2000). The literacy divide perspective examines inequities in the technical skills needed to use the technology efficiently (Hargittai, 2002). The psychological divide perspective examines psychological and cognitive differences that prevent some users from effectively accessing the technology (Broos & Roe, 2006; Freese, Rivas, & Hargittai, 2006; Van Dijk, 2006). There are valid counterarguments to each of these perspectives.

**The Vanishing Technical Divide**

Based on current data and census information the problem of physical access no longer exists (NTIA, 2004). Assess to technology has proven to be a better measure of physical assess than computer ownership. Computer costs have continued to decline and except for the inevitable differences in product efficiency common to any product, access is now universally available in schools and public libraries (Wells, Lewis, & Greene, 2006).

**The Vanishing Literacy Divide**

Technical literacy skills improve as schools move to integrate the use of technology in the curriculum and as more users encounter computers in the workplace. Efficiently of use is developed by experience and need. Computer users appear to adapt to technology quickly as they gain experience. Formal education increases the usefulness of the computer and is an enhancement to the online experience but lack of formal technical literacy skills does not appear to be a barrier to the online experience (Warshauer, 2002).

**The Emerging Psychological Divide**

There is a persistent group of individuals who do not use technology even though they can afford this resource. Proposed rationales explaining this resistance include lack of the needed cognitive ability, fear of technology, and unwillingness to regularly use the technology (Van Dijk, 2006). This perspective assumes that individuals who do not use technology need remediation since information technology is so vital to self-esteem and survival skills that nonusers must be psychologically deficient not to recognize this fact (Van Dijk, 2006).

The first two perspectives are slowly vanishing from the public debate in wealthier economies although technical and literacy issues are still significant concerns in developing economies. The third perspective is an emerging position and has serious flaws that ignore the legitimate values of nonusers. These concerns can be grouped into a fourth proposed perspective labeled the aesthetic divide since this issue is based on aesthetic or value choices that affect the quality of life.

**The Aesthetic Divide**

During the debate on who is participating in the digital age and who is not, one question rarely addressed is how these technologies add value to lives of the users. The minority of users who do not use technology do so because they do not value the changes that technology use would generate in their lives. The single most important reason given by nonusers for not using information technology is that they do not want it because they have
Reexamining the Digital Divide

no need for it (Dijk & Hacker, 2003). At issue is an aesthetic value rather than a literacy deficiency.

Technology has social effects and follows an adoption pattern not unlike that of other products. Nonusers are not outliers in a technology system; they are an expected result in the acceptance cycle of a new product. Only products or elements that meet basic biological survival needs are universally valued. To define technology as a basic need is an overstatement that ignores the unique qualities of information as a product. Need is the prerequisite to value. Individuals who avoid technology have not found a need that technology meets in a way they perceive to be superior to their current behavior patterns.

Information access is a unique product because the need being met is not related to the technology delivering that product. Information can be obtained in a variety of methods such as television, print media, and social networking. How individuals chose to obtain that information is determined by other qualifiers such as the type of information desired, the time value of the information, and the value placed on the media itself. As early as 1978, the trend for information technology to outstrip the needs of the user was predicted with the expected result that as technology advanced the quantity but not the quality of information would increase (Thompson & Shearman, 1978). The Internet provides an opportunity for everyone to become an expert on any topic they chose. It also provides an opportunity for inaccurate information to be widely distributed. Since the main value of the Internet is ease of access, this quality must be important enough for the user to justify home access. The quality of information is not equal and the value of information is individually defined. One person’s newspaper is another person’s tabloid; one researcher’s life focus is an interesting sidebar to a graduate student. Information is a continuously renewing resource and the availability of computer access does not guarantee that computer users explore information in greater depths than individuals who use other types of resources. It provides an opportunity rather than guaranteeing a result.

Technology is shaped by social systems and technology is often rejected when it ignores the social system in which it is implemented (Johnston, 1985). Consider the agricultural extension service which for decades distributed information to farmers through local agents in regional offices and in community workshops. Since this position can involve considerable travel, online conversion of these materials would seem to be an ideal solution. Howell and Haborn (2004) in a study of agricultural landowners found that farmers prefer traditional paper publications distributed by the extension service to receiving the same information electronically. For the farmer, receiving printed material is time efficient; there is no need to go online to search for the relevant information and then spend time to print it. Distributing the material online is beneficial to the information provider but is less beneficial to the end user of that information. Live distribution also offers the additional advantage of interacting with peers through local extension programs. In this example, there is a negative effect for accessing information online that extends beyond the value of the information itself. The information becomes divorced from the social context and this makes it less likely that the electronic delivery system will be readily accepted.

Positive interactions between social systems and technological change have been described as a gradual unfolding of technology rather than a dramatic change (Liker, Haddad, & Karlin, 1999). The majority of successful products move through stages of acceptance. New products are perceived as innovative and as status and luxury items. As they age and the popularity of these products increases, these items become desired by more individuals. It is considered desirable to own one of these products but they are no longer perceived as exotic as they were at their introduction. As the market continues to mature, and more individuals recognize the benefits of the product, perceptions of ownership will move from a nice-to-have item to a needed item. At this stage the product will achieve its highest level of acceptance, which will approach, but rarely reach, universal adoption. It is likely that computer access and literacy will become as common as the telephone but even the telephone, a technological advance that is a century old, has not been adopted by 5% of population (NTIA, 2004). As of 2003, nearly 25% of noncomputer users live in homes with Internet access (NTIA, 2004).

Since it is extremely unlikely that universal technology access is desired by all, the question of how to work with nonusers should be reexamined. Why is avoidance of technology a societal problem? A newspaper article that labeled nontechnology users as “tech-nos” described how these individuals who made a reasoned choice not to use technology often face a negative reaction from others who do not respect their
choice (Kornblum, 2007). It is ironic that the same technology that provides multiple opportunities to explore personal choice is creating a social ethos that denies that choice to individuals who for valid personal and economic reasons do not use that technology. This is a self-correcting problem; individuals will choose to participate in the digital age and will work to improve their computer skills as they identify needs that the technology will support. Fulfillment of these needs in turn will develop an appreciation for the value of technology.

CONCLUSION

Although the concepts of the digital divide animate discussions about access and technical literacy in the digital age, economic and technological segmentation is no longer a significant concern except in developing countries. The debate should shift to the examination of how users decide to participate in the digital world and how these technologies support the activities of their lives. Understanding the aesthetics of technology is an important factor in understanding the pattern of technology adoption.

REFERENCES


KEY TERMS

Aesthetic Choice: An aesthetic choice is a decision based on a value that is believed to enrich the life of the holder through the selection of action that the individual find pleasurable or desirable.

First Level Digital Divide: A distribution of available technology resources that prevents the use of those resources by limiting access to those resources through physical support systems or economic means.

Second Level Digital Divide: A distribution of available technology resources that prevents the efficient use of those resources by ignoring the lack of technical skills and emotional readiness among potential users of that technology.

Technical Literacy: Entry level technical skills that allow a noncomputer user to begin using technology effectively and that serve as a starting point for the development of more advanced skills.

Tech-no: An individual who has made a conscious choice to limit or avoid the use of technology in life due to a value rather than a limiting factor such as literacy or economics.

Technology Penetration: The rate at which a specific technical innovation becomes adopted into the everyday life of individuals within a social group.
Scripts for Facilitating Computer Supported Collaborative Learning

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**INTRODUCTION**

Many distance learning scenarios, for example, virtual seminars, use collaborative arrangements for learning. By applying them, they offer learners the chance to construct knowledge collaboratively. However, learners often do not possess the skills necessary for a beneficial collaboration. It is therefore important that learners are offered support in these learning scenarios. Scripts for collaborative learning can provide support. They can guide learners through their collaboration process (Ertl, Kopp, & Mandl, 2007b) and help them to acquire collaboration skills (Rummel & Spada, 2005).

Scripts for collaboration were originally developed in order to support text comprehension. They facilitate two or more learners—who are similar as far as their existing knowledge and learning strategies are concerned—in their efforts to understand contents provided by theory texts. Collaboration scripts split this process into a sequence of smaller steps, assign each learner to a particular role, and offer a number of comprehension strategies, such as questions, feedback, and elaboration. Each one of these learners has a defined role to play, which in turn is associated with certain strategies and varies within the different phases.

One example of a collaboration script is the so called MURDER script (Dansereau, Collins, McDonald, Holley, Garland, Diekhoff et al., 1979; O’Donnell & Dansereau, 1992). It was originally developed to help individuals with text comprehension, and was then increasingly used in pair and group work. The MURDER script divides the learning process into six phases and introduces individual and collaborative activities. Learners begin in Phase 1 by preparing themselves for the task ahead (mood). In Phase 2 they then each read the text for themselves, and pay particular attention to its main arguments and facts (understand). One partner (Partner A) then repeats the content from memory (repeat), and the other gives feedback and clarifies any discrepancies or misunderstandings (Partner B; detect). Phase 5 involves the learners working together and elaborating the text by connecting it to their existing knowledge and experiences, and sometimes by using imagery (elaborate). In the final phase, the learners go over the text again (review). These six phases can be repeated for several text paragraphs. Partners A and B take turns in repeating and detecting mistakes in the content.

This example clearly demonstrates the basic characteristics of a collaboration script:

- Learners work their way through the text step-by-step (sequencing)
- Learners are given different roles to play, for example, the “repeater” or the “detector” (assignment of roles)
- Collaborative use of strategies to aid comprehension (collaborative strategy use)

Much research was dedicated to the use of collaboration scripts in text comprehension (e.g., O’Donnell & Dansereau, 1992, 2000; Palincsar & Brown, 1984; Patterson, Dansereau, & Newbern, 1992), particularly as this skill is of great importance in school and university education. A number of studies have confirmed the
positive effects of the scripts on learning. Rosenshine and Meister’s (1994) metastudy, for example, provides an overview of existing results.

BACKGROUND

In order to understand how collaboration scripts work, it is necessary to view each characteristic, especially sequencing, role assignment, and collaborative strategy application, individually.

Sequencing

The creation of a number of different steps according to which task should be carried out is one of the most basic characteristics of a collaboration script, but at the same time, it is one of the least specific. An example of these different steps is the aforementioned MURDER script. The sequencing is particularly good for collaborative learning, as it shows the learner how best to carry out the task at hand and provides an effective strategy to do so (Kollar, Fischer, & Hesse, 2003; Weinberger, 2003). However, the issue is raised as to whether a sequencing of various subtasks in itself can have an effect on the learning results, or whether it merely provides a framework in which the learner can take on various roles and hence work through the text.

Assignment of Roles

The assignment of roles may have two effects on the process of collaboration itself. First, certain internal strategies or images can be applied (Dreitzel, 1972). According to the role taking theory, a learner that has been assigned to the role of an “explainer” is more likely to apply strategies the learner has experienced from other people that the learner saw as talented “explainers” of new concepts. A learner in the role of an “examiner” is more likely to ask critical questions. However, these strategies, which the learner associates with the given roles, do not necessarily have a positive effect on learning; particularly if the learner lacks a certain distance to the allocated role (Dreitzel, 1972). If, for example, a learner has a particularly authoritarian view of a teacher, the learner may apply this to the learning situation and thereby prevent comprehension questions and discussion. In order to avoid this kind of situation, the strategies that are applicable to each role must be well trained in advance (Rosenshine & Meister, 1994), and it is important that each learner gets a chance to take on all of the roles. Second, the assignment of roles may result in the learners learning more actively. The learner who assumes the role of the teacher or explainer may particularly benefit from the collaboration script, as the role is connected with an active function (Renkl, 1995). Studies have shown that learning by teaching has a strong positive effect on learning (Renkl, 1995).

Collaborative Use of Strategies

The sequencing of tasks and assignment of roles usually only provide the framework for the collaborative use of text comprehension strategies by learners (Reiserer, 2003). The strategies are usually based on strategies for use by individuals (Mandl, Stein, & Trabasso, 1984). The individual strategies acquire new qualities through the collaboration between the learning partners, particularly the questions, feedback, and explanations. Throughout most phases of the collaboration script, the collaboration partners use different strategies, which are well suited to each other and to the learning phase (O’Donnell & King, 1999; Palincsar & Brown, 1984; Reiserer, 2003; Rosenshine & Meister, 1994; Rosenshine, Meister, & Chapman, 1996).

The influence of typical strategies in collaboration scripts was summarized in the aforementioned metastudy by Rosenshine and Meister (1994). The original studies, upon which the metastudy was based, involved between 2 and 10 strategies for intense study of the material in reciprocal teaching.

The four basic strategies in the reciprocal teaching approach are:

- **Clarifying:** The learners test how well they have understood the text by clarifying issues in it. The answering of the questions inspires them to place more emphasis on particular information, whereby the partner who is asking the questions has the opportunity to clarify any misunderstandings. Brady (1990) found positive effects of clarifying in a study, but made the point that these effects are dependent upon the difficulty of the theory text used.
- **Summarizing:** The summarizing of the text passages is a further strategy. The learners have to focus on the basic message of the text and
then formulate it in their own words. According to Brown and Palincsar (1989), the learners can use this method to test whether they have understood a text passage. The partners can check each other’s summaries, add any missing information and draw attention to any irrelevant information. This strategy has been connected with learning outcome in a number of studies (Rosenshine & Meister, 1994).

• **Questioning:** The students are presented with the task of generating questions about the text and then posing them to each other and answering them respectively. These questions are split into general questions about the main content of the text, and more detailed questions. In order for the questioner to be able to formulate questions about the text, the questioner must have read it thoroughly, as must the partner, who must be able to answer and elaborate on the questions. Rosenshine and Meister (1994) however, did not find a direct connection between ability to ask questions and learning success. This may have something to do with the fact that it is necessary to focus on a particular type of question for the text comprehension to be reinforced (Person & Graesser, 1999), and this is often not the case.

• **Predictions:** The learners attempt to make predictions about the next paragraph of text based upon what they have read up to now. The strategy aims to provoke an intense elaboration and the activation of learners’ prior knowledge. This strategy has however not yet been researched into to any great extent, although first results suggest a positive effect.

Rosenshine and Meister (1994) reach the conclusion that the clarifying and summarizing strategies achieve the best results when used in collaborative learning. However, one has to be aware that the learners were intensively trained in these strategies before the application was tested; on average the learners took part in 20 instructional units. A more detailed description of the training and the support provided can be found by Rosenshine et al. (1996).

**COLLABORATION SCRIPTS IN COMPUTER SUPPORTED LEARNING**

In addition to the “original” collaboration scripts that are most often used in face-to-face classroom learning situations, there is a growing trend of using collaboration scripts in computer networks (Fischer, Kollar, Mandl, & Haake, 2007). It is particularly important that learners are offered enough support in these learning scenarios, as it is often the case that the learners do not know each other very well (Walther & Burgoon, 1992), and the communication process over the Internet can be difficult (Finn, Sellen, & Wilbur, 1997). For this reason, collaboration scripts were adapted in various ways to be more suited to computer supported learning. This has lead to a number of methods of structuring learner interaction in computer supported learning (Fischer et al., 2007). These collaboration scripts are applicable to a wide range of learning material, for example, to learning with case studies (Ertl, Kopp, & Mandl, 2007a), to collaborative problem solving (Rummel & Spada, 2005), to the improvement of argumentation (Weinberger, 2003), or communication skills in network collaboration.

<table>
<thead>
<tr>
<th>Phase 1 Communicate</th>
<th>Student in the teacher role</th>
<th>Student in the learner role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain the text content</td>
<td>Posing of comprehension questions</td>
<td></td>
</tr>
<tr>
<td>Phase 2 Deepen the understanding</td>
<td>Giving of feedback</td>
<td>Repetition and noting of received information in a joint document</td>
</tr>
<tr>
<td>Phase 3 Reflection</td>
<td>Individual reflection and elaboration of the joint document</td>
<td>Individual reflection and elaboration of the joint document</td>
</tr>
<tr>
<td>Phase 4 Discussion</td>
<td>Discussion of the content of the text, based on reflection with partner</td>
<td>Discussion of the content of the text, based on reflection with partner</td>
</tr>
</tbody>
</table>

Both partners then read the next text passage. The roles are swapped. The procedure is repeated until the entire text has been analyzed.
Scripts for Facilitating Computer Supported Collaborative Learning

(Baker & Lund, 1997). These collaboration scripts all have one thing in common: in contrast to traditional collaboration scripts, they do without intensive training because they are immediately implemented in the computer supported communication.

There are, however, a number of differences between collaboration scripts intended for use in verbal communication, such as video conferencing (Ertl, Reiserer, & Mandl, 2005; Ertl et al., 2007b; Rummel & Spada, 2005), and those intended for use in written communication, such as discussion forums or chat (Baker & Lund, 1997; Weinberger, 2003).

Collaboration scripts in videoconferencing are usually similar to the original collaboration scripts, but do not include the training, as this is made difficult by the distance between the participants. The individual steps are therefore often induced by the education setting. Table 1 contains an example of a collaboration script with two roles and four learning phases that was applied in a videoconferencing setting (Ertl et al., 2005).

The results of this study show that task solving in videoconferencing can be made more efficient by the additional use of a collaboration script. It is also possible to prevent inefficient processes (Reiserer, 2003; Rummel & Spada, 2005). The emphasis of the scripts however is, as can be seen in the example, on the sequencing and role taking (Ertl et al., 2005; Rummel & Spada, 2005). The strategies for intensive processing of a text are encouraged by the collaboration script, but cannot be trained before the task is carried out due to the network scenario. There are few studies that have found a positive effect of collaboration scripts on individual learning results in the area of collaboration.

The application of collaboration scripts in text-based computer mediated communication scenarios is very different to those in face-to-face settings or in videoconferencing. In these scenarios, the collaboration script is usually implemented as a particular structure shown on the computer screen, often supported by prompts. This structure may be demonstrated using communication suggestions, for example, “I would suggest that…” that are entered into a chat window when selected. Baker and Lund (1997), for example, report a script, which specifically directed the collaboration process. Their learning environment provided a shared graphics editor for working on a collaborative product and the instructional design added several speech act buttons to this editor. Each time a learner had made changes to the collaborative product, the learning environment required both partners to agree on these changes before continuing; they were required to demonstrate this by pressing the respective speech act buttons. The intention of this mechanism was that both learning partners increased their grounding (Dillenbourg & Traum, 2006) and their collaborative commitment to the joint product (Baker & Lund, 1997).

To sum up, the results of studies that focus on text-based communication scenarios are similar to those that focus on videoconferencing. The collaboration scripts often show effects during the task solving, but the effects on the individual’s learning outcomes are not consistent. Some collaboration scripts appear to have a positive effect, while others even seem to prevent knowledge gain (Weinberger, 2003).

CONCLUSION

Several studies have shown that scripts can facilitate computer supported collaborative learning (e.g., Fischer et al. 2007). These scripts work differently to scripts in face-to-face scenarios. Scripts for face-to-face scenarios require extensive trainings of the strategies provided by the respective script (Rosenshine et al., 1996). As a result of these trainings, the strategies are internalized by the learners and provide them with long-term effects. In contrast, scripts in computer mediated communication try to get by without training. Alternatively, the strategies of these scripts are induced by implementation in the learning environment. This reflects the peculiarities of computer mediated communication because spatial distance prevents learners to take part in trainings. Unfortunately, they often miss the long-term effects evoked by the trainings.

However, it is not enough to merely compare scripts in a face-to-face scenario with scripts in computer mediated communication. This is because scripts for computer mediated communication have to deal with several constraints, in the communication scenario as well as in learners’ characteristics. They face the problem that learners usually do not know one another very well and that they may be inexperienced in the computer mediated communication scenario. Consequently, the role of scripts changes in computer mediated communication. Instead of merely being focused on the outcomes of a learning session, they concentrate more on learners’ collaboration processes. They try to provide learners with a beneficial collabora-
tion environment to allow them to engage in beneficial collaborative learning processes.

REFERENCES


**KEY TERMS**

Assignment of Roles: Collaboration scripts often require learners to adopt certain roles during the collaborative learning process.

Clarifying: Strategy of discussing and resolving comprehension difficulties in a given text.

Collaborative Learning: Method of learning by which a group of learners collaborates to achieve improved learning results.

Collaboration Script: An aid to collaborative learning, in which the learning process is divided into various stages.

Predictions: Strategy of splitting a text into various paragraphs in which the users attempt to make a founded guess at what the next paragraph will discuss.

Questioning: Strategy in which learners pose and answer questions about the content of a text to one another to enhance their comprehension.

Sequencing: The method of dividing of a learning process into a number of stages.

Summarizing: Strategy of condensing the content of a text, so that the important details are clearly visible.

Text-based Communication: Collaboration partners communicate by typing statements with their keyboards. This style of communication does not necessarily take place in real time. Examples of text-based communication are e-mails, chat, and forums.

Videoconferencing: Users use Web cams and headsets to have a face-to-face conversation via Internet. Videoconferencing is often combined with the use of a shared application to enable users to work collaboratively with the same software tool.
Service–Oriented Architecture in Higher Education

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INTRODUCTION

Service orientation has become an accepted concept in how information systems should be exposed and coordinated in higher education. It is important that the learning environments of students and the working conditions of teachers can be planned to provide them appropriate and flexible information systems, data networks, and databases. Appropriate information and communication technology (ICT) tools enable efficient cooperation in networks in a way that they can promote the high quality learning.

The service-oriented architecture (SOA) is the planning method of information systems that uses loosely coupled services to support the requirements of business processes and users. Resources on a network in an SOA environment are made available as independent services that can be accessed without knowledge of their underlying platform implementation (Wikipedia, 2007). The approach is cost-efficient and flexible because it consists of various replaceable applications.

The purpose of this article is to present the framework of the SOA to analyse the service structure in the networked and virtual working environments in higher education. The approach developed in this article is planned to be generic so that it can be applied to various kinds of organisations and networks for the analysis and management of services. This approach helps an organisation to reengineer the architecture of ICT environments. The architecture is useful for the planning of networked learning community. This article is intended for managers and other experts who may wish to familiarise with the benefits and opportunities provided by the SOA.

The empirical context of this article is the Turku University of Applied Sciences (TUAS) and other Finnish profession-oriented higher education institutions. The TUAS is a multidisciplinary higher education institution founded in 1992. The institution has 9,500 degree students and 800 full-time employees. The TUAS has six faculties and a Continuing Education Centre. ICT is an important field of education and it is mixed with the business, biotechnology, mechanical engineering, health care, performing arts, communication, and many other subjects. The cooperation between the 28 Finnish universities of applied sciences is active.

This article is organised as follows: First the background section introduces the concepts and characteristics of the SOA. The main attention of the article is focused on the information system project of the Finnish universities of applied sciences. Thereafter, some future trends are presented, and the results of the article are summarized in the concluding section.

BACKGROUND

Service orientation

The rise of ICTs shifts people out of manufacturing into knowledge-intensive service industries. The knowledge-intensive service sector has grown to dominate economic activity in most advanced industrial economies (Chesbrough & Spohrer, 2006; Wood, 2002). ICTs are translated to support the many dimensions of internal processes of services and manufacturing. The efforts to offer services have focused on the creation of infrastructure necessary to describe, discover, and access services using the Web (Papazoglou & Georgakopoulos, 2003).

The SOA is a topical issue in ICT, because it has potential to develop Web services (Agrawal, Bayardo, Gruhl & Papadimitriou, 2002; Crawford, Bate, Cherbakov, Holley, & Isocanos, 2005; Huang, 2003). The SOA is a collection of services that communicate with each other. The services are self-contained and do not
depend on the context or state of other services. They work within the architecture of distributed systems. The solutions can be broken into a number of discrete services and then organised into an end-to-end solution. This sounds very similar to the component-based architectures of the late 1990s. The main difference is that the SOA takes a more coarse-grained view of functionality.

Figure 1 describes the main elements of the service orientation in the modern business architecture. In most of the cases, the narrow scope for the applications architecture itself is not sufficient. In the service-oriented approach, the service-oriented organisation (managerial dimension) and the service-oriented network (support processes and cooperative partners) are connected with the service-oriented applications architecture (distributed and communicative systems).

In the 1980s the activity-based models of business broke operations into a number of discrete activities based on the idea of a value chain. Information technologies have leveraged this work to simplify the creation of SOAs with the added feature that the resulting architecture will be meaningful to the business. This can be seen as an attempt to align the strategic plans and internal processes with information technology (IT). Typically, processes drive the Web services and services drive the technology.

The service orientation can be seen as a means to integrate diverse systems. Each IT resource, whether an application, a system, or partner, can be accessed as a service that is available through an interface. Service orientation uses standard protocols and conventional interfaces to facilitate access to business logic and information among diverse services. The SOA allows the underlying service capabilities to be composed into processes. Each process is itself a service, one that now offers up a new and aggregated capability (Microsoft, 2007). The SOA reflects the needs of the working environments and services provided for the customers and other stakeholders.

The information systems have typically been planned for the organisation, but they have also been designed for the networked and virtual environments (Bouras, Philopoulos, & Tsiatsos, 2001; Joslin, Pandzic, & Thalmann, 2003; Redfern & Naughton, 2002). The mobile work, including ICT tools, data networks, and increasing amount of cooperation in diverse locations, increases the complexity factors of working environments. Additionally, the common SOA covers both the dimensions of networked and virtual services. In the basic model there are three kinds of organisations including the traditional working organisation, network, and virtual network. The networking and mobility may take place within the organisation or in other places and organisations. The concept of the virtual network overlaps the traditional organised and networked work.

The networked and virtual work can be analysed using the various dimensions that come across the organisation and networked and virtual environments. There

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**Figure 1. Main elements of the service orientation in the modern business architecture**
are ICT tools that have been planned for organisations, cooperation in networks, and virtual environments. Working in these environments requires traditional and wireless data networks and databases. Working and cooperation in networks using modern ICT tools and data networks increase the complexity of information systems and the work loads of employees.

The service-oriented information systems are described in this article at the contextual level at the TUAS. It is not an exhaustive description of all the characteristics of the traditional organised, networked, and virtual work of the institution, but it provides an example of how the complexity factors of the institution can be analysed. The approach helps the management of the institution to analyse the activities and needed information systems, and take them into account in the work design, human resources planning, and the information environment design.

INFORMATION SYSTEM PROJECT IN HIGHER EDUCATION

Education institutions have recently explored the SOA to improve their internal processes, quality, and IT services (Eduventures, 2006; Howare, Millard, Davies, & Sclater, 2005). This article describes the case of the TUAS, where the complexity factors of networked and virtual services are analysed applying the service-oriented approach. The interaction of the institution is close with its operational environment. The strategic plan of the TUAS is to react to the changes of the environment in a flexible way (Kettunen, 2006, 2007; Kettunen & Kantola, 2005). The purpose of the institution is also to increase its external impact on the region (Kettunen & Kantola, 2006; Kettunen, Hautala, & Kantola, 2007).

The TUAS is an active partner in the common information system project of the Finnish universities of applied sciences. The purpose of their development project PROAMK is to define and implement a shared information system consisting of the student and education administration applying the SOA (PROAMK, 2007). The development project of the information system is supported and financed by the Finnish Ministry of Education. The Finnish higher education institutions (HEIs) include also 20 traditional universities, but they will probably join the development project at the later stage.

Figure 2 describes the SOA of the Finnish universities of applied sciences. The institutions are trying to cover the whole education process, research, services, and administration. The PROAMK will be used in the future as the main information system, where the HEI and the Ministry of Education will register information flows needed in the planning, implementation, evaluation, and control of the activities. The system is targeted to be applicable to the different user environments and fulfil the needs of different stakeholders of the national higher education system.

The legal background and framework to the networked development of information environments is stipulated in the Act on Electronic Services and Communication in the Finnish Public Sector. The purpose

Figure 2. Service-oriented architecture of the Finnish Universities of Applied Sciences
of the Act is to improve the efficiency and rapidity of services and communication in the administration. The Act contains provisions on the rights, duties, and responsibilities of the authorities and their customers in the context of electronic services and communication (Ministry of Justice, Finland, 2003).

The next step after the creation of the architectural overview or the big picture is the project of process modelling. The challenge for process modelling is to enable the organisational architecture to bridge the gap between the strategy and the application architecture. This will be done in the form of services modelling or process modelling (Gap Gemini, 2007). Technically the definition work of PROAMK is based on a standard of business process modelling notation (BPMN), which provides users the capability of understanding the internal processes in a graphical notation, and will raise the ability of experts to communicate these processes in a standard manner. The BPMN was developed by Business Process Management Initiative (BPMI) and is now being maintained by the Object Management Group since the two organisations merged in 2005 (Object Management Group, 2007).

The graphical notation of BPMI is targeted to facilitate the understanding about the performance, collaboration, and transactions between the organisations in order to ensure that the experts will understand each other and stakeholders, and enable organisations to adjust their internal processes to their environment.

The Finnish Ministry of Education and other Finnish national bodies started to develop an electronic register of educational definitions. This work has been a useful background for the PPMN notation work. In order to develop information systems that communicate with each other and contain comparative data about education, it has been noticed and understood that common definitions are needed.

The electronic application system of the universities of applied sciences has already been implemented in 2003. Nearly 95% of the applications were obtained through the electronic system in 2006. A joint application system enables the students to apply to four degree programmes of the different universities at the same time using the same application form. The application form can be submitted online or sent by postal mail to the admissions office of the institution that is the applicant’s first choice.

TUAS AS A PARTNER OF THE PROAMK PROJECT

Figure 3 describes the process modelling notation of the TUAS in the PROAMK project. The process description depicts the main stakeholders of the educational process. They include students, teachers, programme managers, education directors (deans), and the PROAMK information system. The project describes the
services and processes of the education institutions in a rather general way, but on the other hand, so accurately that the process descriptions can be used as a basis of the information systems.

An obvious problem is that the processes of the various education institutions have been described in different ways. The degree programmes or even the smaller units within the degree programmes have described their internal processes in different ways based on their historical backgrounds and traditions. Therefore, there is a need for the development and harmonization of processes before the information systems are tailored to serve the processes.

The process described in Figure 3 starts from the course feedback of the previous year students gathered by the electronic course implementation system of the TUAS. Also, the working life needs and budgeting are taken into account in the course planning and approval. The process proceeds through several steps, tasks, and assignments in the actor network ending to the record made to the study register of PROAMK. A necessary condition for the process plan described in Figure 3 is a proper map description of present procedures combined with the agreed definitions using the common register of definitions.

Before the construction of the exact system design, it is critical to identify both specific business drivers of the SOA endeavour and the dependencies between the internal processes and the underlying technologies. Neglecting the operational process context can result in a project in which the infrastructure of the SOA is pursued for its own sake or where the investments are made so that they do not line up well with the needs and priorities of the organisation.

FUTURE TRENDS AND CONCLUSION

The SOA is the evolution of the component-based architecture, interface-based design (object oriented) and distributed systems. The SOA has become a popular subject with no consensus of the standardised reference model to define it. The SOA is the next evolutionary step in computing environment and is based on the distributed components and objects. The architecture can be designed to reduce costs and improve services using the Web.

Typically, the experts try to work with the existing information systems and the contracts having overlapping periods. It is obvious that the information systems of different age live together also in the future. In this respect, the future is probably not different from the past and presence. The SOA is applicable to promote the utilisation of existing information systems and the provision of services using the Web.

The SOA is a cost-efficient way to promote the Web-based services in higher education. The PRO-AMK project will be continued and extended because the close cooperation of HEIs provides synergic advantages, which are highly valued by the Ministry of Education, because it pays the costs of education. The SOA also provides opportunities for some institutions to deepen their specific know-how, which would be the basis for work sharing and cooperation between the institutions.

REFERENCES


KEY TERMS

Component-based architecture (CBA): Software solutions are collected from components. The architecture produces flexible applications that have “plug and play” nature. The architecture consists of reusable components.

Higher education institution (HEI): Higher education institutions include traditional universities and profession-oriented institutions, which are in Finland called the universities of applied sciences or polytechnics.

Knowledge intensive business services (KIBS): Services and business operations that are profoundly reliant on professional knowledge. They are mainly concerned with providing knowledge-intensive support for the internal processes of other organisations.

Networked learning community: Learning community is a group of people in an educational context who is actively engaged in learning together and from each other. In networked learning, information and communication technology is used to promote connections between learners, tutors, and learning resources.
**Process modelling**: This activity represents both the current and future processes of an organisation so that the current processes may be analysed, developed, and described. The process descriptions and improvements may or may not be the basis for the information systems, but typically, the new information systems require process modelling. The term of the business process modelling is used in enterprises to improve process efficiency and quality.

**Service-oriented architecture (SOA)**: Service orientation describes an architecture that uses loosely coupled services to support the users and the requirements of the internal processes of organisations. The environment based on the SOA utilises the resources of a network made available as independent services so that they can be accessed without knowledge of their underlying platform implementation.

**Value chain**: Value chain is a string of organisations or organisational units working together to satisfy market demands or customer needs. The value chain may consist of one or a few value suppliers and many other suppliers that add on the value that is finally presented to the customer.
INTRODUCTION

Diverse institutions of education have paid special attention to the way they can profit from the use of Web-based shared networks in the last years. The literature review shows us a great interest in defining the variables that can have a direct impact on achieving better final results of a good use of these technologies.

In this chapter, we try to present a view of the main variables that should be taken into account in a global model to measure the general satisfaction of the usage of shared networks in technology education.

BACKGROUND

The effect of the use of shared networks in the final results of the organisations seems to not be easy to find, although it is recognised to exist in most of the literature (Dowling, 1998). Ives and Javenpaa (1991), Mahmood (1997), and Mukhopadhay, Surenda, and Srinivasan (1997) accept the existence of intermediate variables that stress the effect of information and communication technologies towards a better result. In this sense, Wille (1982) and Shneiderman (1992) recognised that formal methodologies are needed in order to guide and support design when implementing information and communication technologies in different contexts. Orliwoski (2000) emphasises the power of people interacting with technology in the organisations as a key element to understand the final satisfaction of information and communication technologies. She affirms that structure, understood as a set of rules and resources internalised in recurrent social practice in relation with the technology, can be a factor of success in IT final results. Powell and Dent Micallef (1997) pay special attention to the role of human and business resources in the IT final satisfaction in firms. All these perspectives have, as a main framework, the resource-based view. From this perspective, organisations must be able to develop capabilities around the technological resources in order to achieve positive results in the use of the information technology per se.

MAIN FOCUS OF THE ARTICLE

In the last decade, a great number of structuralism models have appeared in the applied technology areas. They all have generated a great debate about the role that information and communication technologies play in the organisations (DeSanctis & Poole, 1994; Poole and DeSanctis, 1990; Walsham, 1993). These models consider information and communication technologies as tools that allow more efficient alternatives in the management of the information system. The human action occupies a central place in these models, in particular, the actions that have to do with the use given to these technologies. New approaches that give a special importance, not only to the information and communication technologies in the firm, but to the use that firms make of these technologies and the derived consequences (Roberts & Grabowski, 1995; Weick, 1990) have recently appeared. In this orientation, Orliwoski (2000) from a structuralism perspective on the information technologies’ field proposes a practical understanding of the relationship among people, technology, and social action.

By taking into account the theory of reasoned action (Fishbein & Ajzenis, 1975), the attitude reflects the degree of affect that one feels “to or against” any object or behaviour. A person’s attitude in relation with the information technology makes a reference about the perception (positive or negative) a person feels about the information technology. Davis (1989) shows that the attitude of people towards the use of the information technologies is directly related to the perception these persons have about the technologies. Orliwoski and Gash (1994) explain how the use that people make of technologies is critical to understand their interaction. Yates and Orliwoski (1992, 1994) speak of genres of organisational communication.
The purpose of communication in a genre is not an individual and private motive for communication but a built purpose recognised by a community and used in some situations. Let us consider from the bibliographical point of view the approaches that in views of the first considered dimension—attitude—are of greater interest in our analysis.

Rhodes and Cox (1990) in an analysis realised in today’s practices and policies on how to use computers in primary schools the study of the effects of the student’s attitudes through information technologies in the learning process. Fullan (1993) stresses the importance of positively motivating the students in relation to the information technologies to reach a better empathy with them. Russell and Bradley (1997) try to measure the anxiety that people develop towards the computers and the implications they have in the worker’s professional career. From their analysis, we can understand that higher degrees of anxiety lead to a decrease in the worker’s final results. In the concrete case of the virtual education, Mikropoulos, Chalkidis, Katsikis, and Emvalotis (1998) analyse the attitudes of students towards the modality of virtual learning, by stressing the characteristics that make a student the appropriate customer for the use of Web technologies in this learning style. Collins (1999) emphasises the importance of the training to achieve a positive attitude in the education by using distance means. Shrum and Hong (2002) realise a more complete analysis by introducing the two implied parts: students and lecturers. In their analyses, they stress how to know the characteristics of the students, users of Web technologies, is needed so that the lecturers can develop appropriate strategies for these characteristics. Njagi, Smith, and Isbell (2003) propose a methodology that helps to develop attitudes in the students that enable them a more efficient use of the resources based in the network.

From the resource-based view (Peteraf, 1993), the advantages of developing and maintaining specific intangible assets as the culture, the learning, and the capabilities (Hall, 1993) have tried to be explained. Assets specificity (for example, the abilities developed in a certain moment to operate in a specialised way) can offer the organisations ways towards the search of the competitive advantage (Hansen & Wernerfelt, 1989; Powell, 1996; Rumelt, 1984).

In the relation between information technologies and organisational results, Clemons and Row (1991) developed an analysis showing how the competitive imitation removes a great part of advantages coming from the technology itself. The authors conclude in their analysis that “although it is possible to find examples of the use of information technologies in order to reach a sustainable competitive advantage; however, they are not as frequent as we think” (p. 278). Anyway, educational institutions are going to try to reach efficiencies in IT use, and in this sense, they consider that a higher degree of use and the development of routines and procedures in the firm will help to reach IT’s objectives. Let us consider now the main approaches from both perspectives—information technologies’ use and development of procedures and work routines we consider of major reference for our study.

Visscher (1996) emphasises the importance of the human resource procedures when dealing with information as a key factor in achieving the desired results of IT. Russell and Bradley (1997) analyse how the lack of rules in information technology use in educational centres increases the teacher’s computer anxiety and decreases the possibilities of making the best of the information systems. Papandreou and Adamopoulos (1997) compare the way information technology is used in educational centres in two different situations: on one hand, those that have created routines in order to better exploit the technology, and in some others, where IT is a support of free use. Their results show how in the first group of institutions they feel better satisfied with IT in general. Monteith and Smith (2001) illustrate a case showing the pedagogical implications of different students’ experiences when following a group of routines recommended in their virtual campus.

Pyburn (1987) pays special attention to the role of a corporate management information system in the success of information technologies in the firms. Lea and Clayton (2001) in a comparative case study observe the direct influence of induced behaviours over Internet technologies in final results in comparison to the organisations that do not induce behaviours. Polke et al. (2002) stress the importance of having a clear university policy in IT use for achieving the desired objectives in technological infrastructure.

The literature on this issue has paid special attention to another factor that can influence in the way of internalising Web technologies in educational institutions. It is maybe a more abstract element and of group consideration that appear in the organisations and that,
in view of the analysed studies, could promote or emphasise the use of these technologies in educational environments. It has more to do with aspects related to culture, values, and ways of group expression in the organisation. Under these considerations we support what we name organisational inertia, and it includes these mentioned aspects. Here is a summary of the main references to the dimension organisational inertia considered of interest for our analysis.

Cheney and Mann (1986) distinguish a variety of actors that impact in a different way in the final results of IT use. They also try to give some ideas on the critical success factors for the end-user computing as the most influential resource on final results. Schwartz and Sagiv (1995) give, as a main argument, the explanation of different results in university IT expectations of the role of culture-specifics. Benzie (1999) stresses the importance and the need to create models that are able enough to help researchers to explain IT final results in universities. Shrum and Hong (2002) establish IT users profiles—the characteristics of online students and online educators—as a key element for achieving good degrees of satisfaction in both cases.

Where we can find more contrasted references and the more representative studies is in the field of user’s satisfactions and results obtained after using a certain IT throughout the entire study. Satisfaction and results are considered variables of the greatest importance when defining different styles of internalising Web technologies in the educational field. Maybe the most complete analysis is developed by Ives and Olson (1984) where they reach a complete methodology that allows measuring the user satisfaction in IT use. This approach has been mentioned in various analyses for studying the impact of information and communication technologies in firms of different nature (Compeau & Higgins, 1995; Duvall & Schwartz, 2000; Webster & Hackley, 1997). It seems to be a useful tool for the organisations due to the difficulty in measuring such an abstract term as satisfaction. In all cases, the first Ives and Olson’s analysis is mentioned by all of the authors—in some cases because partially they apply it, and in other cases because they have considered it as an instrument of recognised value up to the moment, when trying to measure these variables.

**FUTURE TRENDS**

The literature centred in the analysis of the variables that can explain the behaviour of educational institutions that incorporate shared networks as a work tool have shown some partial factors as the responsible ones, mainly those that have to do with human interaction and the existence of proper rules and procedures in the organisations. Although we have found references of notable interest, we have detected a very important lag when trying to find an explanatory model for the relationship between information and communication technologies and organisational results. For that reason, in this chapter we have tried to collect the main literature references. This is the first step to create a model containing the main variables considered from an integral perspective. After that, in further research, we will try to contrast the suggested model.

**CONCLUSION**

The relationship between the investment on information and communication technologies and the results in the organisation has been found to be of interest in the literature in the last years (Orlwoski, 2000). From the nineties there has been an increase in the number of centres of education implementing Web technologies in order to complete or improve the way they offer their services (Alavi & Leidner, 2001). Among the areas of interest of the institutions that use shared networks for educational purposes, we find that virtual teams (Knoll & Jarvenpaa, 1995) show improvement through work groups by means of technological tools (Alavi, 1994; Alavi, Wheeler, & Valacich, 1995) to optimise the interaction in the classes by using computers (Leidner & Fuller, 1997) and to promote the sending and reception of pedagogical material (Leidner & Jarvenpaa, 1993).

In the study of the impacts of information technologies in this context, we do not defend technology as a specific asset, but as one more resource that if properly internalised in the management information system, it can possibly achieve a group of efficiencies of different natures; it could be a decrease in the cost, an improvement in the quality of the offered services, or an increase in the communication channels offered.
In this sense, Web technologies are resources at the reach of any educational institution. However, not all the educational centres internalise the technology in a same way. In this sense to have the technology does not necessarily mean that the results are going to be improved. Only those institutions that use them, even in a secondary phase, have developed the adequate routines and procedures of use, and can then benefit from the advantages they offer.

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KEY TERMS

Attitude: The degree of affection that one feels about some environmental element.

Genres of Organizational Communication: Socially recognized types of communicative actions.

Information and Communication Technology: Different physical devices such as computers, telephones, Web servers, and Internet connectivity that keeps a company able to communicate inside and with the outside world by electronic means.

Organizational Inertia: Some elements of the culture, values, and ways of group expression in the organization.

Resourced-Based View: A view of the firm as a dynamic evolving quasi-autonomous system of knowledge production and applications where the focus of attention is not only in the resources of the firm but in the services rendered by the firm’s resources.

Shared Network: The ensemble of transactions by which collective rules are elaborated, decided, legitimated, implemented, and controlled.

User Satisfaction: The degree to which the objectives of systems or the organizational unit utilizing the systems are achieved.
Simulation in Teaching and Training

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INTRODUCTION

Simulation has always been about learning. For being able to simulate something, a model of a system must be developed. Thus, the perspective of teaching and training with modeling and simulation is necessarily twofold. Sometimes the model builders are the primary learners. They learn by constructing models of scratch, and by changing model parameters. Sometimes the users of the simulation models are the target learners. They learn by interacting with a simulation. Sometimes, the learners are not aware that they interact with a simulation.

Applications are manifold and can stem from such diverse teaching and training domains as, for example, physics (Rickel & Johnson, 1999, 2002), computer science (Martens & Uhrmacher, 2001), psychology (Künzel & Hämmer, 2006), medicine (Kinchuk, Oppermann, Rashev, & Simm, 1998; Kühnnapfel, Çakmak, & Maaß, 1999; Shaw, Ganeshan, & Johnson, 1999), aviation (Dörr, Schiefele, & Kubbat, 2000), and also military training (McGlynn & Starr, 2001; Moon, Schneider, & Carley, 2006).

Teaching and training in modeling and simulations overlaps with research in intelligent tutoring systems (ITS) (Atolagbe & Hlupic, 1997). In combining modeling and simulation with ITS, the ITS knowledge bases can be used for either steering the simulation run (Stottler, Jensen, Pike, & Bingham, 2002), providing the information for the models to be simulated (Martens & Himmelspach, 2005), or for giving advice and feedback (Bravo, van Joolingen, & de Jong, 2006; Stottler et al., 2002). A simulation can also be a part of a teaching and training system, instead of being the complete teaching and training system itself. This can take place by integrating additional simulated actors in a role-play, as pedagogical agents (Rickel & Johnson, 2002), or by simulating the environment (Dörr et al., 2000; Kühnnapfel et al., 1999). This is also true for game-based approaches (Siemer & Angelides, 1994).

Sometimes the teaching and training system is designed in a way that mimics a real-life situation without actually simulating something in the sense of “execution of a model.” Examples of such systems, which are also called simulations, can be found in areas like medicine. A classical example is the “simulation” of a patient case (Zary, Johnson, Boberg, & Fors, 2006).

Last but not least, models and simulations can be used as part of the design phase of a teaching and training system. Examples would be introducing and simulating learner models for testing tutoring software, and development of models in the context of teaching and training systems (e.g., software models, didactical models, learner models, etc.). As models in teaching and training systems are manifold, this aspect will not be pursued further in this article.

BACKGROUND

In recent years, the term simulation has become part of everyday language. Unfortunately, this goes hand in hand with blurring its scientific meaning. In everyday language, simulation is often used in the sense of “the act or process of pretending,” or as “imitation or enactment.” In the medical or psychiatric sense, simulation is related to feigning. Here it means the (conscious) “attempt to feign some mental or physical disorder to escape punishment or to gain a desired objective” (simulation, 2007). The term simulation has its roots in the Latin term for imitation: *simulationem*. The term *emulation* (in the sense of imitating something), which is closely related to simulation, and which also plays a role in teaching and training, will not be discussed in this article (for further reference, see e.g., emulation, 2007).

Simulation of something always requires some sort of model. Even in the medical sense, the person feigning a disease needs at least a basic concept, that is, a model, of the disease. The term model can be traced back to the 17th century, when the ancient Italian term *modello* became famous in fine arts. In the common sense, a model is an image of reality. Nowadays, the usage of the term is extended. Models can be developed...
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based on natural artifacts or things, on hypotheses, on theories, or even based on pure fiction. The modern interpretation of model is the object which is the result of a construction process. However, everyday language use of the term model is manifold; no single definition exists (see e.g., model, 2007).

From the perspective of computer science, a third term occurs in the context of modeling and simulation: the term system. A simulation in the context of science is sketched as: “the representation of the behavior or characteristics of one system through the use of another system” (simulation, 2007). Similar definitions can be found in the works of Zeigler, Praehofer, and Kim (2000) and Cellier (1991). The first system mentioned in the quotation is related to a fictitious or real system. This system shall be investigated. Usually there exists a hypothesis or a scientific question, which is the basis of an experiment. Often, experiments on real systems are not possible or not sensible. Reasons are that the experiment would take too long, would include too much risk, would simply not be possible, or the system is not available in real life. Thus, an abstract image of the system is required: a model. This model can then be simulated using another system, for example, the computer.

Unfortunately, in teaching and training research (and also in modeling and simulation) often a clear separation between model and simulation is missing. Nonetheless, models and simulations should be perceived to be different parts, that is, a model representing a system (and potentially an experiment) (Minsky, 1965), and a simulation is used to experiment with the system’s representation (i.e., the model) (Cellier, 1991; Zeigler et al., 2000).

SIMULATION IN EDUCATION

There have been many attempts to categorize the large amount of simulations that can be found in educational settings. Min (1995) distinguishes simulations at the level of “what is simulated,” that is, conversation, behavior, moving pictures, and phenomena. Boyle (1997) differentiates between three levels of required learner activity, that is, passive, exploration, and task-based. King (2000) tries to reduce these attempts to a common denominator: “Computer simulation is a form of learning with computers in which the user may experiment with a simulated situation.” Another distinction has been made by Feldstein (2004), who investigated authoring tools for simulations. In the context of learning objects, ASTD and SmartForce (2002) found that simulations are a kind of practice object, where the learner has the possibility to apply knowledge and skills in close to real world environments. They distinguish between different kinds of simulations, such as role-play, software, hardware, and coding simulations. Additionally, they found conceptual simulations, where the learner trains decision making, and business-modeling simulations (see ASTD & SmartForce, 2002). From a top level view, all of these simulation related practice objects represent either training content (i.e., hardware, software, coding, business-modeling) or special types of training (i.e., role-play, conceptual). Training content is related to a certain application area, whereas types of training could be better perceived as underlying learning theories or didactical and pedagogical strategies.

From the perspective of modeling and simulation in computer science, it is more interesting to investigate how models and simulations are used in teaching and training. Three different approaches can be distinguished: interactive modeling and simulation, character simulations, and demonstrative simulations. This distinction abstracts from the training content, learning theories, and underlying pedagogical or didactical strategies. The three types of simulations will be described in the following.

INTERACTIVE MODELING AND SIMULATION

In the interactive modeling and simulation the “system to be taught becomes the subject to be modeled and simulated” (Martens & Uhrmacher, 1999). Interactive modeling and simulation systems comprise every kind of simulation where in the process of training the learner somehow interacts with a modeled and simulated system (Smith, 1999). The behavior of a certain system will be represented to provide for a safe, challenging, and close to real life teaching and training environment. The basis of the interactive modeling and simulation is a model of a system. The learner’s task can be to interact with the complete simulated system or to learn something about the system itself by investigating the model. Accordingly, interactive modeling and simulation can be further divided into interactive simulation and interactive modeling.
In the interactive simulation the learner interacts with the simulation itself. Usually, the learner does not reflect about the influence on the simulation, but the learner acts in or interacts with a “virtual reality” (Kühnapfel et al., 1999), or with an environment which is close to a game based scenario (Dörr et al., 2000). The underlying models are not directly accessible for the learner. Learning does not take place by reflecting about a model’s behavior or structure, but via reacting to and interacting with simulated situations. This is also called “human in the loop” simulation (see e.g., Dautenhahn, 1998). Classical application areas are medical surgery training, aviation, and military training.

The interactive modeling requires the learner to directly interact with the models. Usually, the training models are designed in advance. The learner can access the model’s attributes and/or the model’s parameters. The learner can change them either free or within a predetermined range. After changing the model’s parameters, the simulation has to be executed. The learner can now investigate the model’s behavior over time. Watching the simulation run and the simulation results can give the learner insight about the parameters’ meaning and effect on the model’s behavior. Examples can be found in diverse areas, for example, in medical training (Kinshuk et al., 1998), which provided a simulation of the inner ear. One of the first fields where interactive modeling was applied has been the investigation and reparation of electrical circuits in SOPHIE (sophisticated instructional environment) (Brown, Burton, & de Kleer, 1982). Another approach is that the learner trains model development from scratch (Martens & Himmlschpach, 2005). Model development should help learners to develop system thinking and understanding of inherent dynamics of systems (Arndt, 2007). Often it lends itself to use easy-to-understand modeling languages for such a purpose, for example, system dynamics (e.g., Steed, 1992).

CHARACTER SIMULATION

The subject to be modeled and simulated is a virtual character or avatar, for example, a pedagogical agent. This agent can interact with the learner, give the learner help and advice, and support and accompany the learner in the training process. Examples for pedagogical agents are STEVE (soar training expert for virtual environments), which accompanies the learner in training of physical processes, and ADELE (agent for distance education, light edition), a supporting physician in a medical training system (Rickel & Johnson, 2002; Shaw et al., 1999). Both their tasks are to give feedback, help, and advice. In a game-based scenario, the character simulations can be additional players, combatants, or antagonists. Their tasks are usually different. They range from simplistic aspects like providing the correct feeling in the training situation, to complex tasks like being the opponent in a negotiation (Core, Traum, Lane, Swartout, Marsella, Gratch et al., 2007).

Naturally, also character simulations are based on models. The models comprise models of behavior, that is, interaction and reaction (e.g. proactive, interactive, permanent, or mixed), and models of domain knowledge (e.g. expert knowledge). Modern approaches try to embed human-like qualities in character simulations. For example cognitive models and emotional models become part of the virtual characters (e.g. Gratch, Rickel, Andre, Cassell, Petajan, & Badler, 2002; Marsella & Gratch, 2001, 2003).

The simulation of the “character” model starts either immediately with the teaching and training system (i.e., the character simulation is permanently available) (Core et al., 2007) on demand (i.e., the character simulation is interactive) or if required (i.e., the character simulation is interactive or proactive) (Rickel & Johnson, 2002). Also mixed approaches can occur. Often the simulation of a virtual character is part of an interactive training simulation (Core et al., 2007) or of an ITS (Rickel & Johnson, 2002). Depending on the teaching and training context, the learner’s behavior determines or at least influences the behavior of the character simulation.

DEMONSTRATIVE SIMULATION

Demonstrative simulations are more or less close to multimedia presentations. Simulation in this context is closely related to the interpretation “to act as if.” Min (1995) would call this a representation rather than a simulation. Usually, no simulation in the sense of “experimenting with a model” can be found. There is no simulation which can be started or executed. However, models also exist in this context, but they are not accessible for the learner. The demonstrative simulation replicates, for example, an environment,
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a situation, behaviour, or a person on a very abstract level. It does not mimic behaviour over time. Examples of such a demonstrative simulation are the medical training systems described by Zary et al., (2006) and by Martens, Bernauer, Illmann, and Seitz (2001). In both cases, neither a simulation of a patient in the sense of the above mentioned character simulation, nor a simulation of the environment is provided. The learner has access to a patient case. The learner’s task is to act as a physician, decide about an appropriate patient treatment, and find the correct diagnoses. The training cases are close to reality or even adopted from reality. Models of treatment processes, patient cases, patient behavior, and structure of diseases underlie the teaching and training systems’ knowledge bases. However, these models cannot be executed in a simulation sense.

CONCLUSION

The big advantage of using simulations in teaching and training is the following: “Simulation brings key experiential learning moments to you, usually by allowing you to fail fast, fail often, but fail safely” (Kindley, 2002). Simulations allow the learner to interact with models of systems. Usually, these systems can either not be explored in real life (e.g., they are not available, or they are too expensive), would be too dangerous to allow for making mistakes during training (e.g., making mistakes would endanger the environment or living beings), or which would simply cost too much in real life. Here, teaching and training models and simulations are a meaningful supplement to theoretical lectures and courses. Instead of providing pure theoretical knowledge, they allow the learners to become active, to make their own experience, to discover, to explore, and construct knowledge on their own. They allow for “learning by doing” in a safe environment. Beyond classical e-learning systems, simulations, based on models of dynamic systems, integrate time and temporal aspects as a variable in teaching and training.

The advantage of knowledge construction in close to real life situations and in hands-on training has been well known in learning psychology, pedagogy, and didactics for quite a while. Simulating situations for training, for example, in the form of role-play or in the form of experiments, have been part of education for a very long time. Even the use of computers in educational settings, traced back to the early 1970s, is also a history of using computer simulations for teaching and training.

In the coming years and with the constantly growing impact of computers in education, the role of modeling and simulation in teaching and training will also grow. Interactive simulations and character simulations will become more realistic (e.g., human like characters, complex graphical representations, collaboration with other learners, etc.). As model construction for educational settings is a very demanding task, another future trend will be the development of exchangeable educational models, which can be simulated. Additionally, as the complexity of teaching and training applications grows, a simulation of the learner’s behavior can help to foresee impasses in the learning process. The behavior of certain learner types could be modeled in advance and provide help and support for e-learning content authors. Another trend will go in the direction of combining modeling and simulation for educational settings with approaches of game-based training, as research in learner motivation reveals.

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**KEY TERMS**

**Character Simulation:** A character simulation is based on the model of a virtual persona, a pedagogical agent, an avatar, or the like. Underlying models comprise, for example, behavior models, knowledge model, cognitive models, motor models, and emotional models. A character simulation can be part of an interactive modeling and simulation system.

**Demonstrative Simulation:** The demonstrative simulation is close to a representation of a situation, environment, behavior, or persona. It usually lacks a temporal dimension. The learner’s interaction with a teaching and training system is based on demonstrative simulation influences, neither the progress of the simulation nor the underlying models. No simulation in the sense of executing an experiment with a model of a system exists in the demonstrative simulation.
**Interactive Modeling:** The learner interacts directly with the models. The learner can change parameters or attributes of predesigned models, or the learner has to develop models of scratch. The learner uses the simulation to observe and test the model’s behavior. By simulating the models, the learner can gain insight and knowledge about the importance and role of parameters, attributes, and model behavior.

**Interactive Simulation:** The learner acts and interacts with a simulation. The learner is neither aware of his/her influence on underlying models, nor can the learner access the models directly. The learner behavior steers the development and progress of the simulation.

**Simulation:** Interactive modeling and simulation comprise every kind of simulation where in the process of training the learner somehow interacts with a modeled and simulated system. The learner can either be aware of his/her interaction with the model(s) (see *interactive modeling*) or not (see *interactive simulation*). Interactive modeling and simulation systems provide for close to real-life teaching and training; it enables hands-on training in domains where otherwise interactive training would not be possible. Beyond classical e-learning, time and temporal aspects usually play a role in interactive modeling and simulation.
IntroductIon

In his work, *The Advancement of Learning* (1605), Sir Francis Bacon observed, “Man seeketh in society comfort, use, and protection.” Humans have historically looked to situations in which they interact with one another to inform ideas about culture, morals, and ambition. Plato philosophized that education was the key to the betterment of society, but such a society was possible only if people worked together for a common good. In the Judeo-Christian tradition, believers are called to interact within community. The traditional *shema* affirms the communal nature of humankind and the role that context and social interaction are to play in the preservation and transmission of values.

Hear, O Israel, the LORD is our God, one LORD, and you must love the LORD your God with all your heart and soul and strength. These commandments which I give you this day are to be kept in your heart; you shall repeat them to your sons….write them up on the doorposts of your houses and on your gates (Deuteronomy 6:4-9 Revised Standard Version).

In the modern age, educators have tended to focus on a combination of behavioral and cognitive theories rather than philosophical or religious ones. Vygotsky (1978) proposed ideas about social learning theory in which interpersonal interaction played a fundamental role in learners’ cognitive development; “…human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them” (Vygotsky, 1978, p. 88). It is by observing and modeling others that learners are able to attain their full cognitive potential.

The social learning theory of Bandura (1977) emphasized “prestigious modeling” as the most important factor of human development. Learning occurs when an individual witnesses a behavior, organizes and rehearses it, enacted it, and then receives intrinsic, extrinsic, or vicarious response for it. Replication of behaviors is situated; that is, actions and reactions are predicated by the context in which they occur.

Literacy theorist Louise Rosenblatt (1978, 1995) proposed a “transactional theory of literature” in which she supposed that students’ behaviors are not passive. As reading occurs, the reader acts upon the text but is, in turn, acted upon by the text. There is an essentiality of the time and place in which a reader is situated that is inherent in reading transactions. A learner’s situation, therefore, necessarily impacts understanding. “The inescapable molding influence of the culture into which we are born is an extremely important concept. The teacher should have this clearly in mind before…introducing the student to…literatures” (Rosenblatt, 1995, p. 14).

Judith Langer (1997) adopted a sociocognitive perspective in her assertions that learning is culturally based and “…needs to be understood in terms of time and place and people, communication systems, and technologies and values…” (Langer, 2002, p. 4). Ruddell (1995) studied instructors perceived by their former students to have exerted exceptional influence on their learning habits, and described the characteristics that they shared. The resulting definition of “influential teachers” suggests that context is of equal or greater importance than instructional practices. Hoewisch (2000) posits a corollary idea; the majority of what teachers do in their classrooms is based upon memories of ways in which their own previous learning was situated rather than by any standards or methods encountered during formal teacher education.

SITUATED LEARNING

Combining constructivist and social leaning theories, a learning approach called dually “situated cognition” or “situated learning” has garnered increasing attention (McLellan, 1996). Jean Lave and Etienne Wenger (1991) adapted social learning theory to propose ideas of “situated learning” in which cognitive development occurs as learners participate in the practices of the social communities and use context to become aware of the structures of, and models for, each social
situation. “A person’s intentions to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a socio-cultural practice. This social process, includes, indeed it subsumes, the learning of knowledgeable skills” (Lave & Wegner, 1991, p. 29).

Essentially, situated learning maintains that learning and cognition rely upon social interaction and authentic activity (Roschelle, n.d.). In other words, knowledge, and the ways in which such knowledge may be applied, are mutually dependent. Situated learning generally occurs in an unintentional rather than a deliberate way and is completely dependent upon the authentic context, culture, and activity in which it occurs (Jonassen, 1994). “Situations might be said to co-produce knowledge through activity” (Brown, Collins, & Duguid, 1989, p.32). The culture with which learners become involved offers models of “ideal” behaviors (Gopnik, 2005). Gradually, learners increase their engagement within a “community of practice” and eventually assume the role of expert (Roschelle, n.d.). Peck (n.d.) has created a distance-learning matrix that describes complicated interworkings of individual attributes, interpersonal factors, learning tools, instructional purposes, subject matter, and technology interface that contribute to a learning community.

Interestingly, some learning theorists have pointed to the negative consequences that situated learning may have. If learning is completely tied to the context in which it occurs, then it might become difficult to transfer understanding from one situation to another (Ormond, 2004). However, most proponents of situated learning argue that authentic activities that are situated within real-world applications, such as technological ones, allow learners to recognize the connections between domains, and to transfer learning fully and easily between contexts.

Often credited to Lave and Wenger (1991), descriptions of situated learning have been refined and extended by additional research (Brown, et al., 1989; Jonassen, n.d.; McLellan, 1996; Roschelle, n.d.). While situated learning is a general theory of cognition, it has achieved special prominence as applied to technology-assisted instructional design and delivery (Bhalla et al., 1996; Owen, n.d., Walker, 2001).

SITUATED LEARNING AND TECHNOLOGY

Schools have increasingly come to rely on technology to enhance, to supplement, and, sometimes, to drive their curricula. Teachers and students are being held accountable to basic technology competencies (International Society For Technology in Education, 2004), and online secondary and post-secondary courses are becoming the norm rather than the exception (American Association of University Professors, 1999; Institute for Higher Education Policy, 1999; National Council for Accreditation of Teacher Education, 2004). In 2001, an article in Education Week reported on the trend of “…a small but growing number of prospective and practicing educators logging on to computers to earn teaching credentials or bachelors’ and masters’ degrees in a field that ordinarily prizes face-to-face interaction” (Blair, 2001, p. 14). A 2000 study (Higher Education Program and Policy Council of the American Federation of Teachers (AFT), 2001) revealed the following statistics about the growth of online education. In 1998, 48% of two- and four-year colleges and universities offered online classes. But, by the time the study was released in 2001, the number had grown to 70%. Understanding how “communities of practice” relate to and inform instructional technology has become essential.

Most importantly for instructional design and delivery, situated learning presupposes that a community of learners—whether online or onsite—will undertake authentic tasks that reflect real-world needs (Jonassen, 1994). Stein (1998) explains, “By embedding subject matter in the ongoing experiences of the learners and by creating opportunities for learners to live subject matter in the context of real-world challenges, knowledge is acquired and learning transfers from the classroom to the realm of practice” (¶ 2). The educational implications for situated learning are particularly apparent when considering technology (Bhalla, et al., 1996; Roschelle, n.d.). Educators who attempt to integrate instructional technology into their practices strive to offer learners authentic problem-solving experiences that can be solved in context and by means of collaboration with colleagues. Thus, situated learning theories and instructional technology complement and inform one another, regardless of subject matter (Jonassen, 1994).
Situated Learning

Situated learning within technology-based activities provides numerous opportunities for the construction of new understandings. If learning is an active process in which a learner interprets information in a social context and then transforms it into personally relevant knowledge, technology is the perfect vehicle for so doing. Tam (2000) asserts that technology has the potential to radically alter teaching and learning in that it has the inherent “...ability to function as a gateway; a gateway to resources, collaborative learning and individual achievement” (p. 12). Technology tools aid in situated or case-based learning by means of simulation and strategy applications, multimedia presentations, and telecommunication resources (e-mail, Internet, blogs, etc.). Learners access information from a variety of sources and in a variety of formats, documents, audio/video clips, photographs, and transcripts,—all of which permit learning to be situated in otherwise inaccessible contexts.

Increasingly, educational institutions rely on instructional designs that integrate various technologies in order to foster situated learning environments. Despite this increased reliance on technology-mediated instruction, educators debate pros and cons. Proponents point to the increased accessibility to information that technology affords learners, and maintain that online activities encourage independent learning and constructivist teaching practices, such as situated learning. However, others consider teaching and learning to be inherently social learning processes, and believe direct interpersonal interaction situated in a face-to-face environment to be essential to a successful educational experience (Distance Education, 2001). The Institute for Higher Education Policy (1999) points out inconsistencies in four areas: limitations of available technology resources; ease of access to library and other learning materials; ability of online activities to impact student learning beyond factual recall; and suitability of distance education strategies for all subjects and/or all students. Perhaps the American Association of University Professors (1999) best summarized the tension between “traditional” and “technology-enhanced” education; “...the development of distance-education technologies has created conditions seldom, if ever, seen in academic life conditions which raise basic questions about standards for teaching and scholarship” (¶ 3).

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Situated Learning: Dually called “situated cognition” or “situated learning,” this learning approach combines constructivist and social learning theories to propose that cognitive development occurs as learners participate in the practices of the social communities and use context to become aware of the structures of and models for each social situation.

KEY WORDS

Situated Learning
Software Engineering Education: Prospects and Concerns of Integrating Technology

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INTRODUCTION

The discipline of software engineering was born out of the need of introducing order and predictability in large-scale software development. Over the last few decades, software engineering has been playing an increasingly prominent role in computer science and engineering curricula of Universities around the world (Rezaei, 2005; Tomayko, 1998).

In this article, we explore the prospects and concerns of systematically integrating information technologies (IT) in software engineering education (SEE), both inside and outside the classroom. By IT we will mean the technologies for various activities related to information (such as acquisition, creation, communication, dissemination, processing, archival, retrieval, transformation, and so on), within the context of the Internet and the Web, unless specified otherwise.

The rest of the article is organized as follows. We first provide the background necessary for later discussion. This is followed by the prospects and concerns of systematically integrating IT in SEE and examples of use of IT in SEE, both inside and outside the classroom. Next, challenges and directions for future research are outlined. Finally, concluding remarks are given.

BACKGROUND

The discipline of software engineering (Abran, Moore, Bourque, & Dupuis, 2001) advocates a systematic approach to the sustainable development of large-scale software that aims for high quality within the given organizational constraints. To do that, having a team with diverse knowledge and skills, following a process with intermittent phases for software development, having means for quality assurance and evaluation, using models and/or documentation for communicating the progress of development across team members, making realizable (practical) choices so as to finish the product within given time and budget, and so on, are some of the traits of modern software engineering.

Like other disciplines, SEE needs to be sensitive to the variations and evolution of the social and technical environment around it. In particular, changes in IT environment need to be reflected, and to that regard, there have been calls for a reform of SEE (Frailey, 1998).

There have been some previous instances where the use of IT has been found to be useful in SEE. For example, the use of Java applets in illustrating the dynamics of complex algorithms has been emphasized (Kamthan, 1999), the benefits of hypertext for relating and navigating through software artifacts have been shown (Bompani, Ciancarini, & Vitali, 2002), and the use of extensible markup language (XML) for marking-up software process documents has been reported (Mundle, 2001). However, these works are limited by one or more of the following issues: the focus has been on the specifics of respective technologies rather than on the learner or on the learning process; the approach to IT integration does not appear to be systematic; and the trade-offs are seldom discussed, if at all.

A PERSPECTIVE ON INTEGRATING INFORMATION TECHNOLOGY IN SOFTWARE ENGINEERING EDUCATION

Our approach for integrating IT in SEE is based on a methodology consisting of a nonlinear and non-mutually exclusive sequence of steps as shown in Table 1.

We briefly note the following characteristics of the elements in Table 1. Firstly, we contend that the steps are necessary, but make no claim of their sufficiency. Indeed, the steps are stated at a high level and could be granularized further if necessary. Secondly, the steps 1-3 are in a bidirectional cycle (step 1 depends and is depended upon by step 2, and so on) that we exit only...
when each step is adequately satisfied with respect to the others and is feasible. Thirdly, step 4 depends on step 1.

A detailed discussion of each of the steps is not carried out due to considerations of space. However, from a practical standpoint, we briefly highlight the significance of considering the feasibility of each of the steps 1-5. A variety of feasibility-related concerns can arise. For example, an educational activity may make sense theoretically but may be, practically, unrealizable; the adoption of objectivist or constructivist learning theory or a combination thereof (Cronjé, 2006) may seem appealing and may even be the “best” pedagogical choice, but may not be within the scope of given constraints of time and class size; it may be useful to elicit as much background on a student as possible, but privacy concerns may prevent one from doing so in its entirety; a specific IT may be an attractive option, but the software available for processing it may be proprietary and not within the given budget; and so on. The feasibility study could be a part of the overall course management activity.

The methodology is based on the assumption that IT can be useful in SEE. However, to give some credence to that, we must weigh the possibilities and obstacles in doing so, which we discuss next.

Prospects of Integrating Information Technology in Software Engineering Education

IT can play a role in SEE as means for teaching concepts, as means for learning concepts, or as means for performing tasks. This potential is further elaborated in the following.

Necessary alternative in a classroom. IT can give teachers alternative ways to discuss, in the classroom, the software engineering concepts that, by nature, are dynamic or nonlinear, and are difficult to present using traditional means. This is particularly the case with concepts related to complex structures (such as three-dimensional graphics) and evolving spatial/temporal behavior (such as iteration or recursion) in a software system.

Interactive classroom experiments. IT can be a useful tool to foster an interactive environment in a classroom. For example, a teacher could give a demonstration of a software system with a predetermined, fixed data set, and ask questions based on the variations of the data set (that will lead to unpredictable behavior of the system). In such a case, both correct and incorrect answers can contribute to the learning process.

New horizons. IT can open horizons for teachers and students to new activities and to ask/answer questions not (readily) feasible or even possible before. Using inexpensive and fast computers, it is now possible to carry out complex calculations and process very large data sets. This, for example, allows one to experiment and present the results involving software measurement in a short amount of time befitting lectures and laboratory-based tests.

New means of communication and collaboration. At times, students can find office hours insufficient or inconvenient. On the other hand, teachers may wish to keep in touch with students when they are away. For example, a teacher may need to travel out of town on a conference during the spring break, but would still like to be available for any questions from students on a software deliverable, due at the end of the break. IT can give alternative ways to teachers for communicating with their students outside the classroom synchronously or asynchronously and via client-pull/server-push. The proliferation of mobile phones with support for electronic mail and technologies for syndication has led to

Table 1. A feasibility-sensitive methodology for integrating information technologies in software engineering education

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deciding the Scope of Software Engineering Knowledge, Potential</td>
</tr>
<tr>
<td></td>
<td>Information Technologies, and Educational Activities</td>
</tr>
<tr>
<td>2</td>
<td>Adopting a Learning Theory and a Teaching Strategy</td>
</tr>
<tr>
<td>3</td>
<td>Identifying and Understanding the Participants</td>
</tr>
<tr>
<td>4</td>
<td>Selecting and Applying Suitable Information Technologies to a</td>
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<td></td>
<td>Software Engineering Education Context</td>
</tr>
<tr>
<td>5</td>
<td>Evaluating the Effectiveness of Integrating Information</td>
</tr>
<tr>
<td></td>
<td>Technologies in Software Engineering Education</td>
</tr>
</tbody>
</table>

Feasibility

Software Engineering Education
new opportunities for asynchronous communication. By collaborating amongst themselves, students can learn software engineering concepts as well as the traits of work ethic (Layman, Williams, Osborne, Berenson, Slaten, & Vouk, 2005): software projects make such collaboration a necessity, and appropriate use of IT can help facilitate that.

**Dissemination of course content.** IT can provide opportunities for teachers to make their lectures and related content available outside the classroom. This could, for example, be useful to students that for some reasons (such as absence on medical grounds or preparation for a test) would like to have access to the lectures.

**Rich course content.** IT can provide opportunities for teachers to complement or supplement their lectures with related material. For example, as part of the lecture on a topic, a video by an external expert could be shown in the classroom; as part of the response to a question by a student in the class, the teacher could provide a uniform resource locator (URL) where more information can be found; or in the classroom, using a student-supplied input, run a program that could be started/stopped at arbitrary places to provide explanation if necessary.

**Reuse.** Being able to reuse existing knowledge, in part or in whole, in a justifiable way is critical for large-scale software development. IT can help make that a reality and enable prospects for reuse. For example, the use of frameworks such as AxKit, Ajax, and Rails allows a software engineer not to create everything from scratch, and can thereby accelerate the development of Web applications.

**Future careers.** Being introduced to the state-of-the-art IT could help students in their future career paths. Indeed, the teachers could use market demand as one of the criteria for the selection of suitable IT, particularly for course projects. An appropriate use IT could lead to the realization among students of their *symbiotic* relationship with it: they are not only the consumers of IT but hopefully also, as software engineering students, the future contributors/inventors of IT.

**Rich course assignments.** The course assignments can be made available and submitted electronically over the Internet. This has several advantages over its paper-only counter part: the content of the assignment problems and solutions can be richer (say, dynamic), which is closer to the nature of the discipline; a student does not need to be physically present for submission and therefore, could submit the assignment from virtually anywhere, at any time (prior to the deadline); the teacher does not need to carry the paper load or be concerned about misplacing/losing any of the submissions; the marking of assignments in certain cases becomes more natural, for example, when source code is part of the submission and needs to be checked for certain properties (like syntactic correctness or efficiency).

**Reducing duplication.** It is well-known (Weinberg, 1998) that documentation plays a crucial role in software engineering, and IT could be used to reduce redundancy in documentation. For example, a single source could be transformed into multiple formats and disseminated via the Web for, say, viewing on a desktop computer, viewing on a mobile device such as a personal digital assistant (PDA), and for printing (Figure 1).

*Figure 1. A single source could be transformed for presentation on multiple device contexts*
Concerns of Integrating Information Technology in Software Engineering Education

The integration of IT in SEE has its limitations, details of which are outlined in the following.

No free lunch. There can be costs associated with training, administrating, and/or purchasing software for processing the selected IT, which may need to be balanced with respect to budgetary constraints. For example, the cost involving infrastructure for streaming media remains prohibitive even for non-commercial purposes. Although the presence of open source software (OSS) (Koohang & Harman, 2005) has alleviated some of the costs, there is no priori guarantee that a suitable OSS may be available for a chosen IT.

Technology fatigue. There is a potential for technology overload or “fatigue” for both teachers and students, particularly in keeping up with the technologies that are deemed relevant, but are either transient or moving targets.

Quality concerns. The use of IT can pose a variety of quality-related challenges. It has been pointed out (Yee, Xu, Korba, & El-Khatib, 2006) that privacy and security are concerns for learners in e-learning environments using mobile devices. Furthermore, there can be reliability and robustness issues in use of IT during critical times. For example, there exists potential for device failure or low battery power during project demonstrations or class presentations, unavailability of assignment servers due to overload around the time of the submission deadline, and so on.

Shift of focus. There is a possibility of a shift of focus among students that may be undesirable. For instance, there could be considerable time spent in learning the intricacies of IT for subsequent use rather than the software engineering topic at hand. A case in point is the increasing emphasis on technologies like Java 2 Enterprise Edition (J2EE) rather than on the basics of software architecture (Voelter, 2006).

Obfuscation of concept with information technology. There is a potential for students to exclusively associate a concept with the IT that is used to illustrate it. For example, there is a tendency to associate the notion of hypertext or markup with the hyperText markup language (HTML) and only HTML, or a software model with the unified modeling language (UML) and only UML, unless suggested otherwise.

This leads not only to linear thinking, but also to the potential for obsolescence if the IT in question loses support or gets superseded.

No free lunch: Reprise. The introduction of an IT could lead to regression: although one issue is resolved, other issues could arise from the mere presence of the IT, leading to a “cascade” of issues. For example, as discussed previously, electronic submission of course assignments has many advantages over paper submissions. However, the teacher or the teaching assistants do not have exclusive control over students’ computing environments, and therefore, it is not automatic that assignments created in one environment (that of students) will be readable or processable in another (that of the teacher or the teaching assistants).

We note that neither the aforementioned prospects, nor the concerns are absolute. Furthermore, the same IT may have certain advantages and disadvantages, but may be suitable for adoption if the benefits outweigh the costs.

Scenarios of Information Technology use in Software Engineering Education

In this section, we present scenarios of the use of IT in a classroom and outside the classroom, namely in a course project.

IT-supported notion of performance in a classroom. Performance is one of the common quality attributes of software. During one of the classroom sessions, the author used a sequence of open source IT to illustrate the notion of performance.

The classroom was equipped with a laptop computer running Linux and connected to an overhead projector. Using the Mozilla Firefox user agent, a copy of the Apache Xerces Perl parser and a (predetermined) large XML document were fetched, downloaded, and installed in the class within a few minutes. Apache Xerces Perl was run under a Linux shell, and used some of the various built-in features such as grammar caching or switching between sequential and tree-based parsing modes. (These features were decided in advance to save time.) The XML document was also modified in some of the many possible ways (while keeping it syntactically correct) using the GNU Emacs editor. The timing information from each run was appended to a file, and the final result was illustrated as a rudimentary histogram using the Gnuplot graphics utility.
The students did appreciate that such an exercise could not have been possible on the static medium of the blackboard. It is interesting to note that the technologies itself seemed “transparent” to the students and there were almost no questions about them. However, the exercise led to several non-trivial questions on how the performance would vary with respect to the different versions and vendor variations of the Linux operating system, and with respect to the underlying processor speed.

There were some technological issues. The speed at which the data scrolls down the shell interface and the contrast of background/foreground colors could have been improved for readability on the large projector screen.

The students were then, as part of an assignment, asked to first repeat the exercise as-is and subsequently, by using a different set of features of a slightly different parser (Apache Xerces C++) and with a different set of modifications to the same XML document.

**IT-supported course project.** In one of the semesters, the author supervised a project that required the students to build a Fine Art Auction System as a Web Application. The system would enable users to use the Internet/Web to check the fine art organized under different categories (impressionism, expressionism, contemporary, and so on). An art work could be found by navigating or searching in different ways (using the painter’s name, date, starting price, and so on). Users who wish to bid would have to register and provide basic information about them. The system would enable administrators to add/delete art work, modify the information on an existing art work, and allow/prohibit a user from registering/bidding.

The students were given complete freedom of choice of the underlying technology except that the process artifacts would follow existing standards, and the final system would have to be entirely based on OSS.

The teams on their own set up and used Yahoo! Groups to collaborate, used concurrent version systems (CVS) for configuration management of process documents (specifically, project schedule, requirements, design, and test plan) in Open Office and models in UML.

For the final product, some teams used Amaya as the user agent on the client-side, and the Apache Web Server, along with Apache Tomcat, for a dynamic delivery of resources on the server-side, while the others preferred the combination of Mozilla FireFox and MySQL/PHP Hypertext Preprocessor (PHP). This differential was attributed to the diverse background of courses that they had previously taken.

There were two main challenges faced during the duration of the project:

1. Since currently most of the “industrial strength” software available for quality assurance and evaluation is commercial, addressing quality control was another challenge. The students used the OSS tools from the World Wide Web Consortium (W3C) for automatically evaluating the quality of documents in extensible HTML (XHTML) and the style sheets in cascading style sheets (CSS). However, the evaluation was limited to conformance to syntax and checking for accessibility.
2. Due to security considerations, the students were not allowed to run any network software (and therefore the subsystems necessary for the project) on the University computer network. Although it raises another set of concerns, upon mutual agreement, the resolution found to this issue was that the running and testing of the executable software would be done on a notebook computer belonging to one of the students.

As concluded from an anonymous survey, the students found the project, in general, to be a rewarding experience. Although some students did not have the requisite background in aforementioned technologies but were (with the help of their peers and teaching assistants) willing to learn based on the likelihood that these technologies will useful in other courses and their future careers.

**FUTURE TRENDS**

There have been predictions of the different directions of evolution of IT and the anticipated impact on education in general (Moursund, 1997). The use of non-stationary devices such as notebook computers and mobile phones, the ascent of Web 2.0 (O’Reilly, 2005) as means of participation and collaboration, and the proliferation of OSS are some to name a few. The methodology presented in the previous section should be closely aligned with the role of OSS in SEE (Kamthan, 2006).
The symbiosis between software engineering and information technology is likely to remain active in the foreseeable future, and SEE will need to respond to this continuously changing environment. It is therefore also likely that the prospects and concerns of integrating IT in SEE that we have pointed out need to be revisited periodically.

CONCLUSION

The Internet and the advent of the Web have opened new vistas for SEE. However, the selection, adoption, and inclusion of any IT is not automatic in any sector of society, and the same applies to educational contexts.

To use IT to its full potential in SEE, a systematic approach is necessary. For that, it is important to ask the right questions. The prospects and concerns of integrating IT in SEE, highlighted in this article, provide a starting point for doing so.

In conclusion, any use of IT should be means to the end, not the end in itself. Instead of being swayed by trends, the integration of IT in SEE should be driven by the need to solve real instructional/learning problems that are otherwise difficult to address by traditional means available at the time.

ACKNOWLEDGMENT

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of Programs (EuroPLoP 2006), Irsee, Germany, July 5-9, 2006.


**KEY TERMS**

**Constructivism:** A theory of learning that views learning as a process in which the learner actively constructs or builds new ideas or concepts based upon current and past knowledge. That is, learning involves constructing one’s own knowledge from one’s own experiences.

**Information Technologies:** Technologies for various activities related to information, such as acquisition, creation, communication, dissemination, processing, archival, retrieval, transformation, and so on, within the context of the Internet and the Web.

**Objectivism:** A theory of learning that views knowledge as some entity existing independent of the mind of individuals. The goal of instruction is to communicate or transfer knowledge to learners in the most effective manner possible.

**Open Source Software:** A single encompassing term for software that satisfies the following conditions: (1) non-time delimited, complete software whose source is publicly available for (re)distribution without cost to the user, (2) imposes minimal, non-restrictive licensing conditions, and (3) is itself either based on non-proprietary technologies or on proprietary technologies that conform to (1) and (2).

**Quality:** The totality of features and characteristics of a product or a service that bear on its ability to satisfy stated or implied needs.

**Software Engineering:** A discipline that advocates a systematic approach of developing high-quality software on a large-scale, while taking into account the factors of sustainability and longevity, as well as, organizational constraints of time and resources.

**Software Process:** A set of activities, methods, practices, and transformations that are used to develop and maintain software and its associated products.
INTRODUCTION

Regarding the role of software engineering in the development of different types of e-learning systems, a traditional situation is contrasted with a modern state of the art. Traditionally, these systems, especially the intelligent tutoring systems (ITS) or artificial intelligence in education systems (AIED), are developed as research projects (Harrer & Martens, 2006). This means a comparably small group of people is involved in system development; the systems are developed with a research focus and not with respect to reusability, maintenance, robustness, or extensibility. The systems usually are not sold or used over long periods of time. In recent years, e-learning systems have reached maturity. Several e-learning systems are available as software products. They have left the stage of pure research and can now be found in relation with the buzzwords “everyday and lifelong learning.” In particular generic e-learning systems, in contrast to the more research oriented ITS, are nowadays often developed based on software engineering techniques.

The lack of usage of software engineering in research oriented e-learning systems has led to a situation where the resulting systems can hardly be compared, and communication about the existing systems is difficult. Even if a common agreement about the underlying system architecture exists, for example, the classical ITS architecture (Clancey, 1984; Martens, 2003) or the learning technology system architecture (LTSA) (Farance & Tonkel, 2001), system components usually can not be reused (for an analysis see e.g., Martens, 2004). E-learning projects often reinvent the wheel. The extension of existing research oriented e-learning software and its further development (potentially beyond pure research) seldom takes place; surprisingly, as one characteristic of software is its malleability. Why it is important to use software engineering in e-learning system development—especially in research oriented e-learning—and which methods can be used will be highlighted in this article.

BACKGROUND

In the early 1960s, the so-called software crisis has led to a new field of research, which has been named software engineering (Ghezzi, Jazayeri, & Mandrioli, 2003). Up to this date, software development has had a strong focus on programming as a personal activity. Few people participated in the development process. Programming was (and sometimes still is) perceived to be an art (Hunt & Thomas, 2001, 2006; Knuth, 1974) rather than a craft (Reynolds, 1981).

Since then the growing complexity of software systems has led to a situation where (changing) teams of developers participate over a long period of time on the development process. Nowadays, software itself is usually multiversioned, that is, it is changed during lifetime. Communication between a lot of different people about software and software development has to take place. Component oriented development, which allows different developers to work on one single project, and a clear development strategy are required. Most software systems are constructed for long-term use. Their development has to provide for reusability of components, on maintenance, robustness, reliability, correctness, and extensibility. Thus, one claim from the perspective of software engineering is to carefully design and to “engineer” software. Engineering should take place regarding the development process of the software and also regarding the resulting product. Software engineering comprises rigor and formality in the development process, the anticipation of change and extensibility regarding the resulting product, as well as modularity and abstraction at different levels of development.
E-learning can also look back on a comparably long history. The term was coined in the 1970s and has gained popularity in the last years. E-learning is related to several different types of systems. As the e-learning Glossary of Terms (Learn.com, 2007) summarizes, the term covers:

A wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, CD-ROM, and more.

In this sense, e-learning can be seen as every form of electronically supported learning. Regarding computer based learning in particular, several types of systems are embraced by the term e-learning, for example, computer based training (CBT), adaptive hypermedia (AH), intelligent tutoring systems (ITS), and game-based learning systems, to name but a few. There are some modern system types which are also part of e-learning, for example Web-portals (PostNuke, 2007), learning management systems (LMS) (Avgeriou, Papasalouros, Retalis, & Skordalakis, 2003), and platforms for structured discussion forums like the future learning environment (FLE3) (Muukkonen, Hakkarainen, & Lakkala, 1999). These approaches rely on software engineering techniques, that is, modularization, usage of patterns, and extensibility. These systems can more or less easily be extended by other developers, as it has been done for example, by Dolonen, Chen, and Morch (2003). In contrast to this, research oriented systems, like AIED systems and ITS, are seldom developed based on software engineering. Surprisingly, as these systems often have an inherent complexity. ITS and AIED systems combine different fields of research, like artificial intelligence and cognitive science. Thus, research projects consist of people with different research background. ITS and AIED systems are based on similar architectures (Martens, 2003). Usually they are developed according to a certain pedagogical or learning psychological theory. Unfortunately, in most cases neither system components nor underlying system concepts can be reused. Existing systems are often not malleable. Most of these systems lack a detailed description, which makes communication difficult. Due to these facts, the resulting systems are hardly comparable as insights are often not portable. The combination of similar underlying architectures, a heterogeneous research background in project partners, and a complex system calls for the usage of software engineering techniques in ITS and AIED system development.

Naturally, when it comes to system development, no silver bullet exists, which could cover the broad field of e-learning applications. Thus, in the following, sometimes the type of system, for which the sketched software engineering approach has been invented, is explicitly named.

**METHODS OF SOFTWARE ENGINEERING IN E-LEARNING**

In software engineering, the process of software development as well as the resulting product should be “engineered.” Engineering as an activity comprises a clear definition of the development process and a distinct vision of the resulting product. There are several methods and techniques, which can be applied in the design and development of e-learning software. Some of them are named in the following.

At the project level interdisciplinary communication between experts from computer sciences, experts from learning sciences, and experts from the training application domain is required and calls for project management approaches. At the project level, a careful design of the software production process (e.g., the waterfall model or the spiral model) (Ghezzi et al., 2003) can facilitate communication. Each expert has a field of responsibility and certain concerns regarding the resulting product. For example an expert from the application domain is responsible for the development of the expert knowledge module of an ITS. But the expert is not necessarily interested in the implementation details, like data storage and data retrieval. Also, a computer science expert, who implements the expert knowledge module, does not need to become an expert of the application domain. Given an appropriate level of abstraction can help the different expert groups to organize responsibilities and can facilitate communication about the system to develop. Software design would separate the application domain oriented specification (e.g., domain knowledge) and technical aspects of implementation. One approach in this direction has been made by the Essen learning model (ELM) (Pawlowski, 2000). ELM is a software
development model for e-learning systems. It supports
the planning and implementation of the curriculum, of
learning sequences, and of learning units at different
levels of abstraction. More information can be found at
http://wip.wi-inf.uni-essen.de/elm/elm/index.html
(ELM, 2007).

ITS are based on similar fundamental structures,
which are sometimes called the classical architecture
(Clancey, 1984). Clancey’s description of the archi-
tecture has been on a verbal level. Nonetheless, this
architecture can be seen as reference architecture, and
thus provides a kind of software engineering approach.
Reference architectures specify the main system parts
and their relationship for a special group of systems.
The ITS reference architecture consists of expert
knowledge module, pedagogical knowledge module,
user interface, learner module, and a sort of central
steering component. The naming of the parts of the
architecture varies, but their functionality in different
ITS is more or less the same (Martens, 2003, 2004).
The IEEE has proposed an architecture which should
meet the requirements of various types of e-learning
systems: the learning technology system architecture
(LTSA) (Farance & Tonkel, 2001). Clancey, as well
as the LTSA, describe a system oriented perspective.
Another reference architecture for educational systems,
which takes over a student oriented perspective (i.e.,
the student-model-centered architecture), has been
proposed by Brusilovsky (1995).

Close to reference architectures, but more focused
on best practice solutions and on compiling different
realization variants, are software patterns. Riehle and
Züllighoven (1996) gave a good definition of patterns:
“A pattern is the abstraction from a concrete form which
keeps recurring in specific non-arbitrary contexts.” In
educational systems patterns have been introduced by
Devedzic (2001). He described architecture patterns
for intelligent tutors. His approach was further devel-
oped with focus on the ITS architecture by Harrer and
Devedzic (2002). Based on these approaches, Harrer
and Martens (2006, in press) describe a generic pattern
approach for ITS, which provides the basis for a pattern
language for ITS in particular and can be extended for
e-learning systems in general. The e-LEN (2005) project
or the TELL (2005) project for collaborative networked
learning are examples for usage and development of
patterns in other e-learning projects.

Devedzic (1999) also introduced design patterns in
ITS. In contrast to general design patterns (Gamma,
Helm, Johnson, & Vlissides, 1995), the design patterns
for educational systems usually have a narrow focus,
for example, on ITS specific topics like management
of learner models. Another approach, which simply
adopts and applies existing patterns in the development
of an ITS, can be found by Illmann, Martens, Seitz,
and Weber (2000). They describe the usage of the
pattern PAC (presentation abstraction control) in the
development of a Web-based and case-based intelligent
tutoring system. A detailed discussion and analysis of
design patterns in e-learning systems can be found by
Devedzic and Harrer (2005).

Another type of patterns that can be found in e-learn-
ing is process patterns. Close to process patterns is the
learning design approach. The underlying idea of both
is the explicit modeling of process-oriented aspects in
educational systems. This embraces the transforma-
tion of implicit principles to explicit formal descriptions.
An example is the tutoring process model (Martens, 2005),
where the central steering component of an ITS, which
steers the interaction between the other modules and
is responsible for adaptation mechanisms, is formally
described. The tutoring process model describes a
computer science perspective. Another perspective is,
for example, the transformation of inherent pedagogical
principles to formal declarations, as it has been done
by the instructional design patterns (Inaba, Ohkubo,
Ikeda, Mizoguchi, & Toyoda, 2001), and the sequenc-
ing of learning activities in the IMS learning design
(IMS, 2003).

Techniques like software architectures and different
sorts of patterns are used to describe systems at a con-
ceptual level. Besides these there are other approaches,
which describe the systems at the programming level.
A prominent approach, which can quite often be found
in e-learning system development, is the framework
approach. Frameworks are used to specify software.
They determine which parts of the software system can
be used and reused unchanged, and which parts have
to be adapted. In object-oriented programming this
means for example specialization of existing classes,
instantiation of entities, and interface implementa-
tion. Ikeda and Mizoguchi (1994) developed the FITS
framework for ITS. Another example is the framework
for open distributed learning environments, described
by Müllenbrock, Tewissen, and Hoppe (1998). Oertel
(2007) developed the framework JaBIT (Java-based
intelligent tutoring), which provides a system kernel
for ITS. This framework provides the basis for differ-
ent kinds of intelligent tutoring systems. For example, using JaBIT, it is possible to alternatively construct an ITS with a simulation component, a “simple” ITS, or an ITS with virtual tutor. The framework JaBIT is based on the classical ITS architecture mentioned above, and allows for a flexible exchange of components and modules. Moreover, JaBIT is realized-based on software and design patterns, using the pattern language described by Harrer and Martens (2007).

Component oriented design, as realized in JaBIT, can be seen as another approach to develop and describe systems at program level. A system is constituted by a set of different components. Each component must be developed based on predefined interfaces and exchange formats (see e.g., Szyperski, 2002). Components can have different backgrounds. For example, Martens and Himmelspach (2005) describe the extension of a component based simulation system, JAMES II (Java-based modeling environment for simulation), with ITS components, which are based on the classical ITS architecture. Another example, which is focused on the flexible combination of components, is the scalable architecture for interactive learning (SAIL) (SAIL, 2005).

Refactoring is the last example for development at the program level. The aim of refactoring is to restructure existing software, to make it modular, flexible, and extensible, without changing the main software functionality (Fowler, Beck, Brant, Opdyke, & Roberts, 1999). Thus, refactoring can be used to improve existing e-learning systems (Harrer, 2003).

Close to the sketched software engineering aspects, other approaches support the development of e-learning systems as well. These are, for example, standards, like the learning technology system architecture (LTSA) (Farance & Tonkel, 2001), and extensible markup language (XML) oriented meta data descriptions for e-learning systems, like the Dublin Core Metadata Initiative (DCMI, 2002). The advantage of these approaches is the clear definition of terms. Main disadvantage is that the interpretation of the role, the functionality, and the implementation is not guided or described. This is a potential source of ambiguity, when it comes to system development. For example, even if the verbal description of the ITS architecture (Clancey, 1984) can be relocated in almost all existing ITS, interpretation of each component’s functionality in the system context varies a lot (for an analysis see Martens, 2003). In the long run this leads to systems which are not really comparable.

Yet another approach on the level of concepts is the development of ontologies. An ontology structures the basic concepts and relations of an application domain, and thus provides the basis for communication. At the program level this can be used as the basis for interoperability, for communication between components, and for the homogeneous description of interfaces. An approach in this direction in ITS research is the Omnibus ontology (e.g., Mizoguchi, Ikeda, & Sinitsa, 1997; Omnibus, 2002).

CONCLUSION

Methods and techniques of software engineering support the design and development of software that is correct, reusable, malleable, maintainable, robust, and reliable. These aspects are important when it comes to the development of e-learning systems. Usually, e-learning systems are developed by large teams of people with different research background, for example, computer science and psychology. Rigorous design of e-learning systems can facilitate communication about system functionality from an early stage of development. This adds to the quality of the resulting system, and moreover it can lead to system descriptions which are comparable and support communication across project borders.

In contrast to pure research oriented ITS, other e-learning systems are often commercialized. In such a case, software engineering is the fundament of multi-versioned software, which is supported and extended over long periods of time. Regarding the complexity of the underlying systems, especially aspects like reusability and extensibility are also very important for the ITS research projects, even if their main purpose is not a commercial one.

REFERENCES


Software Engineering in E-Learning Systems


**KEY TERMS**

E-learning Systems: In the broad sense, the term e-learning comprises all kinds of electronically supported learning. In a narrow sense, in which it is often used in research, it comprises all kinds of computer based learning systems, like for example computer based training (CBT), Web-based training (WBT), adaptive hypermedia (AH), intelligent tutoring systems (ITS), training simulations, game-based learning systems, and so forth.
**Frameworks:** Whereas reference architectures and patterns describe systems at a conceptual level, frameworks are used to describe systems at the programming level. Frameworks are used to specify software.

**Patterns:** Patterns (in the computer science sense) describe best practice solutions and different realization variants of a special group of systems. Patterns are abstractions from concrete forms. Examples are architecture patterns, design patterns, and process patterns.

**Refactoring:** Refactoring is used to restructure existing software regarding aspects like modularity, flexibility, and extensibility, without changing the main software functionality.

**Reference Architectures:** Reference architectures specify the main parts of a system (i.e., similar fundamental structures) and their relationship for a special group of systems.

**Software Engineering:** To engineer the development of software comprises a rigorous analysis and design of the product, the application of formal methods in the development process, and the resulting product description, and modularization of the relevant parts of the software to allow for malleability and for reusability. Different participating parties have different concerns regarding the resulting product, for example, different views on the software. These concerns have to be taken into account. During the software development, different levels of abstraction are required and facilitate the development process. Correctness of the resulting product, as well as reliability, is supported by carefully engineered software systems. Examples for software engineering techniques in e-learning are project management systems, reference architectures, different kinds of patterns, learning design, frameworks, component based design, refactoring, and also standards, meta data descriptions, and ontologies.
INTRODUCTION

Evaluating software is an important component in the process of choosing technology for learning and instruction. The saying goes that you can not read a book by its cover but that is not necessarily true for software. In fact the first thing to understand about a possible software solution has nothing to do with the software. Whether it is for student learning or district management, the key to finding the right software is to know exactly why it is needed and how it is going to be used. For example, selecting software for kindergarten students to learn their numbers requires an understanding of how 5-year old children process information, physically manipulate computer keyboards and a mouse, and understanding how they will use it in class. A teacher should know if students will work independently or in groups and how long will they have to work during any one session. Will their work be saved? If students will work cooperatively, software should be chosen that is designed to engage all the students sitting around the computer. These are a few considerations that teachers should use when they initially review software. There are several others listed later in this article and guidelines listed in the references.

There is one basic rule for software selection that helps people make a fairly quick decision about the purchase. It is now commonly used and referred to as the 15-minute rule. It basically means if a person cannot understand software in the first 15 minutes of using it, then give it no more precious time and move on to another company or title. Not only should the software be intuitive but also the installation should be easy and quick. If it is network software do not forget to involve district technicians in the assessment. They can help with questions concerning software versions, computer compatibility, and network accessibility. And the technicians will really appreciate being involved and proactive. The short version of a software assessment is to use the 15-minute rule, know who will use it and why, think of student learning styles and needs, and ask the technicians for help with compatibility. Remember that technicians are not teachers. They are not qualified to select student software, although this often happens. The rest of this article identifies the process for software purchases, Internet software and programs, checklists for easy 1-2-3 evaluations, and hardware needs.

A simple search on Google provides over 343,000,000 hits for software reviews and selection processes. There are an abundance of checklists, processes, and review strategies on the Internet via articles, books, and journals. The problem is that teachers don’t have the time! Teaching and administration in schools requires a lot of time and thought. The question is where we find the time to review software too! Often one or two teachers review software products, but if these results are not shared it may come at a price. This is one case where the more buy in by the whole grade level and the more solutions this software will offer students the better it will serve educational needs and the more equitably it will be used throughout the grade level. Software should impact the curriculum and be a part of its delivery. There should not be options to “not” use it; therefore the more buy in, the better. The same is true for management software. Understanding why it is needed, how it is to be used, and eliciting the input of the end users increases potential success. This will give the district better value for funding resources and increased integration of technology into the curriculum; always a good thing for students. Here are some quick and easy guidelines to use for the selection process:

- Make it a curricula decision and not just a software decision.
- Involve as many people as possible, especially the curriculum and technology directors or supervisor, teachers, students, and the technician.
- Specifically identify the outcomes for the software. Know exactly what skills or concepts the student should experience or what management procedures that need to be improved or automated.
- Have consensus on these outcomes prior to previewing and purchase. It is always a good idea to
put it in the hands of students first and get their reaction!

- Budget for upgrades and write it into the curriculum for ongoing use and review throughout the upcoming years.
- Collect data to determine success and future plan of actions.
- Do not write the title of software into an individual education plan (IEP). Write in the skill set and objective of the technology. This will help manage these needs as the student progresses through grade levels and schools.

A final note about the process is to restate the obvious; educators do not have a lot of time to do this. It is a reality of education. However, if the software truly impacts student-learning, teachers will make the time. Still, keep the discussion meetings short and to the point. Many times a meeting is not needed. Just load the trial software on the computers and let teachers and students play with it for a month. Collect the “checklists” identifying key uses and concepts and talk with the participants at the end of the month and the decision will be made.

There are very lengthy checklists for software selection and this is another time grabber. A good assessment needs a good review but there will not be many responses if it takes a lot of time to fill the survey out. So make it brief. Below are five simple questions for the student and the teacher. Remember when the software was identified the need and title were decided as well as collaboration, the use of data, and compatibility issues with district hardware.

Student Review:
- Was it easy to use?
- Did it keep your attention?
- Was it challenging?
- Would you like to use it again?
- Did it help you learn something?

Teacher Review:
- Was the student engaged?
- Did the software provide student results and were they easy to access?
- Did the use of the software integrate with the curriculum lesson?
- Can the software be managed in the classroom? (Do the students need the teacher’s help?)
- What is the student goal? (To provide consistency and collect reliable data this needs to be identified and planned to synchronize with lessons.)

Students and teachers can use a Likert scale for their assessment. Depending on the grade level the scale can be numbers, words, or even smiley faces. The important thing is to complete an assessment easily and in a timely fashion.

There is much to be said for being proactive and giving staff time to use and reflect on software applications. But the world of education is not perfect and reality suggests that sometimes we need to make decisions very quickly. But good decisions can still be made and stakeholders can still be involved in the process. When decisions have to be made within a short time frame, use the following strategies to complete the review. Locate existing reviews on the Internet and give them to staff to aid in their review. Contact other schools for their evaluations. Gather staff into one review sitting and have them work together. Gather students into one review sitting during recess and have them work together. Participate in a Webinar where the software will be modeled and demonstrated by an expert.

It is important to resist the pressure of time and cut back on the review process. If time really is of the essence, determine how to proceed while protecting taxpayer’s money and the educational experience for students. Planning within realistic expectations and time frames will enable better investments and software selection.

Teachers should be encouraged to use software to help them and their students. Many teachers say that they would not know how to do this or even know what to look for. As a result their students do not interact with technology. But every teacher has the skill set and intelligence to do this. What confuses some teachers is the technology lingo and advertisements. It is hard to read a Web page or catalog when one does not know what to look for. It takes some understanding to adjust our reading habits to the diversity of today’s advertisement. Reading the fine print is necessary and will often help to make that quick decision of whether the product will meet the standards of the district. Here are a few tips: (1) know what kind of computer is used (PC or MAC), (2) what is the computer operating system (OS), does it have DVD or CD, and Internet/Network access. Remember the technician can help with this information and should be involved at this point. (See Table 1).
Software Evaluation

CONCLUSION

Using technology and software for learning and teaching opens the windows of opportunity for all learners. Paradigms will slowly shift to better understand the influence of these resources on our brains, behavior, and learning environment. It is a future that all of us should participate in and model for our students. Knowing how to select powerful and appropriate software is a great first step to helping students learn with technology. By doing so, teachers align educational experiences with the real world and create another authentic learning experience for their students.

REFERENCES


KEYWORDS

Authentic Learning: Learning activities that align with real world experiences and encourage students to use higher order inquiry based skills for problem-based learning.

DVD (Digital Versatile Disc): An optical disc storage format used to store high video and sound.


Hits: A term used to identify each time a Web site is visited or the number of possible sites listed in a Web search.

Likert Scale: A psychometric response scale often used in questionnaires.

Operating System (OS): The required program/software that runs the basic and critical functions of a computer.

### Table 1. Checklist

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
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<th>SOFTWARE</th>
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<td>Computer Make</td>
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<tr>
<td>Computer Model</td>
<td>Software Compatibility – PC/MAC</td>
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<td>OS – version ___</td>
<td>Software Version</td>
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<tr>
<td>DVD – Yes/No</td>
<td>Software Use – DVD, CD, Network, Internet</td>
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<tr>
<td>CD – Yes/No</td>
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<td>Internet – Yes/No</td>
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<tr>
<td>Network – Yes/No</td>
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**PC or Mac:** Two types of computers that run different operating software. PC (personal computer) aligns with types such as Dell, IBM, or HP. Mac (Macintosh) computers are designed by Apple Computers.

**Webinar:** A type of Web conference hosting a program that can be viewed by one or many persons that have access to the Internet at one time.
INTRODUCTION

The spreadsheet and the personal computer are intrinsically bound. In the early 1980s, the spreadsheet was the first “killer app”—the software application that drove people to buy a personal computer. While specialized computers for word processing were replacing typewriters and database software captured the computing power of mainframes, the spreadsheet allowed managers to track, analyze, and model decisions, especially financial decisions, using a tool with low barriers to entry on an affordable computer.

HISTORY

Dan Bricklin, while a student at Harvard Business School, conceived the electronic spreadsheet and developed a simple prototype in 1978. Bob Frankston, a friend from MIT, assisted with the programming to develop the Visicalc, the first commercially available spreadsheet for the personal computer. Originally programmed for the Apple ][, Visicalc was ported to a number of micro-computers as well as handheld calculators (Bricklin, undated).

Mitch Kapor, originally a product manager for Visicalc, developed the Lotus 1-2-3 spreadsheet in the early 1980s. Capitalizing on the introduction of the IBM PC, Lotus became one of the best selling software products ever published. The combination of the IBM PC with the Lotus 1-2-3 spreadsheet, transformed the PC from a hobbyist’s toy into an important business tool (Power, 2004).

Just as the developers of Visicalc had not anticipated the role of the IBM PC, so did Lotus miss the importance of the graphical user interface and its instantiation as Microsoft Windows. Microsoft had developed the Excel spreadsheet for the Macintosh computer and used its experience there to produce Excel for Windows, the subsequent dominant spreadsheet with a market share in early 2005 of 90% (Liebowitz & Margolis, 2001).

Excel’s most recent challenge is coming from Google, which has developed an online spreadsheet to complement its other online applications. While Google’s spreadsheet does not contain as many features as Excel, it has the notable ability to leverage the communicative aspects of the Web by allowing for interactive sharing (Google, 2006).

It is suggested that the electronic spreadsheet originated with the work of Mattessich in the early 1960s (Mattessich, 1961, 1961-1964). However, the Bricklin/Frankston concept, which is the current model, required interactive technologies, such as a mouse, that were not yet developed. Furthermore, the Bricklin/Frankston concept is grounded as a more general purpose tool than the Mattessich model, whose domain was accounting.

CONCEPT

The spreadsheet has become so much at hand that the subtleties of its design, like those of the paper clip, are simply taken for granted. Furthermore, the spreadsheet has matured along with the personal computer, such that original concepts, for example, using a mouse as a pointing device rather than arrow keys, have become integrated as a natural evolution. Furthermore, earlier problems, such as the speed of recalculation, have become secondary, reinforcing the Bricklin/Frankston model that required automatic recalculation. The following discussion intertwines a conceptual perspective and an instantiation using Microsoft Excel as the example application. For the purposes of the discussion, the spreadsheet is a general personal computer application, which runs in a graphical environment. Specialized numerical software, either in statistics or accounting that uses a similar tabular layout or text-based finance programs, fall outside the definition for this article.
Spreadsheets

Visual Operation and Presentation

The current spreadsheet is a multi-dimensional, addressable, ordered array of cells whose contents may be text, values, formulas, or functions, which is able to display and store data and evaluate expressions. The spreadsheet presentation is made up of rows and columns, where the rows are usually identified numerically and the columns are identified alphabetically. A cell, the intersection of a row and column, is therefore addressed by its column heading then row location. For example, the cell in the upper left, or first cell, is A1—indicating the first row and first column. The address at the 29th row and 27th column would be AC27, indicating the 29th column by repeating the first letter of the alphabet followed by the 3rd letter. The current version of Microsoft Excel can create a sheet of 256 columns by 65,536 rows, with the address of the last cell being IV65536.

Operating with a spreadsheet is visual, spatial, and interactive, primarily by using a mouse or cursor keys to select cells, although it may be done programmatically via a scripting language. Once a cell is selected, data may be entered. This data may be text, values, formulas, or a combination thereof. Text includes the use of alphanumeric data, such as “Quarter 1” to indicate the first quarter, or numeric data, such as a Social Security Number or SKU, whose purpose is purely identification. Values are numeric entries which may be used in mathematical operations. Formulas are equations written by the user that the spreadsheet evaluates. Functions are complex formulas programmed into the spreadsheet, such as the PMT, or payment function, in Microsoft Excel, which calculates the monthly payment on a loan at a fixed rate. The requirement that the application recognizes the data type of the cell entry is integral to the spreadsheet. Excel implements this by aligning text to the left of the cell and values to the right.

A single spreadsheet can be thought of as having multiple views. The most common view is the presentation view. In its simplest terms, this view can display or hide grid lines or introduce visual features to cue the user, such as presenting negative numbers in red, as is the accounting convention. More importantly, the format of the cell may cause the underlying value to display differently. For example, a cell with the number 0.0495 formatted as currency will display $0.05. Similarly, a date, represented by a numerical value which begins with the value 1 representing January 1, 1904, may show the data with the month as text, for example “Jan 01 1904”, or numerically, “01/01/1904”.

Despite the presentation of the value in the cell, any calculation, however, will use the value stored in that cell. The result, therefore, of 0.0495 * 20 will be $0.99 and not $1.00 were the operation to have been 0.05 * 20. The storage of value data can lead to errors by those unfamiliar with the accommodations computers make for binary storage and floating point operations.

The presentation view will obscure formulas or functions that may be present in the cells because it shows only the results of such operations. It is possible to switch the view to the formula view that shows the mathematical operations that produce the results. One may also see the actual cell contents in an area independent of the tabular sheet where the formula may be typed, commonly known as the formula bar.

Individual spreadsheets are often gathered into a workbook of multiple sheets. These sheets may be interlinked so that cell contents may be referenced by other sheets. This is known colloquially as a 3-D reference—the first two dimensions are on the sheet, with column and row identification, while the third dimension is a subsequent sheet. It is, in theory, possible to address any cell in any spreadsheet if the full path, including the machine name, directory, filename, and cell location, are known.

The Power of Cell References

Mathematical expressions or formulas, such as adding two numbers, or functions, such as computing the monthly payment, may use specific values, for example 2 + 3 or an interest rate of 5%. However, the power of the spreadsheet comes from creating expressions using cell references, such as A1 + A2. Four reasons drive this power.

First, the result is automatically recalculated. Bricklin reports that the automatic recalculation was inspired by watching his professor erase and re-enter changed values in an example on the blackboard (Bricklin, undated). It is the ability to instantly recalculate that allows a spreadsheet to perform “what if” analysis where the result may be seen when values change. The concept of referencing cells also encourages the development of a spreadsheet for a general solution rather
Spreadsheets

than a specific solution, leading to templates that can be applied across an organization (McKenzie, 2000; Polya, 1981). For example, an income statement has a standard form that accounts for revenue, expenses, their totals, and the net revenue. A spreadsheet to present and compute these results may be used in all departments of a business.

Second, the resultant cell may be in another location. This example, the resultant of $A1 + A2$, could be put into a cell D5. With a well-designed spreadsheet, it is possible to program by example using such common real-world referents as Fixed Expenses + Variable Expenses equals Total Expenses. In more recent spreadsheets, it is possible to refer to cells by labels rather than simply addresses, minimizing the translation between the numerical representation and the business operation. This allows for a measure of self-documenting rather than relying on mere cell references.

Third, the cell references may be relative or absolute. This distinction means that the cells A1 and A2 are two and one places above the cell A3. If a formula, such as $A1 + A2$, is entered into cell A3, then the formula is copied to cell C3. The resulting formula will operate on the cells C1 and C2, again two and one places above the resultant. On the other hand, if the cell references in A3 were absolute, then copying the contents to cell C3 or any other location would result in the operation on cells A1 and A2. Implementing the concepts of relative and absolute addressing allows the building of complex formulas that may be replicated throughout the spreadsheet. For programmers, these different cell references are analogous to local (relative) and global (absolute) variables.

Fourth, the cell references may be grouped as a range of cells and addressed as a range. This is usually done by specifying the top left and lower right corners, as in A1:C3, to identify the range that includes all the cells: A1, A2, A3, B1, B2, B3, and C1, C2, C3. In more recent spreadsheets these ranges may be named, allowing for complex functions, such as a lookup function where a row in the first column in the range contains an entering value while a subsequent column in the same row contains a returned value.

Data Representation

While the spreadsheet is the first application to introduce many personal computer users to the computational aspects of a personal computer, it has capabilities beyond calculation. Numbers are often used to represent real-world concepts, such as profit. However, comparisons of numerical values can offer insights not apparent in a printed grid and sometimes data is represented textually or, as with zip codes, by numeric identification. The ability to manage the rich representation of data also leads to the adoption of the spreadsheet as a general data manipulation tool.

Graphical representation of numbers lends itself to showing comparisons and trends. As with Microsoft Excel, a range of data may be plotted as a chart. The chart form may vary to best represent the types of comparisons in the data, from simple pie charts to more complex hi-lo-close stock charts. Again, as with the numerical values, a change in the underlying referenced cell results in a change in the charted values.

In addition to graphical representation, viewing the data in relationship to other data in the same set can often yield insights. Lotus first introduced what have come to be known as pivot tables in Improv, a spreadsheet designed for the NeXT computer in the early 1990s (Liebowitz & Margolis, 2001). A pivot table allows the user to summarize data from a tabular form by varying the views of the rows and columns. For example, in a range where the first column is gender, either male or female, and the second column is age at graduation, the user can summarize the data with a presentation that will yield the count of the males and females by age at graduation. Pivot tables can encourage data exploration and analysis by comparing categories.

With the flexibility of the spreadsheet to hold different data types in a cell, it is not surprising that many database-like operations have become part of the spreadsheet. Given that the data is already structured in rows and columns, the view looks similar to a flat file database table where the fields are represented by columns, and the records are represented by rows. This layout lends itself to simple ordering, or sorting, filtering, and data aggregation by counts, sums, or similar operations. The spreadsheet has become such a common database tool that there are numerous books, articles, and tools to assist with migrating an Excel tracking workbook to a relational database (Intelligent Converters, 2001).

In addition to the database functions, spreadsheets often contain a full range of text functions. These can transform text in a myriad of ways, such as providing
the ASCII values, searching for a particular letter, or reporting the location of a particular character like a comma or space. This set of functions allows for string manipulation, which is similar to many programming languages. In some ways the features are richer as it is simple to parse text into columns, thereby creating a dataset for subsequent manipulation. For example, a list of e-mail addresses could be parsed at the @ symbol and the upper level domains to create a managed list to order names alphabetically, by domain, or by upper level domain to find all the .edu or .gov. or .com members.

**Programming**

Unbeknownst to casual users of spreadsheets, the spreadsheet is a programming environment. The spreadsheet is a visual and functional programming language, which uses programming-by-example as its core construct. This becomes apparent when a simple cell referenced formula, such as $3 + 2$, is rewritten as:

Set $A1 = 3$
Set $A2 = 2$
Set $A3 = A1 + A2$

Instantiated in a spreadsheet, the result follows by entering the value in the respective cells and the formula into the resultant cell.

This basic programming example may be extended by using the built-in, spreadsheet functions. Currently, Excel has over 350 built-in functions. These functions allow users to develop complex scenarios that include logic, text manipulation, and statistical tests. In addition to these built-in functions, it is possible to get specific add-ons or plug-ins that will allow for specialized operations such as optimization models.

While the notion that building a spreadsheet is actually programming is foreign to some users, many are familiar with the concept of application macros. These originated as recordings of keystrokes to automate repeated actions. With the dominance of Excel, however, its original macro language has been subsumed by Visual Basic for Applications (VBA). This is the programming language for the Microsoft Office suite that allows almost complete access to the applications and operating system. An experienced programmer may develop specialized applications either within Excel or to integrate a database or word processor.

**FUTURE DEVELOPMENTS**

The development of applications delivered via the Web, as with the Google spreadsheet example, demonstrates that the underlying definition of the spreadsheet may move to a declarative language such as XML. This format will make the data more accessible and allow for ease in collaboration among people and simplify exchanging data between applications. It has become apparent from the success of the spreadsheet that the tabular layout has a particular power in organizing data.

An additional area for development lies in error checking tools. As spreadsheets have become so common, frequently designed by end users rather than programmers, the error rates within spreadsheets have become an issue. Given that programmers understand the spreadsheet is a functional programming environment, they should be able to use their methodologies and deeper understanding to create tools to assist with minimizing errors (EuSPRIG, 2006).

Furthermore, regulatory agencies and governments have come to realize that data kept in spreadsheets is often used as business records. The management of this business data may not have the same controls and redundancy as a dedicated system. The United States passage in 2002 of the Sarbanes-Oxley legislation, in part in response to the business scandals of the early 21st century, caused many companies to re-examine the means of keeping their business records. This may lead to control methods, such as embedded access control to enter and change data or formulas, to become built into future spreadsheets.

**CONCLUSION**

The spreadsheet is the characteristic application for the graphical user interface in the personal computer. It combines the features of visual organization in a tabular grid, selection via a pointing device, and programming by assigning values to variable represented as cells. Part of the spreadsheet’s power comes from its being “ready-to-hand”, a concept from Heidegger, which allows one to act in the world without being required to reflect on the tools one is using or what one is doing (Winograd & Flores, 1987). Walking is a
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prime example of “ready-at-hand” because when one focuses on walking, one stumbles. The implementation of the spreadsheet fits the environment so naturally that users are not compelled to think about it; rather they focus on their tasks.

This ease carries a danger. As a general purpose tool, spreadsheets are often used for applications they were not intended to support. For example, a spreadsheet may be developed to provide an initial customer list, using the database functions. As the customer list grows and the variety increases, a relational database would be a more appropriate solution. Or, a spreadsheet may be used to track sales and account transactions, which would be better recorded in a specialized accounting package.

Just as with any tool, its applicability in one area, such as a hammer for pounding nails, says little about its utility in another area, such as a doorstop. In working with passionate spreadsheet users, it is helpful to remember if the only tool is a hammer, everything looks like a nail. The power and flexibility of the spreadsheet coupled with the importance of representing the real world numerically, as in sales costs, sales volume, and derived profit, has introduced many more people to true computing. While word processors, graphics programs, and e-mail give computing a richer dimension, the computer’s origins were in mathematical representation, the natural place of the spreadsheet.

REFERENCES


KEY TERMS

3D Reference: A cell reference that includes a cell located on another spreadsheet.

Absolute Reference: A reference to a cell that is a fixed location.

Cell: The intersection of a row and column in a spreadsheet.

Cell Reference: The means of addressing a cell, usually by its column, a letter designation, followed by a numeral, its row designation. For example, B2 is the cell at the second column and second row.

Formula: A cell entry that contains a mathematical expression which may contain cell references or constants.

Function: A complex formula built into a spreadsheet and referenced by a name, such as AVG for an
average function to calculate the average of a range.

**Range:** An area of cells specified by the upper left and lower right cells.

**Relative Reference:** A reference to a cell that is relative to the selected cell. This reference changes if the cell is copied.

**Spreadsheet:** A multi-dimensional, addressable, ordered array of cells whose contents may be text, values, formulas, or functions, which is able to display and store data and evaluate expressions.

**Text:** Cell entries that include text and numeric identifiers such as a Social Security Number.

**Value:** A numeric entry that has a value and may be used in a mathematical expression.
Spyware

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INTRODUCTION

Spyware is a software program that runs silently in the background draining valuable computer system resources while monitoring the user’s activities. Without a security suite or an antispyware software program installed on a user’s computer, this security breach is difficult for a user to identify while giving hackers an electronic line of attack in hijacking personal information. Spyware applications can run in the background at boot up, slow the microprocessor with requests, and take up random access memory. Spyware may reset a startup page or redirect your search engine; it may likely produce conspicuous advertising pop-ups each time a browser loads ordinary Web pages (Coustan, n.d.).

BACKGROUND

In one variation, unbeknownst to the user, spyware collects personal information from the user’s hard drive and sends this data through the Internet to a Web server. A common function of spyware is reassigning customized popup ads as the startup page to the user’s browser. Spyware is often disguised within freeware or shareware applications that can readily be downloaded from the Internet albeit one must read the small print to know. While all freeware and shareware applications will not contain spyware, consumers must be aware of potential dangers. Spyware contains the capability to collect personally identifiable information such as social security numbers, credit card numbers, passwords, and addresses. Like a Trojan horse, spyware secretly installs itself while the unaware user is installing another program. Frequently these undisclosed downloads transpire through peer-to-peer file sharing networks. For example, after installing a freeware program the user begins to surf the Internet. As an unsuspecting user, most do not realize that a spyware program is tracking and recording their Web surfing habits and sending the personal data back to a third party programmer or Web server. The only way to reveal this spyware, or as it is sometimes called malware, is to install an antispyware program.

IS SPYWARE SYNONYMOUS WITH ADWARE?

There is some confusion between “adware,” which is seen as legitimate software by most consumers, and “spyware.” Adware is defined as advertising that is placed into downloadable products that users will “put up with” in order to gain functionality of a program in exchange for not purchasing it. There is usually some limited functionality if the user does not buy it, but many consumers will decide to try before they buy and agree to endure this adware aspect. Other authors may distribute a product with full features and choose to get paid via the advertising in their product and again the consumer will have to agree to the advertising or not be able to use the software at all. In most cases, the ads are not malicious and do not track or report any buying habits to another party like spyware. Spyware is intrusive because the consumer is not usually informed about it through an end user licensing agreement (EULA) or any other means before downloading the software. It is packaged with software but there may not be any documentation concerning the program in the fine print. The user unintentionally installs the spyware program and in the background possibly sends personal information back to a Web server. Not only can these executable programs steal personal information, but they can install other software programs that can observe keystrokes, monitor chats, read cookies, and sell information to a third party.

POTENTIAL PROBLEMS FACING EDUCATORS AND BUSINESS

Technology support personnel and school administrators should keep electronic security in schools updated through an automated weekly process. Definitions are typically updated and revamped weekly and can
be a time-consuming activity if completed manually. It is important for teachers to let students know that computers, even with the best security software on the most secure networks, cannot be 100% fool proof and never send identifiable information about themselves on the internet. It also protects the schools from liability in the case of liability and hopefully there are policies in place to protect the schools and students. It is almost impossible for one teacher to monitor an entire classroom’s activities in a computer lab, so it is important to have security software in place and have Internet usage agreements signed by parents to keep school liabilities at a minimum.

In some cases, even if users believe that a spyware removal tool has completely removed the spyware contamination from their computer, a user may not have entirely removed the spyware or malware because in some cases it has replicated itself to another location on the computer. It is often recommended then that you use the system restore feature of Windows to go back in time to restore your computer to a time before it became infected. There are times too that the antispyware tool being used will not detect malware because it is so new. However, some of the signs may be there are ads popping up on the screen include pornography, computer slow-down, and other annoyances. If all the latest updates have been downloaded to the antispyware program it may be possible to eliminate the malware threat by going into Task Manager and looking up each process to determine what each does in order to locate the problem or source of the problem. This can be a time-consuming task but can help alleviate the issue at hand.

According to “Keeping An Eye On Spyware” (2006), best practices include keeping operating systems updated, downloading free software from trustworthy sources, ensuring that browser security settings are set to at least “Medium,” installing a firewall that has outbound alerts, and reading all end-user license agreements before downloading any software (especially freeware and shareware). Also, never click on links from a pop-up or pop-under window even if it offers to take you to a screen offering an antispyware product and it is offered for free. Always close the windows of pop-up and pop-under windows by the “x” in the corner of the window.

If you are looking for a trustworthy site to choose a highly rated security suite or antispyware program use CNET.com, PC Magazine, MacWorld, Consumer Reports, or public message boards for reliable reports. Another suggestion includes using Linux as an operating system instead of Windows or Mac OS X because it does not get as bogged down with spyware according to Cantor (2007). At this time, several highly rated consumer antispyware programs include Webroot Spy Sweeper, ZoneAlarm Anti-Spyware, and Spyware Doctor. There are free antispyware software programs including Lavasoft’s AdAware SE Personal Edition and Spybot - Search & Destroy, but it is difficult for these programs to keep pace with some of the commercial software programs. Of course, any antispyware software is better than no antispyware software.

SOLUTIONS

In 2005, Sony introduced rootkits in some compact discs to help curtail the illegal copying of music discs (Schneier, 2005). One of the problems the company did not foresee was the software it was placing on these compact discs, a type of rootkit, was a group of files that subvert Windows and can hide from the registry and the Windows Task Manager. This keeps the code from being detected from typical spyware removal tools. A software program on the Microsoft Web site, RootkitRevealer (Brandon, 2007) can be downloaded and used to find any rootkits on a Windows system.

Webroot, a commercial provider of Internet security software, recently completed a survey of over 3,000 computer users. With 82% of teens in this sample indicating they visit social networking sites and almost all signifying that they surf the Internet, 92% will open an attachment, embed a link, click on a pop-up, and download a game, music, or screen-saver; this will put their computer at risk of spyware contamination (Hothouse Communication, 2007). The results of this could possibly lead to ID theft including credit card robbery, and not just personal data, but of family users as well.

As omnipresent as the mobile phone has become and with the additional technological advances of streaming live television to surfing the Internet the mobile phone has become the one technology to have. On the flip side, hackers have recognized this and mobile devices now have their share of dangers including viruses and spyware. According to Hypponen (2006), a software program called FlexiSpy was discovered that invisibly sends a log of phone calls and multimedia messages.
Spyware

to a third party. As of this article there are more than 300 forms of mobile malware programming bugs and security design flaws. Fortunately for users there is antivirus software available for smartphones but few consumers are using it to protect themselves.

The following are some clues that may help determine if spyware has infected a computer: 1) there are a flood of popup ads on the desktop, 2) the browser is being redirected to random Web sites, 3) the browser’s home page has been altered, 4) there are new toolbars in the browser, 5) there are new icons in the system tray, 5) there are keyboard keys that do not work, 6) there are random error messages, and 7) the computer has become sluggish (N.A., 2006).

LEGAL IMPLICATIONS

There has been growing interest in Congress over issues in spyware during the last few years. “Spyware is technological trespassing, say several members of a House subcommittee eager to pass legislation banning downloads without a user’s clear permission” (Kumler, 2004). According to Coustan (n.d.), federal legislation such as the Computer Fraud and Abuse Act prohibits the installation of unauthorized software on unsuspecting computer users. The dilemma is that this legislation is exceptionally complicated to implement and enforce and hackers know this. Many states including Utah with the Spyware Control Act and California with the Consumer Protection Against Spyware Act have already enacted legislation at the state level that bans spyware. Under the Spyware Control Act, those parties found guilty can be fined up to $10,000 per incident. Under the Utah statute a company that wants to install surveillance software must fully disclose the personal information that it is sending back to the servers (Spring, 2004).

However, the Commissioner of the Federal Trade Commission (FTC), Mozelle W. Thompson, would like to see business and industry standardize themselves if the companies would create a campaign to educate consumers on making informed decisions about spyware and how spyware works. The FTC has held workshops on the consequences of spyware, the effects on consumers, and on best practices. The FTC would like business and industry to formulate an action plan for governmental use that would penalize businesses that continue to use spyware to invade consumer privacy and in other unscrupulous manners (Thompson, 2004).

CONCLUSION

It is critical that educators recognize the consequences and the invasive nature of spyware. Spyware can slow down local computer systems and even networks by taking up valuable resources, send advertising pop-ups, redirect home pages, change search engines results, and steal personal data. It is imperative that educators teach students not to put any personal data into the material they are working on, especially Web pages, or the Internet. Hopefully, this will translate over to the family and Internet computing will become safer for everyone.

REFERENCES


**KEY TERMS**

**Adware:** Software that examines and can report Internet usage pattern to hackers. Also can direct pop up ads to the users computer. Many peer-to-peer file-sharing programs come bundled with adware.

**Cookies:** Bits or pieces of information stored on a user’s hard drive that are used to help Web sites better cater to the interests of the Web surfer. The information is embedded in the HTML is stored as a text string and is sent between the Web servers and the users computer. Cookies are not typically harmful but allow the company’s server to recollect customized information to better serve and improve the experience of the client.

**Pop-up Ad:** Usually with spyware it is an advertising window that appears on top of the browser window of the Web site currently being visited.

**Trojans:** A Trojan horse is a malevolent program concealed as a safe software program. Trojans spread through Web downloads and e-mail and not like viruses. Trojans can disable security software to allow hackers remote access to a computer.
INTRODUCTION

The importance of a student’s involvement in learning is well documented and well known. It is easy to sum up research related to active learning by simply saying, “students who participate in the learning process learn more than those who do not” (Weaver & Qi, 2005, p. 570). Active learning seeks to create a learner-centered environment and engage students as active participants in their education. The opposite of this is passive learning, which is thought of as the traditional way of teaching where the professor is a subject matter expert whose role is to convey the knowledge to an audience of students (Barr & Tagg, 1995).

While the success of active learning is well documented, some instructors may find it difficult to fully engage students as active learners in the classroom. Active learning requires student participation, which is easier for some students than it is for others. Larkin and Pines (2003) found the common practice of calling on students to promote active learning in the classroom resulted in a “clear and unmistakable pattern of avoidance behavior as reported by both male and female students” because many students seek ways to avoid the psychologically unpleasant situation of providing the wrong answer and looking foolish. Larkin and Pines (2003) argue that if a student’s emotional and cognitive resources become directed towards avoiding the immediate threat of being called on, then arguably the practice of calling on students may reduce active learning, which was the intended goal of calling on the student in the first place. Fortunately, educational technologies are able to assist in this challenge.

Debevec and Shih (2005) support the value of computer-assisted presentations and multimedia used in the classroom in terms of helping students remember what they were learning, enhancing their interest in learning the subject, and improving their understanding of course material. Research in the area of science and math education argues that technology has the potential to change how and what students learn (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). While adding technology into the classroom is not a panacea for the challenges of teaching and learning, it does lend itself to accommodating different learning styles. Debevec, Shih, and Kashyap (2006) argue that some students in their study benefited more from classroom technology than others. “Some students chose a more technology-driven route while others chose a more traditional route and both were able to able to maximize their performance given that they attended class and gained the benefits of the multimedia presentation and discussion” (Debevec et al., 2006, p. 305F). As it is important that we develop each and every student to their full potential; we can not overlook the fact that many students may need the benefits of educational technology to succeed.

STUDENT RESPONSE SYSTEMS

Student response systems (also known as personal response systems, clickers, audience response systems, electronic response systems, classroom performance systems, and group response systems) are “computer-based systems that allow audience members to participate in presentations by submitting their responses to interactive questions using hand-held devices or response pads” (Turning Technologies, 2006). Roschelle, Penuel, and Abrahamson (2004) place student response systems in the category of a classroom network which “uses specific software designed to enhance communication between teacher and students” (p. 51).

Generally, a student response system contains several components: a receiver, software, and clickers. The clickers, which are similar to a television remote control, communicate with a receiver by infrared or radio signals and feed the results to the instructor’s computer. Software allows the students responses to be recorded,
analyzed, and graphed (Zuckerman, 2005). The instructor can display responses on the screen, post them on a course site, or save them for reference (Heyboer, 2005). Responses that are posted for the entire class to see generally remain anonymous, but the instructor can keep track of individual student answers.

Using Student Response Systems (SRS) in the Classroom

Student response systems have become one of the most popular teaching tools for giving quizzes, taking attendance, and encouraging classroom discussion. According to Lowery (2005), student response systems are commonly used to (1) improve class attendance and preparation, (2) promote comprehension, (3) create active participation, (4) increase peer or collaborative learning, (5) enhance learning and enrollment retention, (6) and result in greater student satisfaction. Research shows that teachers use response system technology for both instructional and assessment purposes. Many use it to stimulate peer and classroom discussion. As in higher education, there is a sense that both peer and classroom discussions are important to making the system more effective in the classroom (Penuel, Crawford, Boscardin, Masyn, Debarger, & Urdan, 2005).

In a lecture style setting, instructors often use the responses systems in a way similar to a game show. As a means of formative assessment, instructors will scatter questions throughout a lecture based on the material being presented and allow students to answer using the clickers. After everyone has responded to the question, the software automatically tabulates the results. The results are then shown in a variety of formats based on the instructor’s preference, often shown as a percentage or count illustrated with a chart or histogram. Through this immediate feedback, an instructor can determine how many students do not understand the material and plan accordingly to review this material either immediately or at a later date. The goal is for students to be more involved and create an active learning environment that results in immediately feedback so that instruction can be tailored to meet student needs. Instructors who have used student response systems say that the main benefit is helping professors instantly gauge whether or not students understand the material being presented (Heyboer, 2005). In essence, the use of SRS allows for every lesson to be customized for the participants in the room at that time. This type of instruction can truly enhance the effectiveness of the instructor.

In addition to questions offered in a lecture-based environment, SRSs are also used to take attendance. By connecting clicker serial numbers with student names, the instructor can ask students to ring in with the clickers at the start of class. This will result in an instantaneous role call as well as a count of the students present in the class. An effective way of taking attendance with the SRS is to ask a general question at the beginning of class. Some instructors prefer to ask a question related to a current event or a review question from the last class. This approach is effective because it takes attendance while also providing a review of material from the last class and testing the “clickers” to ensure that all are working properly before the main portion of the lesson begins.

In addition to polling students to test material comprehension and taking attendance, SRSs are widely used for administering quizzes. Instructors can set up questions with points attached for every answer that the student answers correctly. In this instance, the instructor would have to set up the system so that “clickers” are associated with a specific student. There are various benefits to administering test with the use of the SRS. For example, instructors are able to manage the time spent answering each question. This is especially helpful for instructors who are attempting to prepare students for a licensure exam as some licensure exams only allow students one minute for each question without the opportunity to backtrack to check answers already submitted. With the use of the SRS, the instructor can utilize a setting on the system that starts a timer when a question is shown, then when the timer reaches “zero” the polling for that question will be closed. The instructor can then proceed to the next question and the student is unable to return to questions previously answered. This format is utilized to simulate the environment the students will be subjected to when they take a licensure exam.

Another benefit of using the SRS for administering quizzes is that students receive immediate feedback. After the quiz has been administered the instructor can return to the slides that were utilized during the quiz and display the answers generated by the class. Answers are displayed with a percentage or count of how the class responded to that question as well as some type of
Student Response Systems for Active Learning

A graphical representation of the answers from the total audience. As questions are being reviewed and the data of how the students replied is displayed, students can see if their answers were correct as well as compare their answers with how their classmates responded. This provides a true teachable moment. If students chose the incorrect answer they can get a “light bulb” moment by seeing where they made their mistake or they can ask why their answer was incorrect. This is known to spur an active conversation among the class. This immediate feedback and consequent discussion has the potential of enhancing the learning experience for the student. Another obvious benefit is that quizzes taken using the SRS are automatically graded and entered in a grade book.

As mentioned, a standard use of the SRS is to poll the students with questions that have definite answers. However, an SRS system can also be used for debates. An instructor can place a Likert-style question of ethical or moral connotation on the slide and request a response from students. Once all students have replied, the instructor can display the results, possibly opening the door for an active conversation about the topic. This is an effective way to engage students in the lesson and can be used with tough topics, such as those related to ethics and beliefs. Students who would not normally participate in class may become more engaged, vocal contributors to the learning experience. In this format, instructors would not have the students name linked to a specific “clicker.” In order to get true results of how an individual feels, the debate format is most effective when the answers are anonymous.

Instructors can implement the SRS in various ways. Interactive SRS questions can be placed at the beginning of a lesson as a means of reviewing past information or to gauge students’ understanding of the material that is to be covered during that lesson. Interactive questions can also be placed within the lesson to check for the students’ understanding of the content as it is being discussed. If an instructor polls the class on information that was just discussed and the results returned demonstrate that the majority of the class does not understand the information, the instructor can go over that information again. In the past, the instructor would ask, “do you understand” or “does anyone have a question,” and with a few head nods or no hands raised the instructor would presume that everyone understood and likely move on to the next item. With the use of the SRS, instructors will get honest feedback from the students and then the instructor can review the content if necessary. Without this tool, students will be more likely to get lost in the content, therefore becoming less interested in the subject being discussed.

How the SRS is utilized really depends on the results that you are trying to achieve. If students’ names are aligned with a certain “clicker,” then the instructor can utilize the reporting feature of the system to determine how each student replied. With this information, the instructor can determine which students need more help or what information seems to be confusing before a major test is administered. Without the use of the SRS, teachers would go through the information, administer a test, and move on. The use of the SRS system provides the student and the teacher with valuable immediate feedback that truly enhances the learning experience.

The use of an SRS can increase active learning and show improved assessment results. A study published by Poulis, Massen, Robens, and Gilbert (1998) showed that when using an SRS in a physics courses, the pass rate increased from 57% to 70%. SRS can dramatically increase student-instructor interaction and discussion in the classroom. With their personal wireless keypad or “clicker,” each student in the classroom can easily respond to PowerPoint-delivered questions presented to the entire class. Faculty can track which students answered correctly and which do not understand the material. Faculty who use the system are able to gather student responses and quickly and easily transform them into measurable results in the form of test scores, charts, and/or graphs.

Based on previous research, the implementation of the SRS should prove to assist in solving problems related to lack of student engagement and lack of attendance. Woods and Chiu (2003) argue that classes are more interesting and lively with SRS, and students report more ownership of the pace and direction of class lecture and discussion. Specifically addressing lack of engagement, Birdshall (2002, p. 2) argues obtaining immediate feedback and increasing student participation in large classes is near impossible without this kind of system. Even in small classes, which most believe can be made highly interactive without this type of technology, this system ensures that all students think through questions without focusing on students who are consistently answering. Ward, Reeves, and Heath (2003) support this argument by stating the anonymity of responding with a hand-held device guarantees near or total participation by the entire class.
In addition to the research described earlier by Poulis et al. (1998), Slain et al. (2004) report significantly higher test scores in classes that used a response system for those questions that required “analytical” type thinking consistent with Bloom’s taxonomy of questioning. Slain et al. (2004) further report that examination grades were not significantly different for questions that required strict memorization (2004, p. 4). While memorization lends itself to some subject areas better than others, this argument lends itself to our belief that student response systems are the missing component from some of the more traditional college level teaching activities.

FUTURE TRENDS

Unlike other educational technologies that have not been fully supported by research, student response systems stand out in terms of education research because there have been studies done that support their use. While this research exists, more research is necessary on the use of student response systems in disciplines outside of the sciences. Also, more research is necessary on student comfort levels with using the technology, especially in terms of returning adult students.

Currently, most student response systems provide the instructor with limitations in question types. This is mainly due to the button selection on the “clicker.” In most cases the instructor asks a question to which the students pick an answer from a list of possible answers. A student needs only to push one button to submit an answer. This certainly limits the types of questions that can be presented to students. Already on the market, although not as popular as the earlier clickers, are more advanced versions of SRSs that have “thumb” keypads and small text screens that allow the student the ability to type in a possible answer. This type of increased functionality on the student “clicker” device increases the question type possibilities for the instructor. Although this technology is currently available, the basic nine-button clickers are purchased more often due to the cost and ease of use. Once there is a comfort level on both the student and instructor side in the use of the basic clickers and the cost of the advanced text-style clickers is driven down, more institutions and instructors will be interested in increasing their functionality with the technology.

CONCLUSION

Students no longer learn the old-fashioned way; the “assembly line” or the one-size-fits-all approach are no longer effective. Students do not think that the use of technology in the classroom is “neat.” They expect teachers to use technology in the classroom. Students become engaged in the learning process when Student Response Systems are integrated into the classroom experience. The educational pendulum of instruction is swinging to student-centered learning and use of the SRSs is just one way to address this growing style of instruction.

Debevec and Shih (2006, p. 305) state that there is more than one path to optimize student learning and performance. It is the instructor’s challenge to adopt appropriate technology to support and create different types of learning environments that expand the traditional classroom and enhance student-learning experiences and maximize their performance. SRSs can assist an instructor in engaging the attention of students, making students actively participate in the learning process, and providing both the student and the instructor with immediate feedback on student understanding of material. SRSs provide faculty with information on students' understanding of course concepts and create an opportunity for faculty to adjust course activities. Responses obtained through SRSs are an effective tool to prompt for classroom discussion and other activities.

REFERENCES


### KEY TERMS

**Active Learning**: Active learning seeks to create a learner-centered environment and engage students as active participants in their education. The opposite of this is passive learning

**Classroom Network**: A classroom that uses specific software designed to enhance communication between teacher and students.

**Clickers**: Part of a student response system, these are hand-held wireless devices that students can use to respond to instructor questions.

**Educational Technology**: Practice and study of facilitating and enhancing the learning process through the use of technological resources.

**Passive Learning**: Traditional way of teaching where the professor is a subject matter expert whose role is to convey the knowledge to an audience of students. The opposite of this is active learning.

**Student Response System**: Computer-based systems that allow audience members to participate in presentations by submitting their responses to interactive questions using hand-held devices or clickers.
Students with Disabilities and Technology

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INTRODUCTION

America’s schools are required to meet all federal laws and regulations for special education including the Individuals with Disabilities Education Act (IDEA), which requires that students are included in the Least Restrictive Environment (LRE), and Section 504 of the Rehabilitation Act.

Each student who is identified with a disability that affects them academically has either an Individual Education Plan or a Section 504 Plan which is created by a collaborative team (e.g., the parents, child, regular and special education teachers, therapists, and the school psychologist). They determine the goals, objectives, and accommodations that need to be made in the classroom setting. IDEA requires that assistive technology, which includes products, tools, and devices that can make a particular function easier or possible to perform, needs to be considered for every student who has an individualized education program (IEP) (Blackhurst, 2005).

Teachers of students with disabilities are utilizing techniques such as universal design to make adaptations to the regular education curriculum to help them garner access and understanding (Hitchcock, Meyer, Rose, & Jackson, 2002; Rose & Meyer, 2000). Also teachers in inclusive environments are using differentiated instruction which takes into account every student’s interests, ability levels, and learning profiles regardless of disability (Dodge, 2006; Drapeau, 2004; Tomlinson, 2001). Often technology plays a vital role as special education teachers seek to individualize teaching methods to meet the needs of their students.

BACKGROUND

Blackhurst and Edyburn (2000) have suggested that four different forms of technology are relevant to special education and rehabilitation: the technologies of teaching (pedagogy and learning environments), medical technology (e.g., wheelchairs and lifts), instructional technology (software and hardware used in the classroom), and assistive technology. Assistive technology devices are defined in the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (Pub. L. 100-407) and the Assistive Technology Act of 1998 (Pub. L. 105-394) as “any item, piece of equipment, or product system, whether acquired commercially, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities” (Title 29, Chapter 31, § 3002(a)(3) (Braddock, Rizzolo, Thompson, & Bell, 2004).

Computer innovations such as enlarged text, spell checking, and text-to-speech are examples of appropriate accommodations that help students with exceptionalities. Digital versions of books provide a variety of modifications that are simple for the student to employ. Students who have physical disabilities can manipulate the display to turn pages by small movements (even, literally, the blink of an eye); those with vision impairments can display the text in larger font, have the book read aloud or printed on Braille paper; students with learning disabilities can highlight or click on a word they are struggling with to hear the word or its definition while using a digital book (Behrmann, 2001).

Virtual Reality Simulations

Smedley and Higgins (2005) explained the benefits of utilizing virtual reality, which includes a text- and graphics-based environment that is simulated by a computer (Auld & Pantelidis, 1999) with students with disabilities:

“Technology-based applications give students access to worlds and environments that are inaccessible, too expensive, or too dangerous in a classroom setting; enable students with disabilities to experience laboratories and field trips at their own pace; and allow them to repeat the experience as many times as necessary” (p. 114).
Virtual reality can be experienced through the use of either a desktop virtual reality system (on a typical computer with a device like a mouse to manipulate through the environment) or an immersive reality system (images are displayed that provide front, side, and back views through a head mounted display and audio is fed in through headphones) (Powers & Darrow, 1994; Smedley & Higgins, 2005). Research is beginning to support the idea that children with exceptionalities can learn skills in virtual reality that transfer to real-world situations, yet there still needs to be more research conducted in this area (McComas, Pivik, & LaFlamme, 1998).

Assistive Technologies: AD/HD

The Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) (2004) published by the American Psychiatric Association (2004) is the handbook used most often in diagnosing mental disorders in the United States. This handbook describes three sub-types of the neurobehavioral disorder AD/HD: (a) inattentive (difficultly focusing or staying focused on a task or activity), (b) hyperactive-impulsive (very active and compulsive), and (c) combined (inattentive, impulsive, and overly active). Assisted technology for students with AD/HD can include personal organizers, books on tape, and computer software that helps with outlining and note taking.

Autism Spectrum Disorder

Autism spectrum disorder is a neurological condition that can include a person who is very low functioning to one with Asberger’s Disorder. Asberger’s Disorder is a pervasive developmental disorder in which the person may have a great discrepancy between his or her intellectual and social abilities. A lack of social skills, including the ability to spontaneously play, is a defining feature of autism (Goldstein, 2002; Wolery & Garfinkle, 2002). Students with autism spectrum disorder often need structure and do not react well to change or a great deal of stimuli. When utilizing virtual technology with this population to teach a variety of skills (how to function in a social situation, for example), the number of stimuli has to be lessened (Max & Burke, 1997). Also, because the need to keep to a regimented schedule is vital for this population, computer-mediated video-enhanced activity schedules and video modeling can be utilized (Kimball, Kinney, Taylor, & Stromer, 2003).

Speech and Language Disorders

Speech and language disorders are defined by the National Dissemination Center for Children (2004) as, “...problems in communication and related areas such as oral motor function. These delays and disorders range from simple sound substitutions to the inability to understand or use language or use the oral-motor mechanism for functional speech and feeding” (p.1).

Touch pads, communication boards, and text-to-speech help students who have severe issues in communication.

Mental Retardation

The American Association on Mental Retardation’s (AAMR) (2002) definition of mental retardation is “a disability characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills.” Students with cognitive issues utilize technology that ranges from low-tech devices, for example, adapted eating utensils or pictorial communication boards, to high-tech devices, which would include voice output devices with adapted software that synthesizes speech (Technology and Media Division, 2003).

Learning Disabilities

It is important to emphasize that a person who has a learning disability has an average to above average IQ, yet a discrepancy exists between their intelligence and their academic performance. Technology can be used to support instruction of students with learning disabilities through electronic books, computer-assisted instruction, anchored instruction, electronic spellers, reading pens with text-to-speech capabilities, and network-based learning (Okolo, 2000).

A specific software package that has made an impact on students with learning disabilities includes Hasselbring’s Read 180, wherein the computer reads a passage, highlights the words to be learned, and the
Students with Disabilities and Technology

Multiple Disabilities

Students with multiple disabilities have a combination of impairments (e.g., mental retardation-blindness or hearing impairments-physical disabilities) that cause such adverse academic problems that cannot be accommodated in a special education program based exclusively on one of the impairments. Deaf-blindness is considered a separate category. Some assistive technology tools that are on the market are software programs such as Mayer Johnson’s Boardmaker, which contains thousands of picture communication symbols to create various games, communication boards, and activity sheets. General input switch applications like AbleNet’s Switch can be used alone or with other adaptive devices so that a physically disabled or multiply-disabled student can activate various types of computer programs, toys, educational games, and appliances independently.

Other Health Impairments

Students who are other health impaired have acute or chronic health problems (e.g., heart condition, sickle cell, asthma, hemophilia, and cancer), which adversely affect educational performance. They often spend a great deal of time in the hospital and technology is helping to make this a more comforting environment in which they can learn and find camaraderie.

Companies such as Starbright (http://www.starbright.org) have developed multiple ways to utilize technology for children who are hospitalized from their health impairments. They have released CD ROMs such as the Explorer Series® that features interactive multimedia programs designed to help children and adolescents with serious illness learn more about medical procedures and conditions in an engaging way. For example, they can learn about IVs from Nurse Ima Helpa or play the Sickle Cell Slime-O-Rama™ Game to garner pain management and prevention strategies. Starbright is best known for a computer network for children who are hospitalized that uses 3-D software, powerful computers, and video-conferencing to connect children’s hospitals. Using Starbright’s technology children can explore virtual worlds and interact with other children who are other health impaired either as an avatar (which is an icon that represents the person in virtual reality) or by using the video-conferencing...
facility in the hospital to actually see and speak to other children (McComas, Pivik, & LaFlamme, 1998).

Physical Disabilities

Students with physical disabilities can begin or increase productivity with the use of an adapted keyboard such as the Smart-NAV by NaturalPoint which features a hands-free mouse; the user only needs to slightly move his or her head to control the keyboard. The mouse works by analyzing the movements of small dots of adhesive reflective materials typically placed on the bridge of eyeglasses or on the user’s forehead that it translates it into cursor movement (Ashton, 2003).

People who have physical disabilities can now safely maneuver through a virtual reality environment to learn to drive their motorized wheelchair. By using the Internet, the students can practice their skills driving in a shared virtual space with other users on the World Wide Web (Inman & Loge, 1995). Another virtual reality program allows students with physical disabilities to participate fully in science experiments and activities (Inman & Loge, 1995).

Academically, students who are physically disabled can learn through technology-based curricula in order to perform tasks such as conducting science experiments that they could not do previously due to their disability. This is done by having the student manipulate devices and tools using a joystick or two binary switches that can be positioned anywhere on the body in an interactive three-dimensional virtual reality lab (Inman & Loge, 1995). Also, students who attend cyber charter schools receive their curriculum through online instruction which elevates distractions and helps them to feel less “different” than the other children because they are not seen by their peers (Hipsky & Adams, 2006).

Traumatic Brain Injury

Traumatic brain injury is caused by an external physical force that results in total or partial psycho-social impairment or functional disability, or both, that negatively affects a child’s academic ability. This term is not applicable to brain injuries that are degenerative, congenital, or induced by birth trauma. Traumatic brain injury (TBI) was added as a separate category of disability in 1990 under P.L. 101-476, as was autism. Personal digital assistants (PDAs) can greatly improve the independence, productivity, and quality of life of persons with disabilities to perform a wide variety of prompted, well-defined vocational, and independent living tasks (Bergman, 2002; Davies, Stock, & Wehmeyer, 2002; Hart, Hawkey, & Whyte, 2002).

Visually Impaired

Knoblauch and Sorenson (1998) described visual impairment including blindness and partial sight as, “An impairment in vision that, even with correction, adversely affects a child’s educational performance,” which is based on the definition in IDEA. People use mental mapping and orientation skills which typically tap into predominately visual techniques to determine possible ways to navigate through a space independently and safely (Lahav & Mioduser, 2004). Without the visual to rely on, the creators of technology need to tap into the auditory skills of the visually impaired. Passive devices are ways to let the person know what to expect prior to encountering the space through verbally explaining, touching a physical model of the area, walking through the visual reality spatial simulation environments (Darken & Peterson, 2002; Waller, Hunt, & Knapp, 1998). Dynamic devices that provide information while the visually-impaired person experiences the situation include: the Sonic-guide device that utilizes the users’ ability to navigate using a Kaspa laser-guided device (Easton & Bentzen, 1999), global positioning systems (GPS) (Golledge, Klatzky, & Loomis, 1996), and signs embedded in the environment that use auditory cues such as stoplights (Crandall, Bentzen, Myers, & Mitchell, 1995).

CONCLUSIONS

From virtual technology to global positioning systems (GPS) and even cyber schools that safeguard identities of students through anonymity and lessen distractions for the special needs child (Hipsky & Adams, 2006), technology can help students with exceptional needs find success in and out of the classroom. Assistive technology needs must be addressed for each student with a special need not only because IDEA states that it is imperative, but also because it can open up the doors of learning and independence for a student with a disability.
REFERENCES


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**KEY TERMS**

**Assistive Technology:** Items, equipment, product, or device that is utilized to increase, maintain, or improve functional capabilities of individuals with disabilities.

**CyberSchools:** Self-paced curriculum and instruction that is delivered via the Internet.

**Differentiated Instruction:** A flexible approach to instruction that is based on the student’s ability, interests, and learning profiles. This technique affects the student’s content, process, and product.

**Disability:** A physical or mental impairment that substantially limits or restricts the condition, manner, or duration under which an average person in the population can perform one or more major life activities.

**Individuals with Disabilities Education Act (IDEA):** The IDEA was originally enacted by Congress
in 1975 to make sure that children with disabilities had the opportunity to receive a free appropriate public education, just like other children. The law has been revised many times over the years.

**Individualized with Education Plans (IEP):** A written plan for a student who has an exceptionality that clarifies the student’s goals, objectives, and accommodations.

**Least Restrictive Environment (LRE):** According to the IDEA, students with disabilities must be included with students without disabilities as often as is appropriate unless the nature or severity of their exceptionality cannot be addressed in this setting.
Synchronous and Asynchronous Learning Environments

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INTRODUCTION

This paper discusses the organizational and pedagogical aspects, benefits, and disadvantages of synchronous and asynchronous technologies as platforms for creating distance learning environments. By comparing the advantages and challenges of the two learning environments, teachers will be able to match the appropriate learning environment and its teaching strategy to their learning goals.

These two learning environments involve distance learning. Distance education (or what is commonly termed “distance learning”) is a method of education in which the learner is physically distanced from both the teacher and the institution providing the instruction. Learning may be undertaken either individually or in groups. According to USDLA (2006), distance learning is: “The acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies and other forms of learning at a distance.”

In its original form, teachers and students in distance education corresponded via regular mail, telephone, or fax machine. The students usually submitted their assignments by mail. Using various forms of electronic media, such as radio, television, and videoconference, and advanced communication technologies such as satellite, cables, e-mail and Internet technologies, increases time effectiveness, enables flexibility of location, and improves delivery of information (Mielke, 1999; Schlosser & Simonsen, 2002).

In distance learning, teachers and students may communicate asynchronously (at times of their own choosing) by exchanging printed or electronic media, or through technology that allows them to communicate in real time (synchronously). This chapter focuses on synchronous and asynchronous learning environments implemented by various technologies.

BACKGROUND

Definitions of Synchronous Distance Learning (SDL) and Asynchronous Distance Learning (ADL)

Distance Learning can be either synchronous or asynchronous. In both, the teacher and students are not physically in the same classroom. In SDL, class members can participate simultaneously, and there is no time lag between teacher and students in spite of the physical distance. In ADL, the teacher and students are separated by both time and space, and learning does not occur at the same time that the learning material is presented. Students learn on their own, individually, at their leisure.

According to Frank (2006), in synchronous communication, teaching and learning are conducted simultaneously and there is a physical separation between teacher and students. The teacher is in the broadcasting studio, which contains the technological means to transmit voice and data (data such as PowerPoint slides). Learning may be undertaken either individually or in groups. In the former form, students who are usually located at their individual homes use their personal computers to interact with the instructor via the Web. In the latter form, students are located in a distant learning center, which generally is technologically set up to allow communication between the teacher and students (a computer for each student or group of students, microphones, headphones or speakers, etc.). Students see the course content on their computer monitors or on a large central screen. Sometimes, the communication also includes two-way video—cameras in the broadcasting studio transmit pictures of the teacher to students and cameras in the learning center transmit pictures of the class to the teacher. Computerized synchronous communication courses are especially prominent in
situations where it is difficult for students to come to an educational facility everyday due to geographical or other obstacles.

Every synchronous distance learning course may have an asynchronous element that includes recording all lessons and some face-to-face meetings. Usually, the first meeting between the teacher and his or her students in synchronous distance learning is a face-to-face meeting. The students are invited to this type of meeting in order to become acquainted with each other and with the teacher. They should also be provided with some details and information about the program’s technologies and procedures (Frank, 2006).

Some Benefits of Both Synchronous and Asynchronous Distance Learning

Much has been written about the disadvantages of traditional teaching, where students are passive. In contrast, both synchronous and asynchronous learning environments, despite their shortcomings which are presented next, do not appear to have this built-in passivity. Both learning environments easily allow teachers to reap pedagogical advantages—applying active and interactive learning principles, using multimedia, organizing the course and its lessons, and providing immediate feedback to students about their progress. Students must be both active and interactive; teachers must organize their courses and the material for the lessons in advance through “trees” that make orientation easy; it is possible to provide feedback and to use multimedia and multiple representation means.

In both approaches, a single, highly qualified teacher can instruct several remote sites so the course can be given to a relatively large number of students (an economic advantage). In addition, it is possible to use statistical data stored in the technological system for follow-up of students’ progress.

Some Benefits of SDL over ADL

The literature indicates several advantages of SDL over ADL. For example, Davey (1999) emphasized that teachers can provide all students ongoing and immediate performance feedback. In a course described by Frank, Kurtz, and Levin (2002a), much use was made of a tool that also permitted immediate feedback for the teacher.

According to Carr-Chellman and Duchastel (2000), the advantages of SDL over ADL include a more direct sense of collegial instruction and immediate answers to the questions posed. Branon and Essex (2001) noted the advantage of simultaneous team decision-making and brainstorming. Power et al. (1999) indicated that synchronous instruction allows students to communicate in real time with each other and with their teacher.

Lister et al. (1999) found that the synchronous part of their course was of crucial importance. Learning outcomes and student retention rates in their purely asynchronous courses were often disappointing for all age groups. However, in the synchronous section of their distance course, they attempted to create a “social construct”—an interactive, face-to-face classroom. The teacher could thus begin each lesson by asking if there were any questions about homework, reading assignments, or group projects. To help answer students’ questions, the teacher could then activate the system’s whiteboard and shared stored graphics, or solve analytic problems interactively by writing texts and equations on the white board which then appeared on all the students’ screens. He/she could also call up a “question and answer” tool that allowed for real-time interactive quizzing and polling. Following the set-up of a typical studio classroom, the teacher could then present a brief lecture on new material, sharing PowerPoint slides and multimedia material, or using synchronized Web-browsing, lead students to Web sites with course-related contents. Furthermore, the synchronous sessions helped keep students abreast of course deadlines and build teams and a sense of community, allowed them to receive immediate feedback and improved retention rates.

SDL: Challenges and Issues

Apart from the relatively complex logistics of organizing synchronous meetings, the necessity of attending classes (or being home) at specific times and a lack of face-to-face interaction with the teacher may have an adverse affect on some students. In other words, this method is not suitable for everyone.

Weak students, or those who are too shy to participate in an ordinary classroom session, are likely to be even more ill at ease when they realize that they can be heard in real time by many other students, most of whom they have never even met. “Because of the
real-time nature of the approach, there may be greater social pressure for conformity in participation” (Carr-Chellman & Duchastel, 2000). Monson, Wolcott, and Seiter (1999) found that “some students experienced a high degree of state-communication apprehension in synchronous distance education.”

**Some Benefits of ADL over SDL and Face-to-Face Based Courses**

ADL courses require a very limited number of meetings in a classroom setting. The bulk of the teaching is executed through the course Web site. In courses where there are a large number of students, ADL enables each student to ask the lecturer a question whenever he or she needs or wants to and to receive an answer (through e-mail, for instance). In contrast, in SDL or regular courses, the teacher cannot hope to respond to each and every one of the students. Moreover, feedback is given only to those who dare ask a question in front of so many co-students (Willis & Dickinson, 1977). In SDL and face-to-face based courses, the time allotted for questions is usually very limited.

The main advantage for students in asynchronous courses is the flexibility of time and place. Students can study anywhere (wherever a computer can be linked to the Internet) and at any time. The course contents remain stored within the system at all times, and each student can access this information at any time. Students may submit assignments electronically through the course Web site and usually there is no need to present hard-copy (written) homework.

Another advantage of ADL over SDL is related to technology. For the latter type course, execution mandates unique and costly technological resources. (As the use of voice over IP technology has increased, technological demands have become somewhat simpler in certain types of SDL). In contrast, asynchronous course implementation is relatively simple—usually only necessitating the use of an off-the-shelf software package (LMS—learning management systems, such as WebCT, Blackboard, Moodle, HighLearn, etc.), personal computers, and an Internet connection.

Branon and Essex (2001) noted other advantages of ADL over SDL: “distance educators have found asynchronous communication useful for: encouraging in-depth, more thoughtful discussion; holding ongoing discussions; and giving all students the opportunity to respond to a topic.”

In an asynchronous course, study and learning can reach a depth unlikely to be attained in a synchronous course, since students can invest as much time and effort as is required, each according to his or her individual learning pace. This contrasts with synchronous and face-to-face frontal teaching classes, which have a time limit and progress at a uniform pace that is not necessarily suitable for each individual student. When the teacher assigns questions/tasks, students in ADL courses have enough time to think before giving their answers—a luxury not always available in SDL or face-to-face classes (Bhattacharya, 1999).

More advantages that learning management systems offer ADL include: the ability to continually update learning material, the capacity to send messages quickly to all students in the course, and the possibility to automatically check exercises and manage grades.

Another benefit, which may appear surprising, is that in fully online courses with a large number of students teachers get to know the students, or at least some of them, better than in a face-to-face course. The acquaintance is usually developed through e-mail correspondence or the course forum. Frank, Reich, and Humphreys (2002b) found that in ADL, the teacher is able to develop a greater personal connection with students through the use of e-mail than he/she is able to develop in a conventional classroom. In a conventional classroom, a dominant student may monopolize the discussion (Brown, 2000), but in distance learning such a situation is unlikely to happen.

The use of a discussion group tool (sometimes known as a “forum”) was found in research to be efficient in building shared understanding, a “learning community” and knowledge through interaction with the teaching staff, colleagues, and others. The benefits and challenges of using this tool as a learning aid are discussed in another chapter of this book.

**ADL: Challenges and Issues**

Lister et al. (1999) noted that, in certain cases, the problem of motivation in asynchronous courses may arise. Lacking a serious incentive, students may not make the effort needed to learn what the course teaches. The fact that the responsibility for learning is on students, who are meant to log in every so often and study, may be a problem for those with low motivation.

Freedman (1998) stressed the proximity of teachers and students in regular classes as compared to
computer-aided teaching. In his opinion, some students prefer standard face-to-face classes that provide warmth, a feeling of intimacy and help when problems crop up. According to Wolcott (1995) and Hill (1997), the interaction in ADL is less than that of face-to-face learning. The teacher cannot see the students’ reactions to the study material. He or she may miss out on facial expressions or body language, for instance. In fact, several researchers related to the difficulties arising from lack of eye contact between teacher and student, as in distance learning. Willis and Dickinson (1997), for example, wondered whether teachers can really be effective if they are unable to maintain eye contact with their students, or to observe students’ non-verbal behavior.

The main conclusions of a research study, which examined the challenges with which 11-12 year old students are faced when participating in a course that is based on ADL, indicate the importance of personal contact and direct connection between teachers and their pupils (Frank et al., 2002b). The main issue that evolved is that of the student’s loneliness when learning from a distance, that is, the lack of personal contact among the learners and between the teacher and the students. It is recommended that, at the beginning of a fully asynchronous distant course, a face-to-face meeting be held. The purpose of such a meeting is for the teacher to get to know the students and vice-versa, and for the students to get to know each other in order to reduce feelings of social isolation and alienation.

Finally, teachers have two more problems that relate to asynchronous courses. First, teachers must invest great effort in writing-up course contents (in the event that these were not prepared beforehand). Second, teachers cannot respond spontaneously to ongoing events, as teachers in frontal/conventional classes can.

**IMPLEMENTATION OF SYNCHRONOUS DISTANCE LEARNING**

**Teachers’ Preparation for Synchronous Teaching**

Synchronous distance learning by means of technology requires careful preparation by the teacher, both from a pedagogical and a technical point of view. Teachers should attend a workshop to familiarize themselves with the technological system and with the pedagogical principles of distance learning.

At the end of the synchronous teaching program described by Frank et al. (2002a), the teachers emphasized the importance of prior training for teaching in an advanced technological environment. In their opinion, careful and detailed preparation is imperative before each lesson, in order to adapt the contents to distance learning.

However, the teachers also felt that too careful pre-course preparation resulted in a lack of spontaneity during the actual lesson. This led to decreased opportunities to respond to class situations that required modifying the planned order of instruction. Being overly prepared restricted humorous responses to situations arising during the course of the lesson, which could have created a special atmosphere, thereby making the lessons more meaningful. Most probably, more teaching experience using this method could help overcome these difficulties.

The teachers also remarked that the output in distance learning is relatively lower than in conventional learning, and that in the SDL, there are certain drawbacks that make it difficult, for instance, writing complicated mathematical formulae, drawing graphs, transmitting complicated messages, or presenting long exercises that require several stages to obtain a solution.

The abilities required for distance teaching are (Frank et al., 2002a) teaching experience, in general, and in distance courses in particular and the ability to concentrate and coordinate with the technological system during the lesson. This list also concurs with the findings of Mortera-Gutierrez and Murphy (2000): “if teachers are to be successful distance educators, they must be capable of using at least the following types of interaction: instructor-learner; instructor-content; instructor-technology; instructor-facilitator; instructor-peers; instructor-support staff (technicians); and instructor-institution.” The teachers who taught the course described by Frank et al. (2002a) had been trained to use the previously-mentioned types of interaction.

**Teacher-Students Interaction in SDL**

In the project described by Frank et al. (2002a), interaction was mediated via computer. Complications arose—if students wished to communicate with the teacher, they had to get permission to do so by means...
of pressing the “indicator” key. Apart from vocal interaction, the students could also write questions or comments, or send e-mail to the teacher. There are both advantages and disadvantages to written interaction. The students as well as the teachers stated in interviews that, compared to conventional teaching, teacher-student interaction in SDL is not easy.

Nonetheless, the teachers agreed about the fact that, apart from the spoken and written interaction, they could also use tools for real-time feedback. For instance, they presented a multiple-choice question and quickly received answers from all the students. Another possibility was receiving anonymous responses from students about comprehension of the study material by using the + or – keys of the distance learning system.

The teachers’ reservations about interaction were essentially related to the lack of immediate contact with students—body language, facial expressions, and eye contact. These were all means that the teachers were accustomed to using in the classroom in face-to-face sessions to assess comprehension. Albeit, there was a camera in the distance classroom that provided an overall picture for the teacher, but due to low resolution, details could not be made out.

The teachers were unable to assign an exercise and then move about the classroom among the students to see what was going on. They were unable to use the “Socratic” approach—a give and take of questions and answers between instructor and students.

Other reservations related to the fact that in SDL one cannot use one’s hands to demonstrate different examples. For that matter, distance teaching rules out the use of any kind of theatrics during the lecture, though these very often help to explain and also create a positive classroom atmosphere.

**SDL: Suggestions for Implementation**

Based on the research presented by Frank et al. (2002a), some conclusions and suggestions may be derived for implementing the SDL approach. All implementation tips in this section require careful consideration and study in order to evaluate their effectiveness, advantages, and limitations.

First, a teaching assistant should be selected for each SDL class, whose “other” job is to ensure that: the classroom is ready (connected, clean, and cool/heated), the students are in their places on time, and all handouts (exercises, summaries) are distributed before the lesson. The teaching assistant should have consulting hours posted on the distance site (at least one hour for every teaching hour) for answering questions, and should be responsible for collecting and correcting exercises, (and grading, if the course is for academic credit).

Second, as in standard lessons, the dilemma as to whether to distribute copies of slides before the lectures also surfaces here. It is suggested that teachers distribute “skeleton” slides containing only part of the information so students will not need to copy every slide but they will be able to assimilate the exhibited data while taking notes.

Third, about one hour before the beginning of each lesson, the equipment must be tested for proper functioning in the classrooms and for complete communication with the broadcasting studio. A reliable technician must be on hand to deal with any technical problems that may occur during lessons.

Fourth, it is recommended that teachers meet their students face-to-face at the beginning, middle, and end of the course, the mid-course meeting to be held at the distant sites.

Fifth, individual computers and headsets separate the students from each other, as well as from the teacher. A large screen, loudspeakers, and classroom microphones would eliminate the need for headsets and computer screens. A feature of voting (1, 2, 3, 4) can be used for multiple choice questions and opinion polls during SDL sessions. Students should be facing the camera transmitting from the classroom to the teacher so that the latter is always aware of what the students are doing at any time (talking to each other, looking at the screen, raising their hand to ask a question, etc.). Students must be able to ask questions and receive answers during the SDL lesson, in a way that allows everyone to hear the question. Teachers must be able to ask questions, collectively and of individual students, and monitor classroom and inter-classroom discussions.

If the students can interact with each other without headsets and the teacher can see and hear all the students (who are facing the camera and the classroom microphones), then it should be possible to establish a video-conference rapport as effective as that of any other teaching method used by any good teacher.
CONCLUSION

This paper reviews the benefits and challenges of two approaches for integrating technology and teaching—synchronous distance learning (SDL) and asynchronous distance learning (ADL). In both, the teacher and students are not physically in the same classroom. In SDL, class members can participate simultaneously, and there is no time lag between teacher and students in spite of physical distance. In ADL, the teacher and students are separated by both time and space.

Advanced technology exists, but using technology simply because it is there does not ensure effective learning. Technology must be a means—not the aim. More important are the pedagogical considerations and the ways of using the technology to extract maximum pedagogical benefits.

Benefits of SDL over ADL include the following: teachers can give all students ongoing and immediate performance feedback; a more direct sense of collegial instruction; immediate answers to questions posed; and simultaneous team decision-making and brainstorming. SDL involves some challenges from the students’ point of view, including: the necessity to attend classes (or be home) at specific times; lack of face-to-face interaction with the teacher; and the fact that shy students are likely to be afraid to participate when they realize that they can be heard in real time by many other students.

Benefits of ADL over SDL from the students’ point of view include: flexibility of time and place and the option for each student to ask the instructor questions and receive answers (through e-mail or the course Web site, for instance). Distance educators have found ADL to be useful for: encouraging in-depth, more thoughtful discussion; holding ongoing discussions; and giving all students the opportunity to respond to a topic. In an asynchronous course, study and learning can reach a depth unlikely to be attained in a synchronous course, since students can invest as much time and effort as required, each according to his or her learning pace. The main challenge in ADL is that a motivation problem may arise. Challenges related to discussion groups are discussed in other chapters of this book.

Synchronous distance learning by means of technology requires careful preparation by the teacher, both from pedagogical and technical points of view. However, teachers who participated in SDL programs felt that too careful pre-course preparation resulted in a lack of spontaneity during the actual lesson. In addition, they found it difficult to write complicated mathematical formulae, to draw graphs, to transmit complicated messages, or to present long exercises that require several stages to obtain a solution. The teachers’ reservations about interaction with the students were essentially related to the lack of immediate contact with students—body language, facial expressions, and eye contact. The teachers were unable to assign an exercise and then move among the students to see what was going on.

There are those who think that SDL, as far as is possible, should resemble conventional classroom teaching. For example, Anderson et al. (2003) stated that: “for interaction to be successful, distance education environments must take the “distance” out of the education.” Is this really what we are aiming for? Regarding the disadvantages of traditional teaching, in which the students are passive, much has been written. The current chapter shows that, together with its shortcomings, SDL easily allows for achieving pedagogical advantages. Students should be active, the teacher must prepare and organize in advance the lessons and the course and ensure that the technological system easily allows for providing and receiving feedback for both teachers and students.

REFERENCES


Synchronous and Asynchronous Learning Environments

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KEY TERMS

Asynchronous Distance Learning (ADL): Any learning event where interaction is delayed over time. This allows learners to participate according to their individual schedules, and be geographically separate from the instructor. It may be in the form of a correspondence course or e-learning. Interaction can use various technologies like threaded discussion (DeVry University, retrieved July 25, 2006, from http://www.elearners.com/resources/glossary.asp)

Distance Education: Distance education or distance learning is a field of education that focuses on the pedagogy, technology, and instructional systems design that is effectively incorporated in delivering education to students who are not physically “on site” to receive their education. Instead, teachers and students may communicate asynchronously (at times of their own choosing) by exchanging printed or electronic media, or through technology that allows them to communicate in real time (synchronously). Distance education courses that require a physical on-site presence for any reason, including the taking of examinations, are considered to be a hybrid or blended course or program.
Synchronous Distance Learning (SDL): A type of distance education that connects students and instructors via real-time communication. Typically, audio and video links connect the distributed learning sites, supporting cross-site discussion. Synchronous distance learning has benefits over watching a pre-recorded video of the instructor only when students learn from each other and from the instructor through interactive episodes (Anderson et al., 2003).
INTRODUCTION

Managing a public sector organization is a highly complex task involving multiple stakeholders coupled with informational and resource material flows. Decision making in such complex tasks, for example health-care system, presents challenges. On one hand, the complexity of public sector organizations does not lend itself well to real-world trial and error approach. Practical, political, and/or ethical constraints often restrict any experimentation with many real-world phenomena such as medical decision-making, hazard-waste management, climate change, and so forth. On the other hand, most of the real-world “decisions and their consequences” are hardly related in both time and space, which makes learning even harder to occur (Hogarth, 1981; Sterman, 1989).

Recent advancements in computer technology, together with developments in system dynamics simulation methods, provide a potential solution that involves design and development of the decision support systems to aid decision making in complex public sector systems (Qudrat-Ullah, 2005). In this paper we argue that system-dynamics-based interactive learning environments (SDILEs) could serve as an effective decision support system for public sector management.

BACKGROUND

The term ILE (interactive learning environment) refers to the computer-simulation-based decision support systems aimed at improving users’ decision-making capabilities. In an ILE, the learning goals are clearly made explicit to the decision makers. Therefore, the computer games played for fun will not count as ILEs. An ILE consists of three components: (i) a computer simulation model to adequately represent the domain or issue on hand (Davidsen, 2000; Homer and Hirsch, 2006; Kriz, 2003), (ii) a user interface capable of allowing the decision makers to make decisions and access the feedback on interactive basis, (iii) a human facilitator or coach responsible for conducting a debriefing session (Davidsen, 1996, 2000; Davidsen and Spector, 1997; Ledrman, 1992). When an ILE’s underlying simulation model is based on system dynamics methodology (Forrester, 1961) we term that ILE as SDILE. Some popular SDILEs are People Express (Sterman, 1988), FishBankILE (Qudrat-Ullah, Saleh, & Bahaa, 1997) and Healthcare Microworld (Hirsch, Immediato, & Kemeny, 1997).

DECISION MAKING AND LEARNING WITH SDILE

The Role of a System Dynamics Simulation Model

The core of SDILE is a system-dynamics-based simulation model. System-dynamics-based simulation models have strengths to map (i) the multiple stakeholders’ interests, (ii) available but limited resources, and (iii) decisions at different levels in the organization, a general characterization of most of the task systems (e.g., health care system, education system, energy system, etc.) in the public sector. The key capabilities of a system dynamics model are:

- Over time feedback processes and interaction between the system variables in and across various functional entities (e.g., human resource, demand sector, supply sector, financials, etc.) are explicitly represented. (see examples in the work of Bunn and Dyner (1996) and/or Qudrat-Ullah (2005a)).
Both physical (e.g., equipment, machines, infrastructure, etc.) as well as non-physical resources (e.g., knowledge and know-how, moral of employee, satisfaction level, etc.) are distinguished and explicitly modeled. (see examples in the work of Bunn and Dyner (1996) and/or Qudrat-Ullah (2005a)).

Delays and distortions in real-world public policy decisions and their outcomes are clearly represented. (see examples in the work of Bunn and Dyner (1996) and/or Qudrat-Ullah (2005a)).

Learning begins to happen during model building process itself: decisions and policies are represented through the consultation with the actual decision makers and the organization logs and data. Once a simulation model is built to adequately represent the real task system then it is subjected to both structural

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**Figure 1: The “Decision Panel” of FishBankILE**

- **Start**
- **Restart**
- **No Ship**
- **One Ship**
- **Two**
- **Three**
- **Use More Ships for Fishing**
- **Click Here and Drag for the Percentage of Fleet You Want to Send to the Sea**
- **Click Here for the Number of New Ships You Want to Order**
- **Click Here for Financial Report**
- **Click Here for the Number of New Ships You Want to Order**
- **Click Here for Financial Report**
as well as behavioral validity testing (Barlas, 1989, 1996; Qudrat-Ullah & Davidsen, 2001).

**The User Interface of SDILE**

On top of the validated system-dynamics-based simulation model, a user interface is built to allow interactive decision making and learning. Figure 1 depicts the “decision panel” window of the user interface of an SDILE called “FishbankILE” (Qudrat-Ullah et al., 1997). A click on “start” button activates the participation of the decision makers in the SDILE, then follows the keying in and execution of the actual decisions. Here, the decision makers not only interact with task model via keying in the actual decision, but also can access to the variety of useful information including summary report and financial report. The availability of “immediate” feedback helps the decision makers to develop a better understanding of the underlying task system.

**The Role of Human Facilitator in SDILE**

The human facilitator/coach plays a key role in enhancing decision making and learning capabilities of the users of SDILE. The primary task of a facilitator is to facilitate the “institutionalization of knowledge” (Elsom-Cook, 1993). Learners can have many experiences with SDILEs. Initially, they have no knowledge of which experiences are important and useful for real-world decision making situations. Similar concerns have been echoed in the “assimilation paradox” (Briggs, 1990). Assimilation paradox asserts that self-directed learners, in the absence of any guidance, face difficulties in assimilating the new knowledge with the existing knowledge and mental models. Debriefing sessions, necessarily held after the participants have completed decision making and learning activity with simulation, appears to help learners overcome these difficulties and update their mental models (Davidsen & Spector, 1997).

**FUTURE TRENDS**

To deal with the complex and dynamic task systems in public sector management, we have presented SDILE as a solution decision support system for better training and enhancing decision-making capabilities of the decision makers. Future studies could advance the science of public sector decision making by investigating, for example,

- Training with an SDILE takes substantial time commitments. How would the economics of training with SDILEs compare with other training support systems (e.g., role play games)?
- Human facilitation comes in different shapes and forms (e.g., individual vs. group-based facilitation, scripted vs. open-ended discussions). Which form of facilitation is the most effective to train the decision makers in public sector and at what cost?

**CONCLUSION**

Managing public sector systems, such as health-care, is complex a task. We have presented SDILEs as the viable decision support technology. The strength of SDILE lies in the underlying system dynamics simulation model that allows adequate representation of the target task system. Pursued systematically, the investigations regarding the overall effectiveness of SDILEs, we believe, will advance our knowledge into the design conditions of an effective decision support system for task systems in the public sector.

**REFERENCES**


System Dynamics Based Learning Environments


**KEY TERMS**

- **Adequate representation:** It (the simulation model) includes all that matters in a particular real-world decision making problem situation.

- **Decision makers:** It refers to the policy decision makers.

- **Dynamic tasks:** These are the tasks where (i) series of decision vs. a single decision are made, (ii) the decisions are interdependent, and (iii) task systems variables related through feedback processes. For instance, managing a health-care facility, emergency decision making, and managing of ambulance fleet are all dynamic tasks.

- **Feedback process:** In a feedback process, when a decision is made, its “outcome” is made available to the decision maker that, in turn, will make the new decision, and the cycle continues until the objective is achieved.

- **Mental model:** The concepts and constructs about real work things we have in our heads are called mental model. For instance, people do not keep a “car” in their heads, but a mental model of it.

- **Scripted:** It means the facilitator delivers only written, prior to the debriefing session, comments.

- **Task system:** It consists of resources and policies within the boundary of the problem to be solved.
INTRODUCTION

System Theory is a powerful paradigm to deal with abstract models of real processes in such a way to be accurate enough to capture the salient underlying dynamics while keeping the mathematical tools easy enough to be manageable. Its typical approach is to describe reality via a reduced subset of ordinary differential equations (ODE) linking the variables. A classical application is the circuits theory, linking the intensive (voltage) and extensive (current) variables across and through each simplified element by means of equilibrium laws at nodes and around elementary circuits. When such relationships are linear (like in ideal capacitors, resistances, and inductors, just to stay in the circuit field), a full battery of theorems does help in understanding the general properties of the ODE system. Positive systems, quite often used in compartmental processes like reservoirs in nature and pharmacologic concentration in medical therapy, enjoy most of the properties of the linear systems, with the nonlinear constraint of non negativity. More general nonlinear systems are less easily treatable unless a simple form of nonlinearity is taken into account like the ideal characteristic of a diode in circuit theory. When the physics of the process is quite known, like in the mentioned examples, it is quite easy to identify a small number of variables whose set would fully describe the dynamics of the process, once their interrelations are properly modeled: this is the classical way to approach such a problem.

Nowadays, on the other side, new fields are growing up, like bioinformatics, where, instead, many data are collected over several possibly correlated variables whose joint dynamics would follow a law not a priori known nor easily understandable on the basis of the state-of-the-art knowledge. Given the opportunity to have so much data not easy to correlate by the human reader, but probably hiding interesting properties, one of the typical goals one has in mind is to face the problem on the basis of a hopefully reduced meaningful subset of the measured variables. The complexity of the problem makes it thus worthwhile to resort to automatic classification procedures in order to pre-process the collected data. Then, the original question does arise of reconstructing the synthetic mathematical model, capturing the most important relations between variables, in order to infer their hidden relationships, like in systems biology.

BACKGROUND

The introduced tasks of selecting salient variables and identifying their relationships from data may be sequentially accomplished with various degrees of success in a variety of ways. Principal components order the variables from the most salient to the least one, but only under a linear framework. Partial least squares do allow extension to nonlinear models, provided that one has prior information on the structure of the involved nonlinearity; in fact, the regression equation needs to be written before identifying its parameters. Clustering may operate even in an unsupervised way without the a priori correct classification of a training set (Boley, 1998). Neural networks are known to learn the embedded rules with the indirect possibility (Taha & Ghosh, 1999) to make rules explicit or to underline the salient variables. Decision trees (Quinlan, 1994) are a popular framework providing a satisfactory answer to the recalled needs.

Four main general purpose approaches will be briefly discussed in the present article. In order to reduce the dimensionality of the problem, thus simplifying both the computation and the subsequent understanding of the solution, the critical problems of selecting the most salient variables must be solved. This step may already be sensitive, pointing to the very core of the information to look at. A very simple approach is to resort to cascading a divisive partitioning of data orthogonal to the principal directions—PDDP—(Boley, 1998) already proven to be successful in the context of
A more sophisticated possible approach is to resort to a rule induction method, like the one described in Muselli and Liberati (2000). Such a strategy also offers the advantage of extracting underlying rules, implying conjunctions and/or disjunctions between the identified salient variables. Thus, a first idea of their even nonlinear relations is provided as a first step to design a representative model whose variables will be the selected ones. Such an approach has been shown (Muselli and Liberati, 2002) to be not less powerful over several benchmarks than the popular decision tree developed by Quinlan (1994).

An alternative in this sense can be represented by Adaptive Bayesian Networks (Yarmus, 2003) whose advantage is also to be available on a commercial wide spread data base tool like Oracle.

Finally, a possible approach to blindly building a simple linear approximating model is to resort to piece-wise affine (PWA) identification (Ferrari-Trecate, Muselli, Liberati, & Morari, 2003).

The joint use of (some of) such approaches briefly described in the present contribution, starting from data without known priors about their relationships, will thus allows reduction of dimensionality without significant loss in information, then to infer logical relationships, and, finally, to identify a simple input-output model of the involved process that also could be used for controlling purposes.

**VARIABLE SELECTION VIA UNSUPERVISED CLUSTERING**

In this article, we will firstly resort to a quite recently developed unsupervised clustering approach, the PDDP algorithm, proposed in Boley (1998). According to the analysis provided in Savaresi and Boley (2004), PDDP is able to provide a significant improvement of the performances of a classical k-means approach (Hand, Mannila, & Smyth, 2001; MacQueen, 1967), when PDDP is used to initialize the k-means clustering procedure. The approach taken herein may be summarized in the following three steps:

1. A principal component analysis defines a hierarchy in the transformed orthogonal variables according the principal directions of the data set (Hand et al., 2001; O’Connel, 1974).
2. The unsupervised clustering is performed by cascading a non-iterative technique—the principal direction divisive partitioning (PDDP) (Boley, 1998) based upon singular value decomposition (Golub & van Loan, 1996)— and the iterative centroid-based divisive algorithm k-means (MacQueen, 1967). Such a cascade, with the clusters obtained via PDDP used to initialize k-means centroids, is shown to achieve best performances in terms of both quality of the partition and computational effort (Savaresi & Boley, 2004).
3. By analyzing the obtained results, the number of variables needed for the clustering may be reduced by pruning all the original variables that are not needed in order to define the final partitioning hyper-plane so that the classification eventually is based on a few variables only.

**VARIABLE SELECTION VIA MINIMUM DESCRIPTION LENGTH**

Based on information theory, the minimum description length (MDL) principle (Barron, Rissanen, & Yu, 1998) states that the best theory to infer from training data is the one that minimizes the length (i.e., the complexity) of the theory itself and the length of the data encoded with respect to it (Friedman, Geiger, & Goldszmidt, 1997). This approach can be applied to address the problem of variable selection by considering each single variable as the simplest predictive model of the whole system. As described in (Kononenko, 1995), each variable can be ranked according to its description length that reflects the strength of its correlation with the system dynamics. In this context, the MDL measure is given by (Yarmus, 2003) weighting the encoding length (with one submodel for each observed value of the variable) with the number of bits needed to describe the data, based on the probability distribution of the target value associated to each submodel. However, once all features have been ordered by rank, no a priori criterion is available to choose the cut-off point beyond which features can be discarded. To circumvent this drawback, one can adopt an iterative approach that starts with building a model on the set of the n-top ranked variables. Then, a new variable is
sequentially added to this set and a new model is built until no improvement in accuracy is achieved.

**VARIABLE SELECTION VIA LOGICAL NETWORKS: TOWARD A LOGICAL MODEL**

Recently, an approach has been suggested—hamming clustering—related to the classical theory exploited in minimizing the size of electronic circuits, with the additional care to obtain a final function able to generalize from the training dataset to the most likely framework describing the actual properties of the data. In fact, the Hamming metric tends to cluster samples whose code is less distant; this is likely to be natural if variables are redundantly coded via thermometer (for numeric variables) or only-one (for logical variables) code (Muselli & Liberati, 2000). The approach followed by Hamming clustering in mining the available data to select the salient variables consists of three steps:

1. Continuous variables are quantised in intervals. The computing process does not require floating point computation but only basic logic operations, allowing the algorithm speed and its insensitivity to precision.

2. Classical techniques of logical synthesis are specifically designed to obtain the simplest AND-OR expression able to satisfy all the available input-output pairs without an explicit attitude to generalize. To generalize and infer the underlying rules, at every iteration Hamming clustering groups together, in a competitive way, binary strings having the same output and close to each other. A final pruning phase does simplify the resulting expression, further improving its generalization ability. The minimization of the involved variables intrinsically excludes the redundant ones, thus enhancing the very salient variables for the investigated problem. The low (quadratic) computational cost allows managing quite large datasets.

3. Each logical product directly provides an intelligible rule, synthesizing a relevant aspect of the searched underlying system that is believed to generate the available samples.

The hamming clustering approach enjoys the remarkable property of directly providing a logical understandable expression (Muselli & Liberati, 2002), which is the final synthesized function directly expressed as the OR of ANDs of the salient variables, possibly negated.

**LOGICAL MODELING VIA ADAPTIVE BAYESIAN NETWORKS**

A possible alternative to logical networks like hamming clustering are adaptive bayesian networks (ABN), derived from naïve bayes (NB). NB is a very simple Bayesian network consisting of a special node (namely one of the desired behaviours) that is parent of all other nodes (the involved variables) that are assumed to be conditionally independent, given the value of the class. The NB network can be “quantified” against a training dataset of preclassified instances, that is, we can compute the probability associated to a specific value of each attribute, given the value of the class label. Then, any new instance can be easily classified making use of the Bayes rule. Despite its strong independence assumption is clearly unrealistic in several application domains. NB has been shown to be competitive with more complex state-of-the-art classifiers (Friedman et al., 1997) (Keogh & Pazzani., 2002) (Cheng & Greiner, 1999). In the last years, a lot of research has focused on improving NB models by relaxing their full independence assumption. One of the most interesting approaches is based on the idea of adding correlation arcs between the attributes of a NB classifier. On these “augmenting arcs” are imposed specific structural constraints (Friedman et al., 1997) (Keogh & Pazzani., 2002) in order to maintain computational simplicity on learning. The algorithm of adaptive bayesian network (ABN) by Yarmus (2003) is a greedy variant, based on the previously recalled MDL of the approach proposed in (Keogh & Pazzani, 2002). The resulting network structure consists of a set of conditionally independent multivariable relationships. Interestingly, each multidimensional relationship can be expressed in terms of a set of if-then rules enabling users to easily understand the basis of model predictions.
**PIECE-WISE AFFINE IDENTIFICATION**

Once the salient variables have been selected, it is of interest to capture a model of their dynamical interaction. A first hypothesis of linearity may be investigated, usually being only a very rough approximation, when the values of the variables are not close to the functioning point around which the linear approximations computed. On the other hand, to build a nonlinear model is far from easy; the structure of the nonlinearity needs to be a priori known, which is not usually the case. A typical approach consists of exploiting a priori knowledge, when available, to define a tentative structure, then refining and modifying it on the training subset of data, and finally retaining the structure that best fits a cross-validation on the testing subset of data. The problem is even more complex when the collected data exhibit hybrid dynamics (i.e., their evolution in time is a sequence of smooth behaviours and abrupt changes).

An alternative approach is to infer the model directly from the data without a priori knowledge via an identification algorithm capable of reconstructing a very general class of piece-wise affine model (Ferrari-Trecate et al., 2003). This method also can be exploited for the data driven modelling of hybrid dynamical systems, where logic phenomena interact with the evolution of continuous-valued variables. Such approach will be described concisely in the following. Piece-wise affine identification exploits $k$-means clustering that associates data points in multivariable space in such a way to jointly determine a sequence of linear submodels and their respective regions of operation without even imposing continuity at each change in the derivative. In order to obtain such a result, the five following steps are executed:

- **Step 1**: The model is locally linear; small sets of data points close to each other likely belong to the same submodel. For each data point, a local set is built, collecting the selected points together with a given number of its neighbours (whose cardinality is one of the parameters of the algorithm). Each local set will be pure if made of points really belonging to the same single linear subsystem; otherwise, it is mixed.

- **Step 2**: For each local dataset, a linear model is identified through usual least squares procedure. Pure sets belonging to the same submodel give similar parameter sets, while mixed sets yield isolated vectors of coefficients, looking as outliers in the parameter space. If the signal to noise ratio is good enough, and if there are not too many mixed sets (i.e., the number of data points is enough more than the number of sub-models to be identified, and the sampling is fair in every region), then the vectors will cluster in the parameter space around the values pertaining to each submodel, apart from a few outliers.

- **Step 3**: A modified version of the classical $k$-means, whose convergence is guaranteed in a finite number of steps (Ferrari-Trecate et al., 2003) takes into account the confidence on pure and mixed local sets in order to cluster the parameter vectors.

- **Step 4**: Data points are then classified, each being a local dataset one-to-one related to its generating data point, which thus is classified according to the cluster to which its parameter vector belongs.

- **Step 5**: Both the linear submodels and their regions are estimated from the data in each sub-set. The coefficients are estimated via weighted least squares, taking into account the confidence measures. The shape of the polyhedral region characterizing the domain of each model may be obtained via linear support vector machines (Vapnik, 1998), easily solved via linear/quadratic programming.

**FUTURE TRENDS**

The proposed approaches are now under application in other similar contexts. The fact that a combination of different approaches taken from partially complementary disciplines proves to be effective may indicate a fruitful direction in combining in different ways classical and new approaches to improve system theory.

**CONCLUSION**

The proposed approaches are very powerful tools for quite a wide spectrum of applications in system theory, providing an up-to-date answer to the quest of formally extracting knowledge from data and sketching a model of the underlying process.
REFERENCES


**KEY TERMS**

**Hamming Clustering:** A fast binary rule generator and variable selector able to build understandable logical expressions by analyzing the Hamming distance between samples.

**Hybrid Systems:** Hybrid systems’ evolution in time is composed by both smooth dynamics and sudden jumps.

**k-means:** Iterative clustering technique subdividing the data in such a way to maximize the distance among centroids of different clusters, while minimizing the distance among data within each cluster. It is sensitive to initialization.

**Model Identification:** Definition of the structure and computation of its parameters best suited to mathematically describe the process underlying the data.

**Principal Direction Divisive Partitioning (PDDP):** One-shot clustering technique based on principal component analysis and singular value decomposition of the data, thus partitioning the dataset according to the direction of maximum variance of the data. It is used here in order to initialize K-means.

**Principal Component Analysis:** Rearrangement of the data matrix in new orthogonal transformed variables ordered in decreasing order of variance.

**Rule Inference:** The extraction from the data of the embedded synthetic logical description of their relationships.

**Salient Variables:** The real players among the many apparently involved in the true core of a complex business.

**Singular Value Decomposition:** Algorithm able to compute the eigenvalues and eigenvectors of a matrix; also used to make principal components analysis.

**Unsupervised Clustering:** Automatic classification of a dataset in two or more subsets on the basis of the intrinsic properties of the data without taking into account further contextual information.
INTRODUCTION

For over 3000 years from Homer, Moses and Socrates onwards, the teacher in direct, personal contact with the learner, has been the primary means of communicating knowledge...until the fourteenth century, when the invention of the printing press allowed for the first time the large-scale dissemination of knowledge through books. (Bates, 1995)

Today there is a range of technologies available to those who design learning events, from the old and simple to the new and complex. Key attempts have been made to develop theoretical frameworks of learning technologies and have been reported in the literature of higher education, human resource development, and instructional design. These three fields are not discrete and some overlap occurs. For example, commentators in the field of instructional design state that their designs are provided for learning in many contexts including schools, higher education, organizations, and government (Gagné, Briggs, & Wager, 1992; Reigeluth, 1983). In many cases the theoretical frameworks are intended to guide the selection of learning technologies but often the conceptualizations have not kept pace with technological change.

There are many definitions of taxonomy and most of them refer to systems for the classification and organization of things. Carl Linnaeus developed the most well known taxonomy during the expansion of natural history knowledge in the 18th century. It is the scientific system for the classification of living things and has the basic structure of organism, domain, kingdom, phylum, class, order, family, genus, and species. It has been argued (Wikipedia, 2005) that the human mind uses organizational structures to naturally and systematically order information received and hence makes sense of the world. A taxonomy is clearly an organizational structure and it follows that as the Linnaean taxonomy assists those investigating the life sciences; a taxonomy of learning technologies can help users and investigators of learning technologies.

It is suggested that taxonomies of learning technologies are appropriate tools to assist in the design of learning events that include technologies.

BACKGROUND

The Linnaean taxonomy has a deep hierarchical structure which reflects the number and diversity of living things. It is reasonable to expect that a taxonomy for learning technologies will be smaller due the smaller number of learning technologies. Just as new species are added to the Linnaean taxonomy as they are discovered, a taxonomy of learning technologies must be adaptable to cater for leaning technologies of the future. A taxonomy of learning technologies is therefore a framework that classifies or organizes learning technologies.

There have been a number attempts to classify or organize learning technologies and while their classification frameworks are logically sound they have not always been developed to assist in the design of learning events that use technology in the most effective and efficient manner. Also, there is a considerable range in the depth of approach or rigor. However, all of the approaches either divide technologies into categories, either by intention or as a result of categorization by other criteria.

Leshin, Pollock, and Reigeluth (1992) present a classification scheme for “media” that is based on attributes in which learning technologies are grouped into five “systems.”

- Human-based system (teacher instructor, tutor, role-plays, group activities, field trips, etc.)
- Print-based system (books, manuals, workbooks, job aids, handouts, etc.)
- Visual-based system (books, job aids, charts, graphs, maps, figures, transparencies, slides, etc.)
- Audiovisual-based system (video, film, slide-tape programs, live television, etc.)
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• Computer-based system (computer-based instruction, computer-based interactive video, hypertext, etc.)

They state that the “systems” share the characteristic of carrying “a message (information) to a receiver (learner)” and that some “systems” can “process messages from the receiver” (Leshin et al., 1992, p. 256). Writing in the field of instructional design, Leshin, Pollock, and Reigeluth use their classification as a starting point from which technology-based learning events can be designed: “Now through the process of message design you will tailor your instruction to a particular medium or set of media.” (Leshin et al., 1992)

The approach taken to the classification of learning technologies by Leshin, Pollock, and Reigeluth provides little or no insight into the application of the technology, and is not much more than a labeling system. As they were writing prior to the development of the World Wide Web, the classification system did not include learning management systems or online technologies. They could easily be added to the last category of computer-based systems, but this adds little to the understanding of them or to their application to learning in an appropriate way.

Also writing in the literature of instructional design, Romiszowski (1988) classifies “media” by the sensory channels they support and provides examples such as telephone for the auditory channel, video for the “audio/visual” channel, chalkboards for the visual channel, and devices or models for the “tactile or kinesthetic” channel. Romiszowski’s approach is slightly more informative than that of Leshin, Pollock, and Reigeluth as he makes the conceptual connection between technologies and “sensory channels.” However his system of classification provides little insight into the characteristics of the technologies which lead to the matching of them to learning activities in an appropriate manner.

Others in the field of instructional design take an even less rigorous approach to the categorization or classification of learning technologies. Reiser and Gagné (1983) argue that a “number of kinds of categories can be devised for the classification of media” and that “frequently employed categories include audio, print, still visual and motion visual, and real objects.” They elaborate that the reasons for categorizing “media” are generally associated with their selection and that their application can be optimized through matching their characteristics to the task:

A particular type of medium can best present a task having a similar classification. For example the learning of a task that requires differentiation of visual features can best be done with a visual medium (Reiser & Gagné, 1983, p. 13).

While Reiser and Gagné’s categorization of “media” is appropriate for the selection of technologies as adjuncts to classroom teaching from the technologies available in the early 1980s, it does not have much to offer the selection of learning technologies as central elements of learning events and does not easily expand to address technologies developed after their conceptualization was published.

Some other commentators have taken a more interpretive approach to the categorization of learning technologies. Contrary to the descriptive classification approaches, Laurillard (2002) categorizes learning technologies through the use of “pedagogical categories” and argues that “there are many attempts in the literature to categorise and classify the forms of media, none of which is very illuminating for our purpose here” (pp. 77-78).

Laurillard continues with the argument that “educational media” should be classified in terms of the categories and extent of learning processes they support and provides the four categories: “Discursive, Adaptive, Interactive and Reflective.” Laurillard’s categories provide limited insight to the nature and characteristics of learning technologies when used outside of the “teaching strategy.”

In a similar fashion to Leshin et al., Romiszowski, and Reiser and Gagné, Bates classifies learning technologies in two ways. First, according to the “medium they carry” and he states:

“In education the five most important media are:

- Direct human contact (face-to-face)
- Text (including still graphics)
- Audio
- Television
- Computing” (Bates, 1995, p. 32)

Second, Bates distinguishes between technologies that are “primarily one-way and those that are primarily
two-way, in that they allow for interpersonal communication” (Bates 1995).

Bates, writing about open learning and distance education in higher education, where in the past communications between learners and between learners and facilitators have been difficult due to the absence or lack of face-to-face opportunities, describes one and two-way technologies for four of the “five most important media.”

Other approaches to the classification of learning technologies are designed for large distance education institutions which have large instructional design resources.

One approach by an organization with instructional design resources (Sun Associates, 2001) is to divide technologies into the categories:

- Tutorial technologies
- Application uses of technologies
- Exploratory technologies
- Communications technologies

This approach is helpful but it does not provide an insight to the nature of the technology, rather, it is suggesting how the technologies should be used. For example, under communications technologies no differentiation is made between videoconference, which is two-way, and Web searching, which is one-way.

Another approach (Bruce & Levin, 1997) divides the technologies into the categories of:

- Media for inquiry
- Media for communication
- Media for construction
- Media for expression

Bruce and Levin’s taxonomy further subcategorizes technologies and while theoretically helpful, could be confusing, as the basic differentiation between one-way and two-way is not apparent. They include document preparation as a subcategory of media for communication. It can be argued that all education is (or should be!) communicative and this category does not help to tease apart the appropriate uses of the different technologies.

By far the most exhaustive approach to the development of a taxonomy for learning technologies is that taken by Tomei (2005). The intention of his work is to provide a “desktop reference for the analysis, design, development, implementation and evaluation of technology based instructional materials” (Tomei, 2005, p. xx).

Tomei expands upon the work of the educational psychologists who developed the commonly known “cognitive, affective and psychomotor domains of teaching” (Tomei, 2005). He argues that a technology domain exists as “the newest domain for teaching [that] addresses technology first and foremost as its own viable content area” (p. 11).

The technology domain is a hierarchic structure containing from the lowest to highest, five levels: literacy, collaboration, decision making, infusion, integration, and tech-ology (Tomei, 2005). The taxonomy is not one of learning technologies per se, rather it is a taxonomy of knowledge of, skills with, and attitudes to technology. It serves as an excellent framework within which curricula may be developed to provide students with opportunities not only to become adept users of technology but critical thinkers about technology and its impact.

Tomei’s is a rigorous work resulting in a theoretical as well as practical contribution to the field.

In many institutions teachers are often asked to design curricula for students who, by virtue of location or time constraints, will use technologies for a significant proportion of their learning. These teachers

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**Table 1. Taxonomy for the technology domain (Tomei, 2005)**

<table>
<thead>
<tr>
<th>Level</th>
<th>Taxonomy Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Literacy Understanding Technology</td>
</tr>
<tr>
<td>2.0</td>
<td>Collaboration Sharing Ideas</td>
</tr>
<tr>
<td>3.0</td>
<td>Decision Making Solving Problems</td>
</tr>
<tr>
<td>4.0</td>
<td>Infusion Learning with Technology</td>
</tr>
<tr>
<td>5.0</td>
<td>Integration Teaching with Technology</td>
</tr>
<tr>
<td>6.0</td>
<td>Tech-ology The Study of Technology</td>
</tr>
</tbody>
</table>
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need a simple yet robust tool to help them understand the technologies they are being asked to use in their teaching while maintaining their research concentration in their own fields.

In 2006, the author presented a new organizational structure, or taxonomy of learning technologies at the Information Resources Management Association Conference (Caladine, 2006). This taxonomy of learning technologies divides learning technologies into broad categories depending on their communications channels. In the top layer of the taxonomy, learning technologies are categorized as one-way or two-way. More descriptive titles have been chosen and the one-way learning technologies are labeled as “representational” as they represent things or materials. The two-way labeled as “collaborative” as they facilitate collaborations.

The taxonomy of learning technologies categorizes technologies as representational or collaborative. Collaborative technologies are then divided into the subcategories of “dialogic” or “productive.” Within each of these categories individual technologies can be further described by their synchronicity or asynchronicity.

The taxonomy for the technology domain (Tomei, 2005) departs from the other attempts as it is a hierarchy of knowledge of, skills with, and attitudes to technology. As such it serves as a relevant and useful guide to the preparation of curricula that develop these attributes in students.

A common characteristic of several of the attempts is the basic division of technologies into one-way and two-way (Bates, 1995; Rowntree, 1994). The taxonomy of learning technologies uses this division and adds subcategories to create an organizational structure that is sufficiently robust for general application to technologies used in learning and simple enough to be accessible to busy academics. The taxonomy is designed to provide designers of blended learning courses an introduction to the appropriate uses of learning technologies.

The taxonomy of learning technologies was developed to describe the learning technologies available at the time of writing. It is difficult to predict the near future and impossible to predict the distant future in the field of learning technology. It is hoped that if the taxonomy does not describe future technologies, it will be able to be easily changed to do so.

CONCLUSION

Many attempts and approaches to the categorization of learning technologies are dated and are no longer relevant to the technologies available to those designing learning events.

REFERENCES


**KEY TERMS**

**Asynchronous:** Not necessarily occurring at the same time. In asynchronous electronic communications it is reasonable to expect that all communicating parties are not at or near their computer or communications technology. E-mail is an asynchronous technology.

**Categorization:** Grouping according to according to the role played.

**Classification:** Grouping according to similar or like characteristics.

**Distance Learning (aka Distance Education):** Education in which learners are geographically separated from facilitators.

**Education:** A structured program of intentional learning from an institution.

**Facilitator (aka Facilitator of Learning):** The person who has prime responsibility for the facilitation of the learning; rather than terms such as “teacher,” “trainer,” or “developer.”

**Flexible Learning:** An approach to learning in which the time, place, and pace of learning may be determined by learners. In this chapter this term is used to include the approaches taken by distance learning and open learning.

**Higher Education:** Intentional learning in universities and colleges.

**Human Resource Development:** Intentional learning in organizations. Can include training and development.

**Instructional Design:** The process of is concerned with the planning, design, development, implementation, and evaluation of instructional activities or events and the purpose of the discipline is to build knowledge about the steps for the development of instruction.
**Interaction:** Reciprocal between humans and between a human and an object including a computer or other electronic device that allows a two-way flow of information between it and a user responding immediately to the latter’s input.

**Learner:** A generic term to describe the person learning; rather than terms such as “trainee” and “student.”

**Learning:** An umbrella term to include training, development, and education, where training is learning that pertains to the job, development is learning for the growth of the individual that is not related to a specific job, and education is learning to prepare the individual but not related to a specific job.

**Learning Activities:** The things learners and facilitators do, within learning events, that are intended to bring about the desired learning outcomes.

**Learning Event:** A session of structured learning such as classes, subjects, courses, and training programs.

**Learning Management System (aka Virtual Learning Environment, Course Management System and Managed learning Environment):** A Web-based system for the implementation, assessment, and tracking of learners through learning events.

**Learning Technologies:** Technologies that are used in the process of learning to provide material to learners, to allow learners to interact with it, and/or to host dialogues between learners and between learners and facilitators.

**Online Learning:** Flexible or distance learning containing a component that is access via the World Wide Web.

**Representational Technology:** A one-way technology that supports interaction with the material.

**Synchronous:** Occurring at the same time. In synchronous electronic communications, it is reasonable to expect that all communicating parties are at or near their computer or communications technology. Telephone is a synchronous technology.

**Taxonomy:** A hierarchical structure within which related items are organized, classified, or categorized, thus illustrating the relationships between them.
INTRODUCTION

The Taxonomy of Collaborative E-learning offers a new conceptual framework for understanding levels of collaboration. This framework can be used to plan, organize, and assess e-learning activities so participants learn to achieve collective outcomes. The Taxonomy of Collaborative E-learning is grounded in the results of a qualitative study that explored an in-depth view of instructors’ perceptions of teaching with online collaborative methods, and descriptive examples of their approaches. Study findings were used to refine and build on the researcher’s original designs for the “Taxonomy of Collaborative Learning.”

BACKGROUND

Educational Taxonomies

What is an educational taxonomy? Scientists have used this term to describe biological systems. “A taxonomy is a system of categories or classifications that are used for purposes of organization, conceptualization, and communication” (Gilbert, 1992). Benjamin Bloom adapted the concept of taxonomy from scientific to educational purposes. He observed that, beyond just classifying observations, a taxonomy should clarify the relationships among classes of phenomena. “While a classification scheme may have many arbitrary elements... a taxonomy must be so constructed that the order of the terms must correspond to some ‘real’ order among the phenomena represented by the terms” (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). By showing relationships between concepts and the skills needed to understand and use them, educational taxonomies provide an organizational framework educators can use to structure progressively more complex learning activities. Taxonomies can facilitate communication among educators by providing a common language for discussing ways to address various educational dilemmas.

The Taxonomy of Collaborative E-learning builds on the work of Bloom and others who have developed taxonomies for educational purposes.

Bloom’s Taxonomy

The materials known as “Bloom’s Taxonomy” are actually the product of a team of five educators: Max Engelhart, Edward Furst, Walker Hill, David Krathwohl, and Benjamin Bloom (Bloom et al., 1956). These materials were organized as three taxonomies for the cognitive, affective, and psychomotor domains. The “Taxonomy of Educational Objectives for the Cognitive Domain” discussed here is a framework that shows six levels of thinking, from knowledge through evaluation.

The original purposes for Bloom’s Taxonomy were to create tools for evaluation and an impetus for exchange of evaluation instruments and strategies. Bloom’s team wanted to counter what they saw as a general focus on evaluation of rote memorization. The work of George Stoddard provided conceptual foundations for this focus on evaluation. Stoddard, President of the University of Illinois and New York Commissioner of Education, was interested in the meaning of intelligence and discussed its implications for education generally, and testing in particular. He believed that “intelligence is defined as the ability to do abstract thinking” (Stoddard, 1944). Bloom’s Taxonomy derived much of its philosophical foundation from the work of John Dewey. Bloom echoes Dewey’s view that educators must expect more than rote learning. Both Dewey and Bloom believed that “knowledge is of little value if it cannot be utilized in new situations or in a form very different from that in which it was originally encountered” (Bloom et al., 1956 p. 29).

The concern for active engagement of learners promoted by Dewey and the concern for abstract thinking and thoughtful assessment promoted by Stoddard were synthesized into Bloom’s Taxonomy.

Educators across disciplines from K-12 through graduate level who use Bloom’s Taxonomy want to do more than teach content, they also want to foster
development of critical thinking skills. These educators understand that it is not enough for learners to acquire information; learners also need to know how to use, apply, and evaluate information, and how to create new knowledge. When an educator creates a learning experience with Bloom’s Taxonomy as a guide, learners are encouraged to pursue two goals through that experience: acquiring competencies in the content area and learning how to learn through critical thinking. Bloom’s Taxonomy motivates educators to scaffold assignments in such a way that learners will accomplish progressively challenging activities at different conceptual or procedural levels.

The wide use of Bloom’s Taxonomy by educators in diverse settings indicates that such conceptual frameworks are useful to those who plan and design educational offerings.

Collaborative E-Learning

Collaborative e-learning fuses two ideas: e-learning and collaborative learning. The literature includes diverse definitions of the term collaborative learning. Roschelle and Teaseley defined collaborative learning as a “coordinated activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (Teaseley & Roschelle, 1995 p. 70). Pierre Dillenbourg and his colleagues admitted that their team of researchers could not agree on a definition of collaborative learning that would encompass all the important elements. Their working definition described “a situation in which two or more people learn or attempt to learn something together,” and their research focused on three elements: the situation, the group, and the nature of group learning. The learning activity on which they focused their research involved “joint problem-solving, and learning expected to occur as a side effect of problem-solving, measured by the elicitation of new knowledge or by improvement of problem-solving performance.” They argued that collaborative learning is not a mechanism nor a method, but a “situation in which particular forms of interaction among people are expected to occur, which would trigger learning” (Dillenbourg, Baker, Blaye, & O’Malley, 1999, pp. 1-2). Collaborative learning encourages development of skills about how to collaborate.

Learning is associated with understanding how to make judgments about, and seek to manage, trust, power, goals and opportunism in collaborative contexts [and] learning associated with understanding how to effect mutual communication, engage with partners’ procedures, negotiate politics and develop effective structures and processes for the particular collaboration (Huxham & Hibbert, 2005, p. 66).

Interaction is intrinsic to collaboration (Gray, 1989; Wood & Gray, 1991). While not all interaction is collaborative, all collaboration builds on interaction among participants. Educators since John Dewey have pointed to interaction as intrinsic to education. Constructivists and social constructivists believe that learning occurs when learners interact with each other and their environment (Jonassen, 1994; Moore & Kearsely, 1996; Vygotsky, 1978, 1987; Weil & Joyce, 1978). Collaborative learning emphasizes learner-learner interaction in situations where the learners have some level of autonomy or responsibility for determining how decisions are made for accomplishing the learning goal. In this way, collaborative learning is differentiated from cooperative learning, where the instructor retains control and determines subtasks that partners solve independently (Dillenbourg & Schneider, 1995; Teaseley & Roschelle, 1995).

Learner-learner interaction takes on new significance in the online learning milieu, where it can help reduce the isolation some may feel when they do not share geographic proximity with the instructor and other learners (Lemak, Reed, Montgomery, & Shung, 2005; Mabrito, 2005; Rankin, 2005). Collaborative e-learning can complement individual study and leverage the power of learner-learner interaction. E-learning is defined for this study as an educational activity or course conducted in an electronic learning milieu, using Internet communication technologies for delivery of instruction, curricular materials and learning activities. In this study, e-learning refers to instructor-lead academic courses that may be offered partially or entirely online.

Collaborative e-learning is defined for this study as constructing knowledge, negotiating meanings, and/or solving problems through mutual engagement of two or more learners in a coordinated effort using Internet and electronic communications.
**Taxonomy of Collaborative E-Learning**

**TAXONOMY OF COLLABORATIVE E-LEARNING: LEVELS OF COLLABORATION**

The Taxonomy of Collaborative E-learning is a framework for planning, organizing, and assessing curricula, courses, projects, and learning activities. While participants may complete parts of a project independently, when they integrate their efforts into one outcome, we can describe their work as “collaboration.” When people collaborate, they think together as well as work together; such activities provide opportunities for people to learn from each other or transfer knowledge. Together they can generate innovative new ideas or approaches, or new applications for best practices.

The Levels of Collaboration describes a sequence of five ways collaborative activities can be organized, with activities at each level building on the previous ones. These levels can be combined in various ways to create multistage projects. The levels can also be used to purposefully build competencies in Internet and communications technology (ICT) literacy, competencies needed for collaborative work online.

When an educator creates a learning experience with the Taxonomy of Collaborative E-learning as a guide, learners are encouraged to pursue three goals through the experience: acquiring competencies in the content area, developing skills in group process, and literacy in Internet and communications technologies.

**Elements of Taxonomy of Collaborative E-Learning**

The Taxonomy of Collaborative E-learning contains three key elements: the Levels of Collaboration, Learning Activities, and Trust Continuum.

**Levels of Collaboration**

Levels of Collaboration lists progressively more collaborative styles of working in a group. One level is not better than another in absolute terms, but one may be better than another in relation to the learning goals, the configuration or social stage of the group, timing, or other issues. The five levels are: Dialogue, Peer Review, Parallel, Sequential, and Synergistic Collaboration. Arrows in the diagrams represent process and the stars represent outcomes.

In the process of completing projects organized with this system, participants can gain the skills needed to lead, organize, and participate in collaborative projects.

**Dialogue**

The foundational level of collaboration is Dialogue, which “encourages incisiveness and creativity and brings coherence to seemingly fragmented and unrelated ideas” (Charan, 2001, p. 2). Dialogue provides participants the opportunity to find coherence in the ideas, plans, and/or tactics needed to coordinate their efforts. Through Dialogue, learners can learn to:

- Use interpersonal skills and respect others’ perspectives;
- Summarize key points that support the goal of the activity; and
- Make decisions in a group.

When Dialogue occurs on the Internet, additional skills are needed at this level including:

- Use synchronous or asynchronous online discussion or conferencing tools to communicate online.
- Participate in or facilitate online discussions; maintain focus on topic.
- Access relevant information and share it with the group.

**Peer Review**

The second level is Peer Review. This term is used to describe a process of critique and feedback between participants. Learners evaluate and make judgments about the quality and relevance of information in materials peers present. When Peer Review is structured with mutually acceptable boundaries and set criteria, participants can provide objective perspectives and learn from each other.

Through Peer Review, learners can learn to:

- Trust others to be respectful;
- Give constructive criticism;
- Compare and contrast own ideas with others’.
Figure 1. Taxonomy of collaborative e-learning: Levels of collaboration

**Taxonomy of Collaborative E-Learning: Levels of Collaboration**

**DIALOGUE:**
Participants exchange ideas to find shared purpose and coherence in the plans and/or tactics needed to coordinate their efforts.

**PEER REVIEW:**
Participants exchange work for mutual critique through peer review and incorporate others’ comments. Participants create individual outcomes based on peer input, or the process moves to another level of collaboration.

**PARALLEL COLLABORATION:**
Participants each complete a component of the project. Elements are combined into a collective final product, or the process moves to another level of collaboration.

**SEQUENTIAL COLLABORATION:**
Participants build on each other’s contributions through a series of progressive steps: all are combined into a collective final product or the process moves to another level of collaboration.

**SYNERGISTIC COLLABORATION:**
Participants synthesize their ideas to plan, organize and complete the creation of a product that meshes contributions into a collective final product.

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**Taxonomy of Collaborative E-Learning**

When Peer Review occurs on the Internet, additional skills are needed at this level including:

- Work with attachments.
- Use shared document tools to enter comments and track changes.
- Organize and integrate information into classification scheme.

**Parallel**

The third level is Parallel collaboration. When an assignment is completed by a group of learners using a Parallel structure, components of the assignment are allocated among learners. Parallel collaboration typically involves individual work and, through a process of Dialogue and Peer Review, contributions are integrated into the final product.

Through Parallel collaboration, learners can learn to:

- Determine and achieve shared goal or purpose;
- Develop protocols in terms of timing, coordination, communication styles, and other expectations;
- Create agreement for combining individual contributions into collective work;
- Develop mutual accountability; deal with underperforming team members, and resolve conflicts; and
- Generate new knowledge by adapting and synthesizing multiple perspectives into a collective whole.

When Parallel collaboration occurs on the Internet, additional skills are needed including:

- Coordinate multiple strands of project.
- Create document, website or media as collective project documentation.

**Sequential**

The fourth level is Sequential collaboration. When an assignment is completed by a group of learners using a Sequential structure, components of the assignment are organized into a series of progressive steps and results are combined into one collective product. Each component is dependent on successful completion of another in the series of steps. Each step typically involves individual work and, through a process of Dialogue and Peer Review, learners determine how each contribution is integrated into the final product.

In addition to the described competencies for coordination and accountability, through Sequential collaboration, learners can learn to:

- Coordinate timing and multistep processes; and
- Use project management tools to track progress.

When Sequential collaboration occurs on the Internet, additional skills are needed including:

- Use project management tools to track progress.
- Use quality control criteria to assess deliverables at each stage.
- Use advanced editing and version control software functions.

**Synergistic**

The fifth level is Synergistic collaboration. When a group of learners use a Synergistic structure, they work together through all steps and synthesize their ideas to plan, organize, and complete the assignment together. Their contributions are fully meshed into collective final product.

In addition to the competencies described, through Synergistic collaboration, learners can learn to:

- Interact with team members at all stages of project;
- Practice participatory decision making; and
- Balance individual interests with group purpose.

When Synergistic collaboration occurs on the Internet, additional skills are needed including:

- Understand ethics of intellectual property and use of sources.
- Generate new information or knowledge by adapting and integrating multiple parts into collective whole.
Learning Activity

The Learning Activity column includes simplified descriptions of the kinds of actions learners take in each corresponding level.

Continuum of Trust

The continuum illustrates a relationship between trust and the level of collaboration. As illustrated here, as collaboration increases, so does the need for trust. The reciprocal loyalties and common purpose among learners involves trust not only among the learners, but also between the instructor and the learners, and the learners and the institution.

Galford and Drapeau say that people use the word “trust” to refer to three different kinds: organizational, strategic, and personal (Galford & Drapeau, 2003). In an educational context, organizational trust refers to the trust learners have in the institutional and curricular systems that include collaborative projects. Strategic trust refers to the trust learners have in their instructors to provide realistic and fair assignments. Personal trust refers to the reliance on other learners’ abilities and integrity, and confidence that they can and will share your commitment toward meeting the learning goal of the assignment. The Taxonomy of Collaborative E-learning encourages purposeful development of trust at the strategic and personal trust.

FUTURE TRENDS

To lead organizations of tomorrow, today’s learners need opportunities to develop 21st century skills that will allow them to work collaboratively across boundaries of geography, time, and culture. Professional life in the age of the Internet requires a different set of strategic, cross-cultural, team, and technical skills than did the face-to-face operations of the past. Those who are preparing today’s learners for the demands of the evolving workplace must incorporate collaborative approaches into both the content and context of educational activities.

New approaches to education and training can better prepare those who will lead, manage, and work in this changing environment. Peter Senge discusses the “collaborative imperative.” He says, “Business as usual is reaching an evolutionary dead end.” Transformational change requires a new mandate for learning across organizations, industries, and sectors. We are at the very beginning of recognizing and responding to this historic shift and we need to learn as quickly as possible” (Senge, Lichtenstein, Kaeufer, Bradbury, & Carroll, 2007).

A 2003 meeting of representatives of seven colleges and universities identified a “proficiency gap” between the ICT literate, “those who have the blend of cognitive and technical capabilities required to negotiate demands in the academy, or in the workplace, or in society” and those who lack ICT literacy. They described an “urgent need for higher education to focus on this proficiency divide and do all we can to close it” (ETS, 2003, p. 3). The Partnership for 21st Century Skills points out that the way to close the gap is by teaching with 21st century tools in a 21st century context, so learners use essential digital skills in the classroom. Learners must learn to think differently and develop an enlarged repertoire of approaches that work in a networked society and economy. They must learn how to learn so they will be able to stay current in a changing world. Educators who see these needs must also develop an enlarged repertoire of approaches to teaching and learning (Learning for the 21st century, 2003).

CONCLUSION

The Taxonomy of Collaborative E-learning is a synthesis of perceptions and examples put forward by the researcher in prototype models, and by research participants in their interview responses. Results of this study indicate that collaborative e-learning enables educators to be highly interactive with and responsive to learners as individuals and as groups.

The Taxonomy of Collaborative E-learning serves as a practical tool for those who plan, facilitate, and assess learners in collaborative e-learning activities. Like other educational taxonomies that came before, these materials can motivate educators and researchers to create new directions for theory and practice.

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**KEY TERMS**

**Collaboration:** Collaboration is an interactive process that engages two or more participants who work together to achieve outcomes they could not accomplish independently.

**Collaborative Learning:** A situation in which two or more people learn or attempt to learn something together through joint problem solving (Dillenbourg et al., 1999).
**Collaborative E-Learning:** Constructing knowledge, negotiating meanings, and/or solving problems through mutual engagement of two or more learners in a coordinated effort using Internet and electronic communications.

**Cooperative Learning:** Cooperative learning is a protocol in which the task is, in advance, split into subtasks that the partners solve independently. Collaborative learning describes situations in which two or more subjects build synchronously and interactively a joint solution to some problem (Dillenbourg & Schneider, 1995 p. 8).

**E-Learning:** An educational activity or course conducted in an electronic learning milieu, using Internet communication technologies for delivery of instruction, curricular materials, and learning activities. In this study, e-learning refers to instructor-lead academic courses that may be offered partially or entirely online.

**ICT Literacy:** Using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society (ETS, 2003).

**Teaching with Collaborative Methods:** Organizing learning activities and creating an environment where collaborative e-learning occurs, and assessing the success of outcomes.
Teaching and Learning with Personal Digital Assistants

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INTRODUCTION

Personal digital assistants (PDAs) are small handheld devices initially designed for use as personal organizers. They can store documents, spreadsheets, calendar entries, games, databases, and lots of other resources normally associated with a laptop or desktop computer. PDAs are relatively inexpensive and highly portable and are designed to utilize small, low-bandwidth files and applications. They are able to perform limited PC tasks such as word processing and spreadsheet analysis and newer PDAs are capable of Web browsing and e-mail functions via wire or wireless connected to networks. Also, they can synchronize with desktop computers and laptops to download Web sites via channels and work off-line. Furthermore, PDAs offer infrared communication, allowing data to be transferred across short distances between devices without the need for networks. The latest developments offer wireless connection via mobile phone networks or Bluetooth, and many combine phone and PDA functions in one unit (Aclear.net, n.d.). This article will provide an overview of PDA technology including advantages and limitations and the use of PDAs in teaching and learning, as well as the future trends. This will help educators assess the use of PDAs in teaching and learning environments and determine how PDAs can be integrated into the curriculum.

BACKGROUND

Computers can be great learning tools when used effectively, but high costs have long hindered teachers from providing each student with a desktop computer or laptop of their own. Some educators indicated that computers have not have a positive impact on teaching and learning because students and teachers have limited access to them, and, thus, are not using them (Soloway, Norris, Blumenfeld, Fishman, Krajcik, & Marx, 2001). Thus, many teachers have been exploring the less-expensive handheld option. Already common in the business world, PDAs are now being introduced into schools. Today, PDAs such as Palms and Pocket PCs are making technology accessible, affordable, and fun for teachers and students alike. More and more school officials believe that PDAs, which are relatively inexpensive compared with laptops or desktop computers, are the best way to put a computer in the hands of each student (Soloway et. al, 2001). This addresses an important equity issue because PDA brings together the power of handheld technology with the ease, convenience, and low cost of small portable devices, thereby offering a solution to access and equity issues.

Advantages

PDAs provide a feeling of true ownership. Unlike the desktop computers or laptops which are generally shared with other students in the computer lab or classroom, PDA can be a true “personal computer” for students. Like desktop computers, PDAs can be expanded by adding various software or hardware. They can be used as scientific graphing calculators, digital cameras, cell phones, digital voice recorders, global positioning system (GPS), or scientific sensing devices. Their small size makes them easy to carry from class to class and from school to home, giving PDAs a major advantage over the desktop computers and laptops. This portability, combined with powerful data processing and versatility, makes PDAs a significant educational tool (Pownell & Bailey, 2001). PDAs offer more versatility than desktop computers and are much more portable than the laptops. Many educators
believe PDAs will transform educational technology in schools. There are many advantages of using PDAs in education and training:

- Small size, lightweight, and high portability.
- Instant access with no waiting for boot-up.
- Access Internet, e-mail, and the electronic diary.
- The ease of synchronization and sharing of data by infrared “beaming.”
- Flexibility for supporting a wide range of learning activities.
- Can be used anywhere.
- Files and information can be transferred between teachers and students quickly and learners can produce individual/team work easily and effectively (Lockitt, 2005).
- PDAs enable students to interact with each other more effectively (Lockitt, 2005).
- Long battery life.
- Less expensive than desktop computers or laptops.

Problems

Despite the potentials of PDAs in education, some school districts see the problems of using PDAs in the classrooms. The PDAs are not universally advocated by educators. Among the major concerns are the theft risk, high cost, and distraction resulting from the misuse by students. PDAs can be a threat to classroom order and student integrity. Some schools have banned their use because some students use the PDAs to cheat on tests, play non-educational games, or e-mail friends inside or outside the school (Shields & Poftak, 2002). In addition, current PDAs have many limitations: (a) the computational power tends to be low, (b) multimedia is problematic, (c) lack of print-out capability, (d) writing extended documents via stylus-input is inefficient, and (e) the screen is too small.

PDA Technology

PDAs are small and lightweight handheld computers that are designed to be personal information manager (PIMs). PDAs are commonly referred to as handhelds, Palms, and PocketPCs. Most PDAs have touch-sensitive LCD screens, with pen/stylus input, and moderate processing power. Most feature stylus input and handwriting recognition. The handwriting recognition systems are reasonably accurate. Palm Operating System (OS) devices use a special set of stylus strokes that the user must learn, whereas Microsoft’s Pocket PCs can recognize cursive handwriting quite well once trained. Both are reasonably accurate and good for taking short notes. When attached to a portable keyboard, PDAs can be used for serious data input. Users find PDAs more convenient to carry around than laptops (Smith, 2003).

There are two main operating systems (OS) for PDAs: Palm OS and Pocket PC. Pocket PCs run a mini version of Windows specially designed for mobile devices. PalmOS devices (e.g., Palm Pilots, Palm Zire) run on the PalmOS operating system. Unfortunately, software is not interoperable between these two operating systems. Most PDAs today are powerful enough to run mini versions of the popular office applications and Web browsing. Some have small built-in keyboards or connect to attachable keyboards. Usually, PDAs include a docking and synchronization cradle for battery charging, administration of application software, and data transfer and backups. Although the provided built-in memory is usually limited on some PDAs, they can be expanded with additional memory. The most popular formats of memory support are secure digital (SD), compact flash (CF), and Memory Stick (Naismith, Lonsdale, Vavoula, & Sharples, 2004). In addition, many third party suppliers provide various add-on cards for the memory expansion slots such as wireless (WiFi) cards, Bluetooth cards, global positioning system (GPS) cards, and camera cards.

Although a full range of software is now available on most PDAs, most users use their PDAs for these applications: calendar, address/contact lists, calculations, notepad, e-mail, diary, e-books, and Internet. However, increasingly PDAs are being used for other tasks such as word processing, spreadsheets, databases, telephone calls, taking and displaying photographs, recording and playing voice/video, listening to music, and making presentations via PowerPoint. Information, and files on the PDA can be easily synchronized with a laptop or desktop computer via a docking cradle or wireless connection. With connection to the Internet now commonly available for PDAs through modem or wireless services, PDAs can also be used to access the Web and serve as global tracking devices both in and out of the car (Lockitt, 2005).
Using PDAs in Teaching and Learning

Klopfer, Squire, and Jenkins (2002) identify five properties of PDAs that provide unique educational opportunities: (a) portability—the small size and weight of PDAs allows students to take them to different places, (b) social interactivity—PDAs allow students easily exchange data and collaborate with other classmates, (c) context sensitivity—PDAs can gather and respond to real or simulated data unique to the current location, environment, and time, (d) connectivity—PDAs can easily connect to a shared network or Internet, and (e) individuality—scaffolding for difficult activities can be customized for individualized learners.

PDAs function not only as a computer, but also as a textbook, media, calculator, calendar, notepad, and pencil. Students can use a PDA to edit and revise their work. Also, the PDA features an infrared beaming capability, which offers opportunities for real-time collaboration and allows students to “beam” word processing documents, spreadsheets, drawings, data, and even applications to each other without having to download and print out or send via e-mail (Shields & Pof tak, 2002). Students can beam questions and assignments to teachers or send parts of a project from their own PDAs to other classmates. In addition, the availability of Web page storage and viewing software for the PDA allows students convenient access to course Web pages, syllabus, tutorials, magazines, newspapers, and reference materials in the classroom. This access, along with basic text search capabilities, provides many opportunities for in-class assignments and team activities that would generally not be possible or efficient in a traditional classroom.

PDAs provide students with a portable organizer and time manager. They also allow students to enter, manipulate, and analyze data at its source. Furthermore, instructional materials like graphic images, video, and audio can be easily downloaded to PDAs for anytime access. PDAs offer simple, quick, inexpensive ways to communicate, teach, and learn wherever one goes. With a PDA, a teacher, student, or administrator can take notes, calculate, sketch ideas, access the Internet wirelessly, collect data, access resources, manage school activities and courses, and instantly beam information to others. Teachers and students can give PowerPoint presentations right from the PDA with a VGA adaptor module such as “Presenter-to-Go” connected directly to a digital projector. Teachers can use PDAs for personal management tasks. They can share information and collaborate with administrators, other teachers, and students. In addition to the general applications for personal management, there are many educational applications for using PDAs in teaching and learning: course management, content delivery, assessment, communications, calculation, and research.

PDAs provide a very useful means of accessing reference material. They can act as a study aid via interactive quizzes and exercises. With wireless connection, PDAs can provide instant, in-class feedback to teachers on students’ understanding. PDAs also help to motivate students (Smith, 2003). They could be used to assist students with special needs such as dyslexic and physically handicapped students. Students can use PDAs to collect, store, and retrieve information. They can use PDAs to monitor their grades and keep track the due dates of their assignments and projects. They can also expand the capability of their PDAs by installing additional software such as dictionaries, e-books, graphing calculators, databases, music notepads, planetarium, and finance.

Access to information has always been central to learning. Recently, the PDA has spawned a new form of Web access that has the potential to hasten the move to online education, which is currently confined to the desktop and laptop. The new form of access is called a channel, which operates through a proprietary Web site such as AvantGo (Oliver & Wright, 2002). The AvantGo Mobile Internet service provides interactive and personalized content and applications to the PDA or Internet enabled mobile phone real time via wireless connection or desktop synchronization. Students can use AvantGo to browse their favorite Web sites on their PDAs or select from over 2,500 channels of news, weather, education, financial, technology, and other content and applications worldwide (AvantGo Inc., n.d.). Today, many top educational institutions such as Harvard, Stanford, and University of Minnesota are deploying PDAs and AvantGo solutions to make the promise of mobility a reality (AvantGo Inc., n.d.). Students at these universities can use their PDAs to access university directories, class schedules and calendars, university policies, lecture notes, reference materials, and handbooks. These universities are using the PDA to deliver academic course content in some of their courses.

PDAs have become commonplace in the business sector, but more and more educators, particularly in...
higher education institutions, are finding varying uses for the PDAs in teaching and learning. Examples of these uses are:

- The University of South Dakota requires all first-year undergraduate students as well as first year law and medical students to have Palm PDAs (Carlson, 2002).
- Harvard Medical School implemented an extensive PDA program for course content, schedules, evaluations, and announcements in fall 2001 (University of Iowa, 2002).
- The college of Science and Engineering at the University of Minnesota Duluth requires all incoming freshmen in engineering and computer science to have a Compaq iPaQ device and has invested $50,000 to train faculty on how to better use their PDAs as teaching tools (Fallon, 2002).
- Kansas State University provides Palm PDAs to 91 faculty members in the College of Education to improve the lives of faculty, preservice teachers, and administrators. The faculty uses Palm PDAs in the classroom to capture real-time data while observing their pre-service teachers in action and provides performance feedback to preservice teachers about their student-teaching performance (Palm, n.d.).
- East Carolina University has initiated a project called the Handsprings to learning Program that uses PDAs in six multidiscipline courses (University of Iowa, 2002).
- The School of Computer Science at Carnegie Mellon launched the Pebbles PDA project to study how PDAs can be used in conjunction with personal computers and other devices in the classroom and lecture environment (University of Iowa, 2002).
- The Penn State Abington campus has integrated Palm PDAs into several classes. Students are using the devices to take notes, organize their classes, take electronic quizzes, and download course-related materials from Web sites using AvantGo (University of Iowa, 2002).
- The University of Pennsylvania’s Wharton School of Business developed “SPIKE to Go” for point-and-click data interchange between Wharton’s intranet-based content and Palm PDAs. The SPIKE to Go provides Wharton business students with mobile access to Web-based communications suite featuring e-mail, news and announcements, course materials, and student calendars (University of Pennsylvania, 2003).
- Stanford University offers campus information in a PDA friendly format that allows the user to download campus information including faculty information (name, address, phone numbers, location map), dynamic campus maps and floor plans, student services, and other campus information (University of Iowa, 2002).
- The Wake Forest University School of Medicine provides each second- through fourth-year student with a Palm PDA to carry with them on their rounds. They use the PDAs to review reference materials, look up phone numbers in the address book, and to log information (University of Iowa, 2002).

On the training side, global learning systems (GLS) uses PDAs to deliver training. Their product, “Learning to Go,” offers true anytime and anyplace learning. “Learning to Go” provides the ability to view text and graphics, record learner data, and download content from a synchronized desktop or via wireless Internet access. The server has the ability to identify the types of PDA, build and download dynamic Web pages specifically suited to the learner’s device, and upload learner data such as lessons completed and quiz scores (Shepherd, 2001).

PDAs could bring important benefits to schools, assisting in administration, supporting classroom management, and enabling personal and group learning (BECTA, 2003). Lockitt indicates that feedback from teachers who have used PDA with learners highlights the increased flexibility they offer and the opportunities for interaction between teachers to students and students to students. Furthermore, the use of PDAs for providing management information, giving demonstration, modeling and undertaking “real time” statistical analysis, assessment, learning modules, timetables, diaries, event calendar, and many other functions can significantly improve the effectiveness and quality of the learning process as well as reducing the bureaucratic burden on the teacher involved (Lockitt, 2005).
FUTURE TRENDS

The next generation of PDAs is likely to be integrated with mobile phones and other mobile devices and possibly have the equivalent computing power of a desktop/laptop computer. They will also have all the functionality associated with 3G technologies and instant access to the Internet. In addition, Choudhary and Singh (2005) as well as Lockitt (2005) make the following assumptions with regard to the future of PDAs and mobile computing:

- **Enhanced battery capacities and more power-efficient PDAs**: As battery technology is becoming increasingly sophisticated, PDAs will be used for extended periods of time without charging.
- **Larger memory storage**: The memory storage capability of PDAs will be equal to that of the desktop/laptop computer.
- **Faster processors support feature-rich applications**: Wireless MMX technology will bring desktop-like multimedia performance to PDAs while minimizing the power needed to run multimedia applications.
- **Wider connectivity**: PDAs will be constantly connected to the Internet and telecommunications network with faster, more ubiquitous wireless services.
- **Greater functionality**: The functionality of PDAs will increase with the inclusion of high definition TV, online films, digital video, digital radio, and global tracking systems.
- **Software**: The software used on PDAs is exactly the same as those used on desktop/laptop computers.
- **Flexible screens**: The lightweight, flexible screens such as “roll out” or spray on screens will be available to overcome one of the barriers when using PDAs.
- **Input innovations**: The projection keyboards, improved voice recognition, and advanced transcriber technology will be available to provide significant improvement of the effective input of data.

CONCLUSION

PDAs are changing the way people access and work with information. These devices are becoming smaller, cheaper, better, and more connected. PDAs may just become the mobile computing technology that revolutionizes the face of learning. The intuitive interface, portability, and wealth of third-party software applications make the PDA an ideal educational tool to enhance teaching and learning in and out of the classroom. Educators are now exploring ways to take advantage of the emerging PDA technology to encourage exploration, stimulate learning, and enhance lifelong learning. PDAs give students full-time access to educational materials and wireless Internet access. This will help expand learning opportunities beyond traditional classroom walls.

The use of PDA can provide students with a very dynamic and interactive learning experience. It helps students access and study the course materials at anytime, anywhere. PDA gives the students more flexibility in where, when, and how they interact with the educational materials, and allows students with different learning styles and special needs to learn successfully. The use of PDA technology enhances the classroom learning experience and allows students and instructors to participate and collaborate in ways that would not be possible in a traditional classroom. With PDAs continuing to grow more powerful, become less expensive and more mobile, and allow more personal computing, educators should consider how they might use the devices to enhance teaching and learning.

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Teaching and Learning with Personal Digital Assistants


**KEY TERMS**

**802.11:** The official designation for the wireless protocol. Also known as *Wi-Fi* (wireless fidelity). 802.11 is a set of wireless LAN standards developed by working group 11 of the IEEE LAN/MAN Standards Committee (IEEE 802). The 802.11 family uses the same wireless Internet protocol. 802.11b was the first widely accepted wireless networking standard, followed by 802.11a and 802.11g.

**Beaming:** Beaming allows PDA users to easily exchange important information using the infrared (IR) port.

**Bluetooth:** A specification for wireless personal area networks using radio frequencies to link mobile devices.

**Global Positioning System (GPS):** A satellite navigation system used for determining one’s precise location and providing a highly accurate reference almost anywhere on earth.

**Hotspot:** A hotspot is a Wi-Fi access point or area, in particular for connecting to the Internet. Hotspots are found near airports, train stations, convention centers, hotels, restaurants, cafes, libraries, and other public places.
**Palm OS**: Palm OS is the type of operating system that Palm and Sony types of PDAs run on.

**PDA**: PDA is a small, relatively inexpensive, handheld device that serves as an organizer for personal information. PDA generally includes electronic schedule, contact list, to-do list, note taker, handwriting recognition capabilities, and other productivity tools.

**Pocket PC**: The successor to the Windows CE operating system developed by Microsoft. The Pocket PC operating system is used on PDAs such as the Hewlett-Packard, Dell, and Toshiba.

**Smartphone**: Smartphones are a hybrid of the functionality of PDAs and mobile phones. They usually provide a means of connecting to a desktop or laptop to perform the same functions as a PDA docking and synchronization cradle.

**Synchronizing**: PDAs have the ability to synchronize to a personal computer. This is done through synchronization software provided with the PDA such as the HotSync Manager, which comes with Palm OS handhelds, or Microsoft ActiveSync, which comes with Windows Mobile handhelds. Synchronization compares the data on the PDA with the personal computer and updates both devices with the most recent information.

**Tablet PC**: A computer that is approximately the size of a paper tablet. Users can write with a digital pen directly on the screen of the Tablet PC.

**Wireless Application Protocol (WAP)**: WAP is an international standard that allows users to connect to the Internet using WAP-enabled mobile phones. WAP is optimized for mobile networks with narrow bandwidths, mobile devices with small screens and limited keys for user entry, little memory storage, and limited processing and battery power.
Technology and Student Achievement

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INTRODUCTION

Since the introduction of the No Child Left Behind (NCLB) Act of 2001, education in the United States has, in the words of President Bush, been seen as “a national priority and a local responsibility.” The first of the four basic education reform principles stated in the NCLB Act is local accountability for results. The second principle, flexibility and local control, empowers states to create their own standards and to test every student’s progress using tests aligned with these standards. In addition, there are also programs to promote the alignment of technology with educational goals within the NCLB legislation.

In more and more states, school performance is assessed by means of a standardized assessment test which is designed to assess the academic level of students, schools, and districts. It is also intended to assist in identifying students’ strengths and weaknesses and to foster improvements in academic achievement. In one such state (that will remain anonymous) the reading and mathematics portions of the exam are administered to grades 5, 8, and 11.

A considerable body of research links student achievement on such tests with the presence of technology within a school or school district. Such investigations would imply a potential correlation between student scores received by schools, and the ratio of students to computers found in those schools.

Following the publication of the test results, concerns were expressed about the apparent inequities among schools in this state with respect to instructional technology in general, and to computers in particular. A research project, conducted by instructional technology doctoral students, sought to determine whether there is a significant correlation between achievement scores and the ratio of students to computers in those schools.

It was considered that such a research project would make a valid contribution to the literature on this subject, because of the size of the target school population. The large district maintained 93 schools and served approximately 38,000 students. It was recognized that other factors, such as socio-economic status and teacher usage of technology, can have an important influence on student achievement. Such factors, however, are outside the scope of this research, which is confined solely to the correlation of test scores and student-to-district’s computer ratio.

REVIEW OF LITERATURE

The following is a brief overview of available literature pertaining to the movement to integrate technology into educational systems in an effort to increase state-wide testing scores. While instructional technology is still considered to be in its pioneer stage, several studies have been conducted that both support and refute what appears to be the generally accepted assumption that the integration of technology will ultimately increase student achievement.

This review of the current literature clarifies the need for additional testing and research as well as attempts to discover a true correlation between the number of computers and overall student achievement. Additionally, it is imperative that more variables be taken into consideration before hypotheses are established. However, based upon both existing information and the statistics garnered from this study, numerous sound recommendations for the successful integration of technology in education are proposed.

Reforming Schools with Technology

Several recent studies suggest that the simple application of technology into daily educational practices could potentially cause overall test scores to progressively increase (Branigan, 2000; Mann & Shafer, 1997). Many scholars in the academic world have argued this idea since the introduction of instructional technology (Johnson, 2000). Furthermore, several studies have been conducted throughout the U.S. to either prove or
disprove a correlation between technology use in the classroom and educational achievement (Coulter, Ken- gor, & Mateer, 2000; Mann & Shafer, 1997; National Center for Education Statistics, 2002; Weglinsky, 1998). Proponents of both schools of thought have been able to statistically support their stance.

For instance, a study conducted in 2000 reported that standardized achievement scores increase with an increase in information technology (Lance, Rodney, & Hamilton-Pennell, 2000). Here, information technology was defined as networked computers that linked the library and classrooms to online databases and the Internet. This study suggests that the number of computers in a particular school is not necessarily the only factor when it comes to bettering student achievement. On the contrary, it appears that exposure to Internet resources and computers, not simply access to non-networked computers, increases test scores. This finding is also supported by the 2002 study from the National Center for Education Statistics that indicates a correlation between Internet access and student achievement. Furthermore, Lance et al. (2002) suggest that as other factors increase, such as “staffing, information technology, and integration of information literacy into the curriculum ... library staffing, [and] information resources” test scores also increase (p. 6). Hence, the implication of increased staff numbers, training, and available resources as it pertains to student achievement should not be overlooked. Moreover, in Pennsylvania specifically, Johnston (1997) has found that many teachers have not achieved even a moderate comfort level with technology. These same teachers may not even know what to do with technology once they have been given access.

**Achievement Testing**

During the spring of 1999, a project team consisting of one faculty member and two or more graduate student researchers visited 14 of the 93 schools in an attempt to compile a case study addressing the implementation of technology in these schools. It was discovered that, while the purchase of computerized classroom instructional units in all grades was valuable to the districts, the actual training of the teachers in the development of programs and activities for their students to profitably use this technology remained a top priority and principal challenge (ETIA Team, 1999, par.2)

Ultimately, no definite link between the increase of technology in the target district and their achievement scores was noted. This is not to suggest, however, that there is no link; rather, it is evident that more testing was necessary for a relationship to be found. While findings from some studies indicate that there is a correlation between computers with Internet capacity, additional testing will be needed before a final verdict can be reached (Lance et al., 2000; National Center for Education Statistics, 2002).

**Related Studies and Trends**

While there are collections of studies that relate to the topic of technology’s effect on student achievement, there is not a wealth of rigorous research information. For every article suggesting there is a positive correlation between technology and student success on standardized tests, there is an equally convincing article to suggest otherwise.

For instance, one report generated in 2002, which incorporated the data analyses from many different reports, suggested that the investment in technology did provide an equitable return in its usage in schools across the country (Ringstaff & Kelley, 2002). On the other hand, a different report issued in 2000 by the Shenango Institute for Public Policy concluded that there is no true correlation between better achievement on standardized tests and student to computer ratios (Coulter, Kengor, & Mateer, 2000).

Other studies have mixed findings as well. The Milken Family Foundation produced a report in 1999 that examined the results of five research studies. Again, the results are a mixture of success, failure, and something in between (Schacter, 1999). Regardless of the study, there appear to be common recommendations on what to do to ensure that technology is positively implemented into classrooms to ensure improvements in student achievement in the future.

**Planning for the Future**

One aspect that most of the available literature seems to agree on is that proper implementation of technology and training for educators is critical to the success of technology in schools. Weglinsky (1998) concludes that technology can make a difference in student performance, but it is “how” technology is used that
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is the determining factor. Furthermore, Weglinsky suggests that “the frequency of school computer use was unrelated to the social environment of the school and was negatively related to academic achievement,” but that when computers, “are properly used, [they] may serve as important tools for improving student proficiency” (p. 3-4).

The study reiterates other findings recommending that schools take a more pro-active approach toward technology, spending more time on teacher training, supporting poorer districts financially, and offering incentives to increase computer usage in the classroom (Branigan, 2002).

METHODOLOGY

To succeed in technology implementation, implementers must come to realize that the technology itself cannot be the ultimate goal. Those responsible for evaluating implementation must understand the role that technology deserves in the teaching and learning process. In addition, they need to understand that technology is not a means to an end. Rather, it is simply a tool that when used efficiently and effectively, can have a positive impact on students’ zeal and impetus for school (Rockman, 1998, p. 2). With this in mind, evaluating the impact computers have on student achievement is critical to gauging the success of the implementation.

Correlation Assessment

Clearly, the overall indicator of the success of any educational plan is student achievement. Correlation between student-to-computer ratios and test scores can be easily aggregated and analyzed. Through statistical analysis, this data has the ability to interpret the impact computers have on the teaching and learning process.

In the schools investigated here, concerns were raised about the apparent inequities with respect to instructional technology in general and computers specifically. A multitude of factors can be analyzed and those actually selected would simultaneously establish a correlation between achievement and student-to-computer ratio and also provide the possibility of raising questions for administrators who want to ensure that their schools are taking advantage of their technical potential (Rockman, 1998, p. 3).

Data Gathering

Data was collected using a standard electronic spreadsheet using school summary reports submitted during the academic year 2000-01. Further, data identifying CD-ROM capabilities, Internet capabilities, and school contact information were included in the spreadsheet in the event that this information might be helpful at a later date.

Measurement and Data Analysis

Assigning meaning to the variables under consideration in this study was extremely important to determining whether or not relationships existed. When defining the independent variable, for example, student-to-computer ratios were calculated by dividing the number of students by the number of computers. Test scores for math and reading were captured. A linear regression was employed using the independent and dependent variables to uncover any correlation and determine whether the correlation found was statistically significant. Pearson’s R was used to establish the correlation by computing the square root of R Square on the ANOVA tables. The plus or minus sign for the correlation can be determined by looking at the slope of the scatter plot. Then the F value on the ANOVA table was examined to determine if the R calculated from R Square was statistically significant. F value was based on 95% confidence level.

FINDINGS

The purpose of this study was to investigate the correlation between the computer-to-student ratio and standardized student achievement test scores. The research was divided into four individual tests: the first pair correlating math and reading scores with student-to-computer ratios; and the second two to correlate math and reading scores with the number of computers able to access the Internet. Even though Pearson’s r indicated some correlation between the independent and dependent variables, the F values were not large enough to conclude that the correlation was statistically significant in reading, math, or writing.

Using linear regression and the ANOVA test to find out more about the relationship between the two variables, the student-to-computer data was considered
the predictor and the two tests (math and reading) acted as the criteria. The test results indicated that there is neither a negative nor a positive correlation between the predictor and the criteria. Thus, the study found that the number of computers available in a school had no significant positive effect on test score results. The
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Figure 3. Correlation between reading scores and student-to-computer ratios of machines with Internet connectivity

Figure 4. Correlation between math scores and student-to-computer ratios of machines with Internet connectivity

student-to-computer ratio and the effect on test results showed no correlation, either positive or negative, as represented in the scatter plots.

In addition, tests of the relationship were conducted between student-to-computer ratios for machines connected to the Internet as related to math and reading
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Table 1. Summary of findings

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Relationship</th>
</tr>
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<tbody>
<tr>
<td>Correlation Between Reading Scores and Student-to-Computer Ratios</td>
<td>None</td>
</tr>
<tr>
<td>Correlation Between Math Scores and Student-to-Computer Ratios</td>
<td>None</td>
</tr>
<tr>
<td>Correlation Between Reading Scores and Student-to-Computer Ratios of Machines with Internet Connectivity</td>
<td>None</td>
</tr>
<tr>
<td>Correlation Between Math Scores and Student-to-Computer Ratios of Machines with Internet Connectivity</td>
<td>None</td>
</tr>
</tbody>
</table>

scores. These results also showed no significant relationship and can be seen in Figure 3 and Figure 4 with the data represented in Table 1.

RECOMMENDATIONS

The research undertaken in this project did not find a correlation between student achievement scores and the ratio of students-to-computers in the selected school district. The findings of this research, therefore, do not indicate that the current inequities among schools with respect to instructional technology in general and computers specifically affect student academic achievement.

The methodology of this project involved the investigation of official data in a large school district in one U.S. state. This number, as well as the significant variety of schools included in it, was large enough to make our sample representative of schools and students at least nationwide in the United States. This choice of sample was a measure to assure the validity and reliability of our findings.

This particular study significantly contributes to the existing literature on the subject. A review of the literature indicated that previous studies vary in their findings. Some have found technology to have a positive affect on student achievement and some a negative effect. The available information does not seem to suggest a preponderance of findings on either side. Researchers, therefore, agree that student achievement may not be simplistically linked to the number of students per computer in a given school and that it is possible that the influence of computer technologies may involve more factors than those that have been studied in the past or in this project.

It is recommended, therefore, that future studies are broader in scope, incorporating several, potentially interactive factors. Significant factors to include would be teacher use of the available technologies in schools, access of teachers to professional development in technology, and the amount of time teachers assign students to use technologies for higher-order skill development and basic skill development. These recommendations are supported by a recent research that studies the effect of such factors on student achievement (Chung, 2002; Williams, Sochats, Kyrish, & Kiely, n.d.) The need to undertake such a more broad-scale study is warranted by concerns that educators and schools districts often express regarding differences in student achievement.

REFERENCES


Technology and Student Achievement


KEY TERMS

Assessment: A related series of measures used to determine a complex attribute of an individual or group of individuals. Generally, the term connotes a broader implication than measurement, although the terms are often used interchangeably.

Correlation Assessment: A correlation is defined as a causal, complementary, parallel, or reciprocal relationship found to exist between various variables examined during an investigation and based on specific criteria. The value of a correlation coefficient can vary from minus one to plus one. A minus one indicates a perfect negative correlation, while a plus one indicates a perfect positive correlation. A correlation of zero means there is no relationship between the two variables. When there is a negative correlation between two variables, as the value of one variable increases, the value of the other variable also increases. The variables move together.

Criterion Referenced Assessment: Learner performance is compared to a well-defined set of criteria appropriate for a particular content or set of specific objectives, such as the ability to look a word up in the dictionary, multiplying two digit numbers, and so forth. Criterion referenced interpretations deals with performance within the specific domain and evaluates a learner’s ability within that domain. Criterion-referenced assessment does not consider the relative performance of the learner as compared to peers.

Data Gathering: Data gathering is the process of collecting data of software measures to help us improve an educational process. The purposes of data gathering include characterization (e.g., describing weaknesses and strengths), assessment (e.g., evaluating program effectiveness), evaluation (e.g., examining the quality of the educational process or learner outcomes), control, prediction, and improvement. Data is most effectively gathered according to specific objectives and a plan. Data gathered without a clear objective is unlikely to be useful. The choice of data to be gathered is based on a model or hypothesis about the process being examined, and the data gathering process must consider its impact on the entire organization since it can be very expensive and time-consuming. Finally, effective data gathering has management support.

Measurement: Measurement is defined as the process of determining the characteristics of an educational process, program, or curriculum through the use of an accepted standard or applied criteria in an effort to compare performance or learning.

No Child Left Behind Act of 2001: (Public Law 107-110), commonly known as NCLB, is a United States federal law signed on January 8, 2002 that reauthorizes a number of federal programs aiming to improve the performance of U.S. primary and secondary schools by increasing the standards of accountability for states, school districts, and schools, as well as providing parents more flexibility in choosing which schools their children will attend. Additionally, it promotes an increased focus on reading and re-authorizes the Elementary and Secondary Education Act of 1965 (ESEA). NCLB is the latest federal legislation which enacts the theories of standards-based education reform, formerly known as
outcome-based education which is based on the belief that high expectations and setting of goals will result in success for all students (Wikipedia, 2007).

**Norm Referenced Assessment:** An evaluation of learning based on a comparison of one learner’s performance to that of another given a similar learning situation or circumstance (i.e., class or course). For example, how well a student did on a test is often described in terms of how the other students in the class did. Norm referenced interpretations are limited because they do not say what a learner can or cannot do, but rather focus only on the relative performance of one learner to another.

**Standardized Tests:** Standardized tests are achievement tests that measure the knowledge, skills, and abilities defined as learning standards or curricula by educational agencies. One such example is the achievement test that measures what students know or are able to do at the time of the test assuming that the learner has been afforded the opportunity to learn the content through instruction or training. Tests are typically divided into content areas (e.g., reading, writing, mathematics, science, etc.) composed of sub-categories, or components, for which a more meaningful score is provided. These scores allow further analysis of a learner’s performance.
Technology and the Standards-Based Mathematics Classroom

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INTRODUCTION

In the current standards-driven academic environment, success is most often measured by student achievement on state and national assessments with the end goal of preparing our students to be able to communicate effectively and to be critical thinkers. Technology is not addressed in many state standards (including Pennsylvania’s), but as our society continues to develop and place more emphasis on the uses of technology, schools must learn how to incorporate technology into the classroom.

Hundreds of software applications exist for use in the mathematics classroom. Many of these packages were developed with academic standards in mind, but several other applications exist that are useful in both academic and non-academic settings. Considerable research has been conducted examining not only the effectiveness of technology as an instructional tool but also regarding the various learning styles of our students. I feel that it is imperative for all educators to explore the possibilities presented through the use of technology because, if implemented properly, technology can be a powerful aid in not only meeting academic standards but also in helping to prepare students for the technical climate of the “real world”.

BY THE BOOK: WHAT THE STANDARDS SAY

In the Academic Standards for Mathematics, the Pennsylvania Department of Education (PDE, 2002) states: “Because our capacity to deal with all things mathematical is changing rapidly, students must be able to bring the most modern and effective technology to bear on their learning of mathematical concepts and skills.” Within these standards, however, few provisions are made for the inclusion and use of technology in a mathematics classroom. For example, in Section 2.2, which lists 28 standards regarding computation and estimation for Grades 3, 5, 8, and 11, only one standard is listed that addresses technology. Section 2.2.11.F, a standard for students in Grade 11, states that students should be able to “demonstrate skills for using computer spreadsheets and scientific and graphing calculators” (PDE, 2002). Throughout the Academic Standards for Mathematics, the use of technology is included sparsely as separate standards, but the standards leave room for creative interpretation and implementation by teachers and administrators alike.

The National Council of Teachers of Mathematics (NCTM, 2000) has developed Principles and Standards for School Mathematics, which they feel presents the ideal goals of a mathematics curriculum. They have developed six principles that are intended to be the foundation for school mathematics programs and the basis for which educators make decisions regarding mathematics instruction. NCTM recognizes the importance of technology by listing it as one of the principles, stating: “Technology is essential in teaching and learning mathematics; it influences the mathematics taught and enhances students’ learning.”

Even though educators are not held accountable for being in compliance with the NCTM-developed standards, Principles and Standards for School Mathematics serves as a guidebook for non-traditional teachers who seek a well-rounded curriculum that is in tune with state academic standards as well as the modern social climate. Pennsylvania’s state standards do not include or specify the use of technology as part of the plan for successfully achieving the standards; however, opportunities exist to incorporate technology into the instruction for the other academic standards if educators are properly prepared.

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TECHNOLOGY’S BENEFITS IN THE CLASSROOM

Over the last decade, countless research has been conducted regarding the effectiveness of technology’s use as an instructional tool and as a supplement to education. Since the Enhancing Education through Technology Act of 2001, the amount of research on this topic has drastically increased due to an increased urgency to fully understand how technology is and should be implemented in classrooms. The research has brought forth both advocates and opponents of the use of technology in schools; however, upon further inspection of the critics’ views, common courses of action can be seen, such as the use of different methods of instruction and appropriate training for teachers (Kimble, 1999), and can be used to make technology a successful component of students’ learning and academic achievement.

Even though there is no “best practice” regarding the use of technology in the classroom, numerous studies are readily available that quote positive outcomes of technology-based or -supplemented instruction in math as well as other academic areas. James A. Kulik from the University of Michigan analyzed 16 studies regarding the use of integrated learning systems (ILS), which combine drill-and-practice and tutorial lessons, in mathematics courses and found that, in all 16 studies, test scores were higher among students who were taught with the help of ILS software (Branigan, 2003). This type of computer-based instruction offers the additional benefit of individualizing instruction for each student based on needs, current knowledge, and learning style and has been found to increase student learning in a shorter period of time than traditional teaching (Schacter, 1999).

In a study on the effects of simulation and high-order thinking technologies, Harold Wenglinsky found that the proper implementation of these technologies, coupled with adequate professional development for teachers, led to increased math scores up to 15 weeks above grade level as measured by the National Assessment of Educational Progress (Schacter, 1999). One of his “negative” findings was that students who used these technologies only performed three to five weeks ahead of students who did not. Given the current pace of our education system in the race to teach all the content standards that will be tested, I would hardly count a three to five week advantage as a negative.

Other studies have shown that the use of multimedia software can decrease student anxiety and help students perceive math as being relevant to everyday life, that computer software can help students learn to solve multi-step math problems more quickly, and that students taught using mathematics software retain their math skills longer than traditionally-taught students (Chaika, 2005). Gorev, Gurevich, and Barabash (2004) feel that using computerized tools to solve routine and non-routine problems invokes students’ ability to perform competently and methodically in familiar and unfamiliar situations. Regarding the use of calculators in mathematics classes, research has found that using calculators for instruction and testing “enhances learning and performance of arithmetical concepts and skills, problem solving, and attitudes of students” and that “teachers ask more high-level questions when calculators are present” (Apthorp, Bodrova, Dean, & Florian, 2001).

Considering the multitude of positive outcomes of technology-enhanced education, educators should realize the importance of this tool not only to enhance students’ learning but also to help prepare them for the technology-laden world they will encounter outside school. When analyzing situations in which technology has become an important benefit in the classroom, several key factors are always present and should be made aware to administrators, educators, parents, and students.

PUTTING IT IN PLACE

Despite the pressure to integrate technology into schools, educators cannot simply walk into a classroom one day and begin teaching with technological resources. Technology undoubtedly affects academic achievement, for better or worse, but the type of effect it has depends on how it is implemented (Kimble, 1999).

Researchers have compiled strategies for properly implementing technology, and some of the most common guidelines are careful planning to determine the most appropriate and beneficial way to use technology in accordance with set curriculum objectives and proper training and professional development for teachers and other staff members (Kimble, 1999). Conner (2002) suggests that schools work cooperatively in this ven-
ture and share success stories and tips on effective technology-supplemented instruction. Ms. Conner also recommends encouraging parental involvement and keeping the general public posted about the use of technology in schools so that everyone in the community can observe student progress, offer their own evaluations, and become excited about curriculum developments in the school.

Many educators and non-educators alike recognize that mathematics and technology go hand-in-hand. Sometimes the use of technology is the most appropriate tool to use when teaching a lesson, and other lessons require the more traditional pen-and-paper approach (Hudnutt & Panoff, 2002). Dozens of software packages have been developed for math classrooms, such as Geometer’s Sketchpad and MATLAB, but other non-specific programs and resources can be incorporated into mathematics lessons to increase critical thinking as well as students’ “techno savvy”.

Students can use word processing software to create their own rubrics for class projects. Spreadsheet programs, such as Microsoft Excel, can be used to create tables and graphs and to organize data, and tools like Microsoft PowerPoint are useful for summarizing and presenting ideas. Even in a mathematics classroom, students could benefit from the use of multimedia programs, digital cameras, and personal digital assistants (PDAs), which can be used for projects or merely to enhance lessons.

Computers are an invaluable tool in mathematics classrooms. The Internet can be used to access courseware such as Project Interactive, WebQuests (organized learning activities), and resources from textbook publishers’ Web sites. Given that computers are designed to quickly perform repetitious calculations, programs can be written to simulate some of the time-consuming processes involved in certain mathematical concepts like probability (Hudnutt & Panoff, 2002). In this case, the use of the computer allows teachers to focus on teaching the concept without having to spend copious amounts of time covering the details.

The extent to which calculators are used in everyday math lessons has become a topic of hot debate, but as with other forms of technology, proper implementation and training can lead to great student successes. Many schools now have access to graphing calculators, which can help students gain representational skills, conceptual understanding, and problem solving abilities. Like the case with computers, calculators can be used as instructional supplements regarding the lesson or concept the teacher is presenting, and they should never be used as the sole method of instruction. As Apthorp, Bodrova, Dean, and Florian (2001) state: “Low student achievement may just as easily ‘cause’ calculator use as the other way around.”

CONCLUSION

Without any set procedures for using technology in mathematics lessons, educators are allowed the creative freedom to explore the best ways to meet their curriculum objectives and state standards with or without the aid of technology. Brabec Fisher, and Pitler (2004) outline nine research-proven instructional strategies—identifying similarities and differences, summarizing and note taking, reinforcing effort, homework and practice, non-linguistic representations, cooperative learning, providing feedback, generating and testing hypotheses, and organizing—that can all be assisted through technological methods. Educators should determine their academic goals for their students and then determine ways in which technology can be used to meet their goals rather than focusing their effort on teaching technology skills (Kimble, 1999). As Dr. Martha Stone Wiske stated, “One of the enduring difficulties about technology and education is that a lot of people think about technology first and education later” (Schacter, 1999).

The global environment has a definite effect on the way in which our schools are run, and students should be prepared not only academically but also with skills that will equip them for life after school. Regarding technology’s place in schools, Raymond Yeagley said, “I question, however, whether impact on student learning—usually translated through test scores—is the only way to measure the value of technology in schools” (Branigan, 2003). With careful planning and training, educators and students can both benefit from technology’s presence in their classrooms, and students can acquire knowledge that will help them succeed in any path that they might take.

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KEY TERMS

**Best Practice:** A technique or methodology that, through experience and research, has proven to reliably lead to a desired result.

**Calculator:** Device for performing numerical computations.

**Integrated Learning Systems:** Packages of networked hardware and software used for education that provide instructional content as well as assessment and management tools.

**Multimedia:** A combination of various types of media, including sound, animation, video, and graphics.

**Rubric:** A set of criteria specifying the characteristics of a learning outcome and the levels of achievement in each characteristic.

**Simulation:** A program that imitates a physical process or object by causing a computer to respond mathematically to data and changing conditions as though it were the process or object itself.

**Spreadsheet:** Software for entering, editing, manipulating, and printing structured, tabular information.
Technology Assignments Using Team-Based Learning

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INTRODUCTION

Educators face an increasingly difficult task in preparing students for today’s information technology and/or information systems (IT/IS) jobs. The foundation must ensure that students master solitary tasks such as programming and logical design. However, the reality of IT/IS jobs requires that students must also be prepared to deal with increasingly complex design projects and work in teams made up of peers who come from many different business disciplines and bring the requirements of multiple organizational functions. As a result, IT/IS educators must design their courses to give students experience working in teams and on problems that reflect the complexity of the business environments in which they will be employed.

Lecture-based IT courses expose students to the conceptual foundation that students need, but do not assure that students either retain the course knowledge or that they can actually apply what they have learned to solve the kinds of problems they will face in their future jobs. Team-based learning (TBL), by contrast, is specifically designed to ensure that students both master critical content knowledge and develop the skills needed to work in interdisciplinary teams and apply course concepts to solve complex problems. The focus of TBL is on what the students are doing in the classroom and how they are learning from their experiences. With TBL, the majority of the content coverage occurs through students’ individual preclass study and the majority of class time is used for lab and/or team assignments that require students use the technology to research, critically compare, and decide on an alternative, and then defend their solutions. As a result, TBL is ideally suited for teaching technology oriented management classes such as management of information systems, analysis and design, or e-commerce, in which students must go beyond passing the content exams and develop the ability to work effectively as a member of an interdisciplinary team and apply IT/IS concepts to solve complex business problems.

The purposes of this article are to outline the key principles and practices of TBL, how they can be applied in developing technology oriented team assignments, and why TBL consistently produces a wide variety of student outcomes that are rarely achieved with other approaches for using small-group assignments and activities. To be practical and meaningful, we will use management of information systems business classes as examples throughout.

The TBL method has four essential principles:

1. Groups must be properly formed and managed;
2. Students must be accountable for the quality of their individual and group work;
3. Students must receive frequent and immediate feedback; and
4. Team assignments must promote both learning and team development.

To be effective, the team assignments must meet conditions:

1. Significant problem,
2. Same problem,
3. Specific choice and,
4. Simultaneous report.

Examples of effective assignments using the 4 Ss for information systems will be given.

KEY PRINCIPLES AND PRACTICES OF TEAM-BASED LEARNING

TBL differs from other forms of small group work in two very significant ways. First, the majority of the group assignments are completed during class time.
As a result, much of the responsibility for “covering” the content occurs through students’ individual study and peer teaching. Second, TBL relies on developing groups into self-managed learning teams. As a result, implementing TBL requires using permanent and purposively formed groups and explicitly designing assignments to accomplish two purposes: deepening students’ learning and promoting the development of high-performance learning teams.

Groups Must be Properly Formed and Managed

In forming the groups, the instructor must manage two important variables. One is ensuring that the groups have adequate resources to complete assignments that are so sufficiently difficult that they can not be done by even the most talented individual in the class. Thus, the groups should be relatively large (5-7 members), as diverse as possible, and have approximately the same level of resources to draw from in completing their assignments (Michaelsen, Knight, & Fink, 2004). The other is avoiding establishing groups whose membership characteristics are likely to interfere with the development of group cohesiveness. Thus, the instructor must 1) form the groups and 2) use an approach that avoids either a previously established relationship between a subset of members in the group (e.g., boyfriend/girlfriend, fraternity brothers, etc.) or the potential for a cohesive subgroup based on background factors such as nationality, culture, or native language. (For specific methods for grouping students see www.teambasedlearning.org; Michaelsen et al., 2004, p. 39-40; Sweet, 2007.)

To ensure that groups have the opportunity to develop into learning teams, they should be formed at the beginning of the course and kept together throughout the semester. Only when students work together over time can their groups become cohesive enough to evolve into self-managed and truly effective learning teams (Michaelsen et al., 2004, Chapter 4). Over time, trust and understanding build to the point that members are willing and able to engage in intense give-and-take interactions without having to worry about being offensive or misunderstood.

Students Must be Accountable for the Quality of their Individual and Group Work

In traditional classes, there is no real need for students to be accountable to anyone other than the instructor.
By contrast, with TBL it is essential for individual students to be accountable to both the instructor and their teams for the quality and quantity of both their individual preparation for group work and for the input they provide in completing the group assignments. Further, teams must also be accountable for their quality and quantity of their work as a unit.

In TBL, the instructors can, to some degree, ensure that group members have common goals by setting up a grading system in which individual preparation for group work and group assignments both “count” as part of members’ course grades (Sweet, 2007, Chapter 2). In addition, students’ motivation to work on behalf of the group is at least partially dependent on the extent to which the rewards (grades) hinge on the quality of the group work.

The real key to both individual and group accountability is ensuring that students receive immediate and unambiguous performance feedback on quality of their work. A key reason for the success of TBL is the use of a readiness assurance process to ensure that individual students are truly accountable for preclass preparation for the in-class group work, the first step in each major unit of instruction. In TBL, students are accountable to the instructor because the first in-class activity for each major unit of instruction is an individual, multiple-choice test over the preclass reading assignment that counts toward the course grade and are accountable to their group because of what happens next (see Figure 1). As soon as students complete their test, they hand in their individual answer sheets and immediately answer the exact same questions as a team using a “scratch-off” answer sheet (the forms are called IF-AT, see www.epsteineducation.com) that gives truly immediate feedback on each of their choices. As a result and with no intervention from the instructor, every student is accountable to the team because they know that, on every question, students will be asked to give 1) their individual answer and 2) the reasons for their choices, and that the team will know immediately whether or not their input was accurate.

The immediate feedback from the IF-AT forms provides two key benefits to the teams. One is that they enable members to quickly correct their misconceptions of the subject matter. Finding a star immediately confirms the validity of their choice, but finding a blank box lets them know they have more work to do. The other even more important benefit is that, with no input whatsoever from the instructor, teams quickly learn how to work together effectively. In fact, IF-ATs virtually eliminate two problems that often plague student groups: overly dominating students and smart but silent students. First, using IF-AT answer sheets ensures that one or two members will seldom, if ever, dominate team discussions because “pushy” members are only one scratch away from having to “eat crow.” Second, with IF-ATs, quieter members tend to speak up because they are one scratch away from being validated as a valuable source of information and two scratches away from being told that they need to speak up. Providing immediate feedback application-focused group assignments. Other than the team readiness assessment tests, most of the group assignments are application-focused team assignments and are aimed at developing higher level thinking skills. As a result, these assignments can be much more difficult to design and grade, but by using the 4 Ss given below, immediate feedback is built into the assignment and much of the burden of providing immediate feedback shifts from the instructor to the students themselves. Team assignments must promote both learning and team development. The development of appropriate group assignments is a critical aspect of successfully implementing TBL. In fact, most of the reported “problems” with learning groups (free-riders, member conflict, etc.) are the direct result of inappropriate group assignments. Fortunately, problems that result from bad group assignments are both predictable and, in our judgment, very nearly 100% preventable. In most cases, the reason that group assignments produce problems is that they are not really group assignments at all. Instead, the structure of the assignment is such that individuals working alone rather than members working together as a group wind up doing the actual work.

The most fundamental aspect of designing effective team assignments is ensuring that they truly require group interaction. In most cases, team assignments will generate a high level of interaction if they 1) require teams to use course concepts to make decisions that involve a complex set of issues and, 2) enable teams to report their decisions in a simple form. When assignments emphasize making decisions, intragroup discussion is the natural and rational way to complete the task. In contrast, assignments that involve producing complex output such as a lengthy document are likely to limit discussion because the rational way to complete the task is to divide up the work and have members individually complete their part of the total
Technology Assignments Using Team-Based Learning

**The 4 S's of Team Assignments**

No matter the type of technical content being taught (programming, networking, computer science, managing IS, etc.) the 4 Ss can be used to create assignments that both create accountability and foster discussion, and, in combination, constitute guidelines for creating and implementing effective group assignments. These are: 1) assignments should always be designed around a problem that is significant to students, 2) all of the students in the class should be working on the same problem, 3) students should be required to make a specific choice, and 4) groups should simultaneously report their choices (Figure 2). Further, these procedures apply to all three stages of effective group assignments: individual work prior to group discussions, discussions within groups, and whole-class discussion between groups. The “4 Ss” are explained in the following paragraphs.

**Significant Problem**

Effective assignments must capture students’ interest. Unless assignments are built around what students see as an interesting and/or relevant problem, most students will view what they are being asked to do as “busy work” and will put forth the minimum effort required to get a satisfactory grade.

In management of information systems one of the greatest challenges is convincing nontechnical students that the subject is of value. In this case, a properly formed group assignment is an opportunity to emphasize the connections between technical and nontechnical business issues that will relate to a student of any major. For example, making a Web site will more likely be perceived as significant if the information related to the assignment is part of a real-life case. *Same problem.*

One of the essential characteristics of an effective group assignment is the necessity for discussion both within and between groups. It is through such discussions that students receive immediate feedback regarding the quality of their own thinking both as individuals and teams.

In order to facilitate such an exchange, groups must have a common frame of reference. That commonality is derived from working on the same problem. Unless everyone is working on the same problem there is no basis for comparison, first between group members, and then between groups. Further, having everyone

**Figure 2.**

Four Keys for Creating and Managing Group Assignments

<table>
<thead>
<tr>
<th>Individual Work</th>
<th>X</th>
<th>Within Teams</th>
<th>X</th>
<th>Between Teams</th>
<th>= Impact on Learning</th>
</tr>
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To obtain the maximum impact on learning, assignments at each stage should be characterized by "4's":

- **Significant Problem.** Individuals/groups should work on a problem that is significant to students.
- **Same Problem.** Individuals/groups should work on the same problem, case or question.
- **Specific Choice.** Individuals/groups should be required to use course concepts to make a specific choice.
- **Simultaneous Report.** Whenever possible individuals and groups should report their choices simultaneously.
work on the same problem is necessary for students to be able to give and receive peer feedback on their own thinking and their performance as a learning team.

**Specific Choice**

As previously discussed, cognitive research shows that learning is greatly enhanced when students are required to engage in higher level thinking. In order to challenge students to process information at higher levels of cognitive complexity, we must provide them with assignments that create those challenges.

In general, the best activity to accomplish this goal is to word the assignment in such a way that students are required to make a specific choice by using course concepts to “make sense” out of a complex problem situation, in much the same way as a jury must sift through a large set of issues to come to a verdict of guilty or not guilty. We will provide both several examples of “make-a-specific-choice” assignments and a rationale as to why they work so well in promoting both student learning and team development.

**Simultaneous Reports**

Once groups have made their choices, they can share the result of their thinking with the rest of the class in one of two ways: sequentially or simultaneously. One significant disadvantage of sequential reporting is that the initial response often has a powerful impact on the subsequent discussion because later-reporting teams change their answer in response to what seems to be an emerging majority view, even if that majority is wrong.

On the other hand, requiring groups to simultaneously reveal their answers virtually eliminates the main problems that result from sequential reporting. This simultaneous public commitment to a specific choice increases both learning and team development because each team is 1) accountable for their choice, 2) motivated to defend their position, and 3) the more difficult the problem, the greater the potential for disagreements that are likely to prompt give-and-take discussion between the groups.

**EXAMPLES OF IT/IS ASSIGNMENTS USING THE 4 SS**

**Hardware/Software Design Application**

In the past, one of the coauthors of this article had assigned management of information systems student groups a task of finding a PC that could be a standard for an outside entity, such as a case involving a small business. She was disappointed in the outcomes for two reasons. First, because most groups chose to divide up the work; few of the students could see how the hardware had to support software decisions, or how monetary restraints affected both hardware and software choices. Second, even though the students had been exposed through the business case to a variety of end user issues and needs, students seldom appeared to learn very much from the PC solutions presented by other groups. Even when students were “forced” to critique each other’s solutions by including them in the grading process, their interest in and understanding of the technical aspects of other group solutions was very limited, leading to inflated grading. As a result, she decided to modify her approach and use the 4 Ss. Still using the same assignment of choosing a PC, the assignment has been modified to 4 Ss that have individual accountability, then group work.

First, the assignment was changed to make it significant to the student. Most students have bought, or will buy a computer, but they are unsure of what makes a “good” computer or what the components do. Textbook content on CPU, RAM, bus, along with operating systems, application systems, and so forth, was made into an application-based individual assignment. Students were asked to find or build a system that would be for their use. Then, the specifications of the hardware and software were set by the instructor, so all students would be researching the same system. For example, the CPU had to be 3 GHz, the hard drive had to be 80 Gb, and the applications had to include word processing, spreadsheet, database, and so forth. In all, the requirements covered almost 25 components. The completed individual homework was then brought to class, where the team used their member’s individual research to find the cheapest PC that met the minimum requirements. This forced team discussion as the team made a specific choice. After a set amount of time, all teams put their chosen system’s cost on the board simultaneously and the team with the lowest costs “won,” unless they had
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NOT met a minimum requirement (does their specific CPU support the minimum required RAM?, does that application suite hold all the required applications?, etc.). The teams were then challenged by other team members to defend their choice of system, engendering discussion between teams. If it was found that they had not chosen correctly, $300 per wrong component was added to their cost, and the next team was challenged, and so forth. Grading by the instructor was easily done as the team with the cheapest system got the “A,” and distance from the average system price of the class determined the grades of other teams.

Web Design Application

Past attempts to teach Web design skills to non-IS majors had involved using a “real case” by asking each team to adopt a charity that needed a Web site, and each group would design and implement that Web site. The problem here was that the students were novices at interviewing the clients, so the level of expertise for user requirements and system definition was varied. Some students returned with an excellent product, others struggled to produce very poor products, and some products did not reflect the client’s mission or culture. Student Web design skills were not at the level desired, nor were the aesthetics of the sites. Many sites, including one designed for retired citizens going through a grieving process, succumbed to the black background, multiple animated gifs, glaring text, and font that the technical (usually male) member of the team enjoyed.

To apply TBL and the 4 Ss the assignment was split into individual preparation, then team decision and development. Rather than multiple charities, the entire class adopted one charity, making the project significant to the students. The director was brought into class, and system requirements concerning content were determined in class, as were critical navigation components and aesthetics. With user requirements clearly defined, articulated, and written down, each individual could work on a prototype of the same Web site. One of the remaining “free” elements that could not be pinned down at this point was the professionalism and creativity of the individual Web design. Members then brought their design to lab/class, where their team engaged in within-team discussion and chose which specific design they wanted to use as a team. Once that design was chosen, the teams improved their Web site by adding elements that their team discussion brought to light. During one class period, all Web sites were presented (usually in published, or uploaded, form). Although the presentations were sequential, they had the same impact as simultaneous reporting, since no group could change their site, and had to present their chosen uploaded design and work. During presentation hour, the director of the charity, the other students, and the instructor met and graded each Web site on clarity, completion, aesthetics, sensitivity to the charity’s mission, and so forth. Technical feedback (either the link works or does not, etc.) oral feedback and written feedback from peers and stakeholders was immediate.

CONCLUSION

Teams have become an important part of IT/IS education, but their use, especially with technical assignments, is not always positive for either the instructor or the students. By using team-based learning methods and assignments that are characterized by the “4 Ss”, instructors can deepen students’ learning and promote the development of high-performance learning teams. In addition, these types of application-based assignments increase student motivation and create the opportunity to engage in give and take discussion. With properly designed assignments, the final result is increased learning and retention, as well as higher satisfaction for students and a much greater sense of accomplishment for instructors.

REFERENCES


**KEY WORDS**

**Cooperative Learning:** A teaching strategy in which small 2-4 member (and usually temporary) groups with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject.

**Effective Team Assignment:** Assignments that truly require group interaction because they cannot be divided up and completed by individual members working alone. In most cases, team assignments will generate a high level of interaction if they 1) require teams to use course concepts to make decisions that involve a complex set of issues and, 2) enable teams to report their decisions in a simple form. When assignments emphasize making decisions, intragroup discussion is the natural and rational way to complete the task.

**Group Formation:** Ensuring that the 1) groups have adequate and approximately the same level of resources to draw from in completing their assignment, 2) instructors avoid establishing groups whose membership characteristics are likely to interfere with the development of group cohesiveness.

**Learning Group:** Putting individual students in a class into small groups for the purpose of promoting more active and more effective learning.

**Learning Teams:** Student learning teams are distinctly different from learning groups. Characteristics of teams vs. groups: 1) as the students begin to trust each other and develop a commitment to the goals and welfare of the group, they become a team; 2) when they become a cohesive team, the team can do things that neither a single individual nor a newly-formed group can do; and 3) team-based learning starts with groups and then creates the conditions that enable them to become teams.

**Performance Feedback:** In team-based learning, performance feedback is immediate, frequent, and discriminatory (i.e., enables learners to clearly distinguish between good and bad choices, and effective and ineffective strategies, etc.).

**Small Group Learning:** Classroom method of promoting more active and effective learning through students interacting in groups of no more than 5-7 students.

**Team-Based Learning (TBL):** An instructional strategy that is designed to (a) support the development of high performance learning teams and (b) provide opportunities for these teams to engage in significant learning tasks.
INTRODUCTION

Teaching conceptual and qualitative material effectively while leveraging the contents efficiently has been an elusive goal for many computer-aided learning (CAL) packages in the past. With the advent of newer technologies such as multimedia and virtual reality, these technologies are being researched and applied to various areas of educational settings, especially in science and technology. However the potential of these technologies has not been fully exploited, particularly in the teaching of engineering. In this paper we describe an innovative approach based on the principle of CAL to design and implement an integrated package known as technology assisted problem solving (TAPS) packages, which could guide students step-by-step to complete various engineering mechanics exercises. Some key concepts and development aspects of TAPS packages are also discussed.

BACKGROUND

Present CAL applications offer numerous advantages. Most importantly, CAL facilitates the implementation of effective training packages that can be made available to anyone who requires it without imposing any time constraint in learning. In addition, the CAL tutoring packages do not rely on the availability of a skilled human instructor and is not influenced by the number of students requiring training (Dean & Whitlock, 1983).

Although there are numerous benefits inherent in CAL, a major disadvantage with it is the way in which information is presented to the student. Conventional CAL packages present information at a pre-determined tutoring level and follow a set of structures. These packages do not take the student’s basic knowledge or learning style into account and therefore lack the ability to adapt intelligently to meet the student’s specific learning requirements (Vasandani, Govindaraj, & Mitchell, 1989). The only form of student adaptation that is occasionally implemented is the pace at which the course material is presented (Sclechter, 1991).

However over the past few years, CAL packages have been designed to incorporate multimedia to allow learners to perform multi-task simultaneously during a tutoring session. For example, a learner can read text and be narrated by displaying a video clip to explain certain concepts of the subject matter. CAL in its simplest form does not cater for the individual student. Information is presented in a predetermined sequence, regardless of how knowledgeable the student is at the beginning of the learning activity, or how quickly or slowly the learner absorbs and understands the course material (Rickel, 1989).

TECHNOLOGY ASSISTED PROBLEM SOLVING PACKAGES

A New Approach to Learning, Visualizing, and Problem Solving in Engineering

Problem-based learning, as the name implies, begins with a problem for students to solve or learn more about. Often these problems are framed in a scenario or case study format. Problems are designed to be “ill-structured” and to imitate the complexity of real-life cases. The problem-based approach uses an inquiry model, that is, students are presented with a problem and they begin by organizing any previous knowledge on the subject, posing any additional questions, and identifying areas they need more information. Students devise a plan for gathering more information, then do the necessary research and reconvene to share and summarize their new knowledge. Students may present their conclusions, and there may or may not be an end product (Duch, 1995; Hoffman & Ritchie, 1997; Stepien & Gallagher, 1993). All problem-based learning approaches rely on a problem as their driving forces, but may focus on the solution to varying degrees. Some problem-based approaches intend for students to clearly define the
Technology Assisted Problem Solving

problem, develop hypotheses, gather information, and arrive at clearly-stated solutions (Allen, 1998). Others design the problems as learning-embedded cases that may have no solution but are meant to engage students in learning and information gathering (Wang, 1998).

In this paper we define technology assisted problem solving (TAPS) packages as specialized computer programs developed to work as stand-alone (PC-based) or with Web servers that can supplement student learning—for revision, laboratory experiments and self-study. The term TAPS is used to represent interactive multimedia CAL in which the student is engaged with a computer tutor in the problem-solving task of the subject matter. TAPS packages offer similar pedagogic values as an experienced human tutor, with the added advantage of guiding students to solve engineering problems on a more flexible mode, that is, a student has the freedom of working on the problem at his/her own pace, repeat all or certain steps, spend more time at each or particular step until they are able to understand and solve the problem. The objective of TAPS packages is to improve student’s understanding of the selected engineering problems by guiding and presenting the problem-solving steps accordingly. The ultimate goal is to instill a sense of independent learning, encouraging critical thinking, and to promote deep learning. When tutoring a student on solving an engineering problem, a human tutor is expected to gauge the student’s background knowledge, impart relevant course material at the correct level of detail, and clarify student’s misunderstandings.

TAPS packages include the use of the computer to provide most aspects of instruction, which a classroom instructor could provide such as tutorials, questioning, and feedback contingent on answers—analytical and testing. The TAPS packages developed for this research has been customized to anticipate student needs, and have various interactive features built in to allow delivery control, navigation, and feedback. More specifically the packages are designed to assist the student in learning, visualizing, and problem solving in a step-by-step approach.

The TAPS packages also employ a variety of multimedia elements such as text, 2-D animated and still graphics, 3-D animated and still geometric models, audio, video and animations, stereoscopic images and simple artificial intelligence techniques, to develop individualized computer-based learning environments in which the student and computer tutor can have a flexibility that closely resembles what actually occurs when a student and human tutor communicate with each other. Such suppleness is important because without it, the package cannot be fully adaptive to the individual student’s on-going learning and problem solving needs during instruction.

There are numerous difficulties with the implementation of realistic TAPS packages. The major problem with TAPS package development is that most of the features that are commonly found in non-computer-based tutoring packages are difficult to implement on the computer. In addition, many aspects of the tutoring process are taken for granted by the student. These include direct verbal feedback, visual and audio interaction, and an extensive knowledge base. When a student does not understand a concept, the norm is to ask a human tutor to provide a simpler explanation or to apply the concept to an everyday situation. This feature is difficult to implement in any computer-based tutoring package because the computer does not have sufficient intelligence to understand and interpret the course material.

Based on the aforementioned arguments, it is envisaged that an ideal TAPS package would be difficult to develop and implement. It is therefore necessary to identify key concepts that constitute a TAPS package and decide the best way of implementing similar forms of each of these concepts in a way that makes the tutoring and problem-solving environment as realistic and pedagogically effective as possible.

There are a number of key concepts that can be applied in the development of a TAPS package. Some of these are similar to intelligent tutoring systems (ITS) whereby a computer tutoring system incorporates aspects of intelligence, in particular an assessment model (used to monitor the performance of the student), and domain knowledge representation. In TAPS packages, these concepts can be divided into three main categories, namely learning scenarios, knowledge representation, and assessment modeling. However learning scenarios and knowledge representation concepts are discussed in details in the next sections of this paper.

**Learning Scenarios**

A learning scenario is a situation in which the student’s learning takes place. When implementing a TAPS package, the criterion for determining the most appropriate learning scenario is based on the interaction required
between the student and computer. These learning scenarios could take one of the learning forms, that is, explanation of theoretical concepts, simulation of real-world tasks on a computer, and discovery of knowledge through investigation and exploration. The learning scenario selected will therefore be dependent on the type of information to be imparted to the student during the tutoring session and the amount of knowledge the student is expected to gain from completing the problem-solving tutorials and to a certain extent on the knowledge base of the TAPS package.

In general, most computer-based tutoring packages are implemented using one of the three learning scenario categories as mentioned previously. However the most common learning scenario category to be implemented is the explanation of theoretical concepts to the student. In this scenario, the TAPS package must convey predefined knowledge to a student in ways that maximizes his/her understanding of concepts being taught. This is the simplest learning scenario to implement, as the main challenge of developing the TAPS package is ensuring that more precise information is presented at the correct level of detail for students to comprehend and learn.

The second learning scenario that is commonly employed in computer-based tutoring packages is the simulation of real-world tasks on a computer. These tasks include the detail operation of a specific component or the simulation of the process that the student is expected to perform in the future. In any event, the learning scenario must deal with simulating the appropriate real-world properties as accurately as possible on computer. This is a difficult requirement to implement successfully, as the TAPS package must both simulate the process as realistically as possible, as well as have the pedagogical ability to explain the process to the student in the best possible way.

In general, the most difficult learning scenario category to be implemented in a computer-based tutoring package is the discovery of knowledge through investigation and exploration. In this third learning scenario, the student is required to actively participate in the learning experience, by manipulating the package and observing the direct response to the student’s actions.

Because of the uncertainty of the student’s actions, in a problem solving-based environment, the third type of learning scenario as mentioned earlier is very difficult to implement successfully. One of the reasons for this is that the TAPS package must make allowance for any action made by the student and must be able to act accordingly, providing him/her with sufficient explanation for all decisions or conclusions made leading from the problem statement through a series of steps and solution. Irrespective of the category of learning scenario implemented, the relevant course material will be memorized more effectively if the student is an active participant in the learning process. The tutoring environment may be further enhanced by involving several of the student’s senses during the tutoring session. This allows the student to combine the knowledge acquired in the course with actual experience and application.

Knowledge Representation

The knowledge representation component of a computer-based tutoring package can be divided into two categories, namely domain knowledge and pedagogical knowledge (Burns, 1991). Domain knowledge involves issues in the representation of knowledge and refers to the facts, figures, and interrelationships between the various objects in the domain. Pedagogical knowledge is the sequence of instructions that a computer tutor uses to carry out various tasks in operating a system. Pedagogical knowledge therefore involves the finding of techniques to solve particular problems. The knowledge of computer-based tutoring packages contains definite information content and structure, as well as procedures for accessing and utilizing the information (Chu et al., 1989).

Domain Knowledge

One of the major limitations with conventional computer-based tutoring packages is that they have poor structure of knowledge of their domain in the database. The tutoring session typically consists of the presentation of information, problems with which to test the student’s knowledge, answers to these problems, and at best, pre-specified branches based on the student’s results obtained in the test. Rickel (1989) noted numerous disadvantages with these computer-based tutoring (CBT) packages such as the CBT package is unable to adapt to the requirements of the student, there are no facilities with which to assess the student’s true misunderstandings, and the pre-specified branches prevent the CBT package from handling unanticipated
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answers. If human tutors are expected to possess a great deal of domain competence, this should be the ultimate challenge for TAPS packages.

The domain knowledge of a TAPS package should incorporate the necessary information so as to correct these limitations. This implies that the TAPS package should contain an extensive knowledge database and have the ability to filter out the course material that is not directly relevant to the student. In addition, the TAPS package should have the ability to interact with the student in the same manner as a human tutor. Interaction is perhaps the most difficult part of TAPS package design. A good TAPS package should be able to answer course-related questions asked by the student, as well as present summaries and overviews whenever these are required. Furthermore, the TAPS package should know when and how to present the student with information and should be able to determine immediately whether the student has understood this information or not. A good TAPS package should constantly monitor the student and have the ability to automatically offer explanations to match the student’s current level of understanding.

The domain knowledge component of a good TAPS package requires a great deal of intelligence and effort to implement successfully. In general, it is for this reason that to date, no computer-based tutoring package has been commercially developed and fully accepted by learning institutions. Even if such packages exist, these packages may be used only for a short period of time. Therefore, it will probably take many years of research in the field of artificial intelligence before an intelligent computer-based tutoring package could be successfully developed. Currently, when developing a TAPS package, it is necessary to compromise on various aspects of the domain knowledge, to ensure that a simplified advanced computer-based tutoring package, can be physically realized.

**Pedagogical Knowledge**

Pedagogical knowledge is an essential component of a TAPS package. Although the domain knowledge is responsible for filtering useful information from the vast knowledge base, the pedagogical knowledge is responsible for relating this information to the student. The pedagogical knowledge decides how to interact with the student, when to interrupt the student, and how to address to the student while he/she is using the tutoring package.

Although the pedagogical knowledge is burden with many responsibilities, the most important of these is determining a strategy to deal with student errors. Since students are seldom consistent, a computer tutor cannot simply provide correct answers to a student’s mistake. When a student makes a mistake, the TAPS package must select between ignoring the error, pointing it out, correcting it, or somehow guiding the student towards recognizing the error and correcting it without the explicit help of the computer tutor.

**Contributing Technologies**

There are various technologies that have, and will, contribute significantly in the development of TAPS packages presently, and in the future. It is assumed that with the current level of progress in the field of computer hardware and software, most of these contributing technologies could dramatically change the environment of TAPS packages. Although computer hardware is a contributing technology in itself, the technologies that are of greatest interest are those multimedia and virtual reality, which are briefly described in the next sections.

**Multimedia**

Cairncross and Mannion (1999) described three main attributes of multimedia applications namely multiple media, interactivity, and delivery control. These attributes can be further shown with its sub-functions or properties as shown in Figure 1.

According to this model (Figure 1), a given piece of information could be delivered using one or more media elements. For example, an image can be used to illustrate a text-based description. The information originally presented on screen can be supplemented by the use of audio, video, and pop-up boxes. Audio is useful as text can be minimized on the screen. Thus, multimedia has the ability to support multiple representations of the same piece of information in a variety of formats.

In general, multimedia applications demand some kind of delivery control. The non-linearity offered by many interactive CAL multimedia learning applications provides a learner/user greater navigational freedom.
Technology Assisted Problem Solving

Figure 1. Key attributes model of multimedia

Users may go to any section in a multimedia tutorial and in any order (Cairncross & Mannion, 1999). Dynamic media such as video and audio can be controlled, that is, pausing, playing, and repeating clips.

Another attribute is interactivity. Interactivity in multimedia assisted learning applications should go further than simply allowing a user to choose his/her path, and pointing and clicking at various menus and buttons. Most multimedia applications provide some interactivity in that it responds to user instructions. What makes the difference even in a simple educational software is whether the software allows the user to work at his/her own pace, in the order desired, repeating sequences at user’s will, manipulate virtual objects on screens, and simulation of experiments or industrial processes (Cairncross & Mannion, 1999).

Virtual Reality

Virtual reality (VR) is a remarkable technology that allows three-dimensional artificial worlds to be created on computer. What makes this technology unique is that it is possible to move about and interact within these artificial worlds in a way that allows all navigational and manipulative movements made by the user to be emulated in this computer-generated environment (Pimentel & Teixeira, 1993). This is accomplished using immersive VR input devices, such as the head mounted

Figure 2. Extended key attributes model of multimedia and DVR
display (HMD) and data glove. Using this equipment, the user believes that he/she is actually immersed in this artificial world. A typical VR system in general consists of one or more input devices, several forms of output devices, and a computer to manage all the data. On the other hand, there are also desktop virtual reality (DVR) applications that do not require expensive hardware equipment to be used. DVR requires a PC or laptop, some specialized hardware such as a 3-D graphics card, 3-D sound card, a 6-D tracker, a joystick, and software that displays and permits navigation in virtual environments such as Cortona™ and Cosmo™ viewer, and Macromedia™ Shockwave. The delivery control features of DVR as shown in Figure 2 are an extension of the key attributes model of multimedia shown in Figure 2. These new features enable the user to move along any direction on the screen and have the object displayed continuously and updated instantaneously. Therefore, the user could gain a greater understanding of a given problem. In terms of cost, DVR is cheaper than immersive VR systems.

Virtual reality would be one of the key technologies to influence TAPS packages in the near future. With constant developments and improvements in the field of computer hardware and software, it will eventually be possible to create immersive VR TAPS packages at an affordable price. Such packages could help students learn and understand better, that is, if an environment responds realistically to various inputs given by the student, the student can observe exactly how the system functions in reality.

Development Aspects of TAPS Packages

Self (1988) argued that a computer-based tutorial system should have a representation of what is being taught, who is being taught, and how to teach the student. As such TAPS packages should dynamically analyze the solution and use principles to decide what to do next, rather than simply providing solutions. Providing a truly “interactive” system was recognized to be a non-trivial task that needed experts from several disciplines. The major features of a TAPS package therefore should incorporate the following aspects:

• TAPS packages provide more detailed analytical errors rather than simple drill and practice.

In summary, the design of a TAPS package requires various key components to be successfully integrated. These include the appropriate choice of learning scenario, a comprehensive domain and pedagogical knowledge, and a dynamic student assessment model. With these components firmly in place, the TAPS packages should have the ability to present relevant course material at a level of detail ideally suited to the individual style of learning. In addition, the TAPS packages should be able to constantly assess the capabilities of the student and provide adequate feedback throughout the problem solving process. A good TAPS package demands a great deal of computer intelligence to be incorporated into the problem-solving package. Presently, it is not possible to represent all the characteristics of a human tutor in TAPS packages. Consequently, it is permissible to compromise on the knowledge representation of a human tutor to a certain extent to produce a tutoring and problem-solving package that can teach students in a more effective manner than other already existing CAL packages.

REFERENCES


**KEY TERMS**

**CAL:** A terminology used for imparting educational experiences electronically.

**Learning Style:** The way individuals/learners grasp and process information.

**Problem-Based Learning:** Instructional strategies that are intended to engage students in authentic, “real world” tasks to enhance learning. Students are given open-ended problems with more than one approach or answer, intended to simulate professional situations. Both learning approaches are defined as student-centered, and include the instructor in the role of facilitator or coach. Students engaged in problem-based learning generally work independently or in cooperative groups for extended periods of time, and are encouraged to seek out multiple sources of information. Often these approaches include an emphasis on authentic, performance-based assessment.

**TAPS Packages:** Specialized computer programs developed to work as stand-alone (PC-based) or with Web servers that can supplement student learning for revision, laboratory experiments, and self-study.
Technology in the Cities

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INTRODUCTION

“We are trying to conceive a new way of thinking about computers in the world, one that takes into account the natural human environment and allows computers themselves to vanish into the background” (Weiser, 1991).

We are making progressive advances towards Weiser’s vision. Technologies are already being embedded into our environment. Smart floors can sense when a person has fallen and immediately send vital information to paramedic support (Abowd, Atkeson, Bobick, Essa, Maclntyre, Mynatt, & Starner, 2000). People are using mobile devices, such as cell phones for e-mail, instant messaging, Web browsing, games, and MP3 playback (Lendino, 2006). Presence technologies are already informing us as to our IM buddy’s physical presence, such as online, off-line, busy, or away from the desk. Current uses of the Web for searching, photos, music, video, various levels of electronic communities, and online, collaborative software applications are preparing users to advance to the next Web 2.0 level of Internet use. Combine Web 2.0 with expanded WiFi capabilities, and we won’t need large computing devices for sharing large amounts of data within virtual, collaborative environments.

Users have become cyber-designers and cyber-community builders of the technology that surrounds them in their physically populated environments in such ways that we are in great need of creating new metaphors and models regarding technological culture and intimacy (Bell, Brooke, Churchill, & Paulos, 2003; Galloway, 2004; Zhang, Jin, & Lin, 2005). In the past, user interfaces have been predominantly designed by corporations and used by consumers. However, with the development of new devices and environments that open themselves for user adaptation, hardware and software designers are finding that “the design process now extends beyond the formulation of a computational artifact and onto how the user experiences an artifact” (March, Jacobs, & Salvador, 2005, p. 2,126).

Hardware and software designers are recognizing the shift from the formulation of artifacts to how users experience artifacts within community technology projects. Shouldn’t teachers and instructional designers also pay closer attention to how users experience artifacts within community technology projects in order to maximize our ever-present and ever-growing need for a socio-cultural focus in educational technology environments?

The current and future growth of wireless fidelity (WiFi) technologies leads us toward more electronic community building within virtual and urban environments. This focus that involves socio-cultural theories and social networking community technology projects comprises the base for this article. The primary goal of this article is to contribute to discussions of the design of current and future technologies within that focus.

BACKGROUND

Given the focus of current and future technology design based upon socio-cultural theories and social networking community technology projects, two background areas need to be reviewed: (1) social interaction support for calm technology in the cities, and (2) socio-cultural theoretical framework support for research and design.
Social Interaction Support for Calm Technology in the Cities

When computers are all around, so that we want to compute while doing something else and have more time to be more fully human, we must radically rethink the goals, context, and technology of the computer and all the other technology crowding into our lives. Calmness is a fundamental challenge for all technological design of the next fifty years (Weiser & Seely Brown, 1996, p. 3).

Weiser and Brown emphasized the use of calm technology for future computing eras. Calm technology refers not only to the fact that computers remain basically in the background of operations, but that people operating the technology are also serene and in control.

According to Weiser, not only would ubiquitous technologies release us from the restrictions of desktop computing, but they would also liberate us from equally absorbed and simulated virtual reality environments. Howard Rheingold visited researchers at Xerox Palo Alto Research Center (PARC) in the late 1980s for an article he was writing for Wired Magazine, and interviewed Weiser:

The lab’s new direction, Weiser says, “recognizes even more that people are social creatures.” He referred to his ideas as a form of “postmodern computing,” in that he wants to “return to letting things in the world be what they are, instead of reducing them” to data or virtualizing them into illusions. “Ubicomp honors the complexity of human relationships, the fact that we have bodies, are mobile,” he said (Rheingold, 1994, p. 3).

Socio-Cultural Theory Support for Technology in the Cities

This focus on the social and cultural realms more than the technological realm provided a fresh look into human-computer technological designs (Weiser, 1993).

According to Galloway (2004), the concept of transduction allows us to shift focus from technologically networked objects to diverse procedures or performances in which socio-technical groupings take shape.

The primary benefit of this sort of approach is the ability to identify precise moments and locations in which we may possibly intervene and alter the course of events, thereby reasserting the role of social and cultural agency—and the potential for critiques of everyday life—in the development and use of ubiquitous computing” (Galloway, 2004, p.22).

Mackenzie (2002) also suggests that ubiquitous computing is transductivie in understanding technology through flow and movements between virtuality and actuality. Shields (2003) has explored these and other categories, such as virtual, concrete, abstract, and future, in terms of intensities and flows. The idea here is that through focused attention on these relations and flows, we may better understand the role of technologies in everyday life. Hence, transduction produces the need for researching such interactions from socio-cultural theoretical frameworks.

Towards Community Projects Utilizing Future Technologies

Given the rapid rise of digital social networks, portable technologies, and nanotechnologies in recent years, educators are faced with pedagogical design issues. Design issues based upon technological opportunities are not new to the field of education through the years of technological advancements. What is new, however, is the exponential rapidity of such advancements. This exponential explosion will continue to occur, necessitating a shift of a teacher to student-centered, socio-cultural pedagogical design focus for all educators, given the ubiquity of technologies throughout the world.

As professional educators, it is our responsibility to research, evaluate, and inform our hardware, software, and application development colleagues with socio-culturally sensitive educational design issues and needs. One approach to forging such efforts is to: (1) research design considerations promoted by our application development colleagues, and then (2) apply instructional design considerations integrating constructivist theories conducive to socio-cultural theoretical frameworks. What follows is an attempt to open instructional design research and development dialogue based upon such design considerations.
Developing Concepts for Community Projects Utilizing Future Technologies

The Intel Corporation, FX Palo Alto Laboratory, and PLAY Interactive Institute in Sweden are some of the organizations and corporations that have been engaged in several community technology projects and associated research in cities. They recognize that future, pervasive, and anticipatory technologies within appliances and future algorithms will “respond better to our needs, delivering ‘smarter’ more context-appropriate, computing power” (Bell, Brooke, Churchill, & Paulos, 2003, p.4).

They make a point of including intimacy as a cultural category or construct to design:

...intimacy as something that is related to our innermost selves, something personal, closely felt. Such a construction could include love, closeness, or spirituality. Or perhaps it is in the way we understand, feel, and talk about our lives, our bodies, our identities, our souls.

In all these ways, intimacy transcends technology, and has a role to play in shaping it. As we move towards designing for communication, emotion, reflection, exploration, and relationship, we need to critically reassess our reliance in design on outmoded conventions and old models of computation and connection. We need to employ new metaphors and create new models (Bell et al., 2003, p. 4).

This specific focus of intimacy transcends cultures, age, time, and several other possible barriers or refining lenses through which current and future educational technological use could be limited. It also provides specificity in socio-cultural design constructs and implications. The intimate socio-cultural design constructs referenced earlier include:

- Deriving understandings of people’s nuanced, day-to-day practices:
  - concern for people in their day-to-day world, including affective responses;
  - concern for routine, finely-grained, and socially-ordered ways in which people see, hear, move, interact, express, and manage the real world;
- Elaborating cultural sensitivities:
  - developing countries could leap-frog into newer technologies, thereby necessitating exploration into culturally constructed intimacy in different geographies and cultures;
  - explore cultural differences in emotional significance and resonance of different objects;
- [Revising] notions of mediated intimacy, through explorations of play and playfulness:
  - humans seamlessly move in and out of the context of play;
  - when at play, humans are more exploratory and willing to entertain ambiguity in expectations about people, artifacts, interfaces, and tools; and
- Exploring new concepts and methods for design:
  - include more empathy, emotional richness, and broadened imaginative range;
  - including modernity with foundations of moral purity and integrity (Bell et al., 2003, pp. 4,5).

These four constructs envisage future computing landscapes as well as future design practices in corporate developments. These same constructs greatly inform current and future instructional technology design in educational environments, bearing in mind culturally diverse practices and values throughout cultures.

The Frontier Service Development Laboratory aims at creating “ubiquitous services using new information technologies that will become available in the future” (Egami, 2003, p. 1). Their research encompasses a variety of technologies found in cities. They incorporate Weiser’s vision of supporting people’s daily lives by computers and networked technologies blended into their living environment. They incorporate users’ expressed opinions, such as “must be easy to understand, needs to be more intelligent…must be more customized, must be simple, etc.” (Egami, 2003, p. 4).

One of their research results includes the six tests for providing a ubiquitous environment, which include: (1) smart navigation for personalized direction; (2) context marketing for individual tastes; (3) seamless benefit offering real-time added value (irregardless of time, place, and space); (4) calm technology creating relaxing new spaces; (5) universal platform, or simple use by all; and (6) a personalized information space, including knowledge enabling with appropriate data (Egami, 2003). A framework for educational technology
Table 1. Intimate, socio-cultural instructional design, research, and evaluation considerations (Elwood, 2007, adapted from Bell, et al., 2003 & Egami, 2003)

<table>
<thead>
<tr>
<th>Socio-Cultural Instructional Design, Research, &amp; Evaluation Considerations</th>
<th>Evaluation</th>
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<td><strong>Design Questions</strong></td>
<td>Smart Navigation</td>
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| **Nuanced, Daily Practices** | 1. In what ways can current, ubiquitous hardware technologies be envisioned as purposeful tools within a global learning environment?  
2. What are freely available Web2.0 software applications envisioned as purposeful tools within a global learning environment?  
3. What are day-to-day interactions people have in terms of how they see, hear, move, interact, express and manage the real world in relation to this environmental learning design? | | | | | |
| **Cultural Sensitivities** | 1. How could cultural differences in emotional significance and resonance of the available technologies affect or better inform this design?  
2. How could cultural differences in emotional significance and resonance of the environmental applications of this idea affect or better inform this design? | | | | | |
| **Intimacy / Playfulness** | How can learners seamlessly move in and out of the context of play through constructivist learning within this design? | | | | | |
| **Concepts & Methods for Design** | 1. How are the foundations of moral purity and integrity established?  
2. How are empathy, emotional richness, and broadened imaginative range each addressed in the design? | | | | | |

**Socio-Cultural Theoretical Framework Possible Research Questions:**
1. How does this instructional design utilize and impact the role of social and cultural agency?  
2. What are the possibilities for critiques of everyday life - in the development and use of available or needed technologies towards greater socio-cultural communication and learner design?  
3. How can the areas of intensities through flow and movements between virtuality and actuality better inform socio-cultural communicative need and design?  
4. What more abstract and future hardware, software, and application visions could contribute to greater socio-cultural flow and movement intensities?
design issues can be derived from this proven ubiquitous service offered within technology-enhanced cities.

**Towards Intimate, Socio-Cultural Instructional Design, Research, and Evaluation Considerations**

The six tests of a smart-station concept and intimate socio-cultural design constructs were joined to create the intimate, socio-cultural instructional design, research, and evaluation considerations tool (Table 1). This tool is presented as a form of entering dialogue and discussion for such emergent design considerations within our current and future exponentially changing forms of technologies. It contains a three-part process of: (1) addressing design questions, (2) contemplating research questions, and (3) evaluating the intimate socio-cultural design constructs in terms of the smart-station concepts through a simple checklist format per construct.

This tool may assist educators and instructional designers towards the construction of learning environments for incorporating emergent technologies in the cities. Design questions are presented to not only instructional designers, but also to the learners within the environment. Given the exponential explosion of ubiquitous technologies, it is not uncommon for students to have greater technological skill levels than instructors in many given situations. By asking the design questions of both learner and designer, greater opportunities for effective tool integration can result towards the greater outcome of more intimate, socio-culturally shared communication and learning environments.

**FUTURE TRENDS**

Immediate and long-term future trends provide some useful ideas in stimulating creative or critical responses to the intimate, socio-cultural instructional design, research, and evaluation considerations presented earlier.

**Immediate Future**

Haskin (2006) presents six portable technologies that will change our lives within the next couple of years: (1) near field communications; (2) commanding presence; (3) Internet everywhere; (4) GPS tracking devices; (5) ubiquitous media; and (6) health monitoring.

The first four portable technologies focus on cell phone use. With near field communications technology, you can wave the phone in front of a terminal and have the amount of the purchase deducted from the credit carried on your phone. Commanding presence, such as the mechanism that tells you if someone on your IM buddy list is online, off-line, busy, or away from the desk, is going mobile according to your parameters. Allow family calls to come through while commuting and viewing real-time traffic information and immediately know needs and client location upon arrival at your destination. Internet connectivity will be in your appliances to help you start dinner on the way home and order grocery items for you when supplies are depleted. GPS tracking devices will enable special cell phones to provide video monitoring of performance skills test, such as truck drivers’ skills exams. Such presence changes the behavior of the driver. Perhaps this presence will also change the behavior of distance education.

The final two portable technologies include other portable devices. Ubiquitous media devices, such as iPods and video phones, currently exist. Further applications are being developed that include two-way video for live videocasts. Looking someone in the eye while conducting business is important to people, just as it can be important in education. Live video for multi-national collaboratives would encourage more intimate, socio-cultural learning environment designs. Easier health monitoring will occur through wireless technologies that allow us to send readings to data records and be immediately readable by health providers. This telemedicine started in 1993 and continues in development to the point that family members will be able to monitor their elderly parents’ medicine intake schedules and whether they are sleeping or awake.

**Long-Term Future**

Ray Kurzweil (1999) has long been noted as a technology visionary. In his *Age of Spiritual Machines*, he makes predictions regarding the future of technology.

A few of his predictions for the year 2019 follow:
1. Computers are now largely invisible and are embedded everywhere—in walls, tables, chairs, desks, clothing, jewelry, and bodies.

2. Three-dimensional virtual reality displays, embedded in glasses and contact lenses, as well as auditory “lenses”, are used routinely as primary interfaces for communication with other persons, computers, the Web, and virtual reality.

3. Most interaction with computing is through gestures and two-way natural-language spoken communication.

4. High-resolution, three-dimensional visual and auditory virtual reality and realistic all-encompassing tactile environments enable people to do virtually anything with anybody, regardless of physical proximity.

5. Blind persons routinely use eyeglass-mounted reading-navigation systems. Deaf persons read what other people are saying through their lens displays. Paraplegic and some quadriplegic persons routinely walk and climb stairs through a combination of computer-controlled nerve stimulation and exoskeletal robotic devices.

6. Automated driving systems are now installed in most roads.

Predictions for the year 2029 include:

1. Permanent or removable implants (similar to contact lenses) for the eyes as well as cochlear implants are now used to provide input and output between the human user and the worldwide computing network.

2. Direct neural pathways have been perfected for high-bandwidth connection to the human brain. A range of neural implants is becoming available to enhance visual and auditory perception and interpretation, memory, and reasoning.

3. Automated agents are now learning on their own, and significant knowledge is being created by machines with little or no human intervention. Computers have read all available human- and machine-generated literature and multimedia material.

4. There is widespread use of all-encompassing visual, auditory, and tactile communication using direct neural connections, allowing virtual reality to take place without having to be in a “total touch enclosure”.

Kurzweil predicts that in the year 2019 a $1,000 computer device (in 1999 dollars) will be approximately equal to one human brain and in the year 2029 equivalent to 1,000 human brains. Given this and the other predictions, socio-cultural discussions regarding design guides and design models become imperative in this age of exponential technological growth.

CONCLUSION

The purpose of this paper was to present some current and future applications of technologies to be used in cities and throughout the world in relation to intimate, socio-cultural instructional design, research, and evaluation considerations. Research regarding concern for socio-cultural considerations exists and continues to grow as the era of calm technology is upon us. Intimate, socio-cultural considerations will continue to be of paramount importance as the exponential explosion of technological advances continues.

The intimate, socio-cultural instructional design, research, and evaluation considerations presented in this paper were presented to promote continued discussion and dialogue within the field of education as we progress through this exponential growth of technology and rapid advancements seen in cities and cultures throughout the world. Given the future predictions referenced in this article, how can educators and researchers envision pedagogical changes and developments to meet the creative opportunities, challenges, and demands that will result from the development of future technologies?

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**KEY TERMS**

**Calm Computing/Calm Technology:** Technology that is so embedded, so pervasive, that it is taken for granted; becoming so commonplace that we forget its enormous impact, just as we have with other ubiquitous technologies, such as writing and electricity (Galloway, 2004).

**Mobile Learning:** Delivery of learning to students who are not keeping a fixed location or through the use of mobile or portable technology.

**Nanotechnology:** A field of applied science and technology covering a broad range of topics. The main unifying theme is the control of matter on a scale smaller than one micrometer, as well as the fabrication of devices on this same length scale.

**Online Collaborative Software:** Software designed to help people involved in a common task achieve their goals through shared applications and media storage through the World Wide Web.

**Pervasive Computing:** A model of computing in which computer functions are integrated into everyday life, often in an invisible way.

**Presence Technology:** Capabilities that not only provide details about your availability but also help make you and those you connect with far more efficient and productive.

**Transduction:** A shift of focus from ubiquitous technologies as networked objects to ubiquitous technologies as diverse procedures or performances in which socio-technical assemblages take shape (Galloway, 2004).

**Ubiquitous Technologies:** Takes into account the natural human environment and allows computers and technological devices themselves to vanish into the background (Weiser, 1991).

**Web 2.0:** Refers to a perceived second-generation of Web-based services—such as social networking sites, wikis, communication tools, and so forth—that emphasize online collaboration and sharing among users (O’Reilly Media, 2004).
Technology Support for Collaborative Learning

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INTRODUCTION

Collaborative learning is an activity that takes place between a teacher and a learner, between learner and learner, and sometimes, one would hope, between learner and teacher. The free flow of ideas between the various parties can be inhibited by a variety of factors, including perceived or actual power barriers, language skills, previous learning experience, and personal factors such as shyness or dominance. Technology can be used as a way of overcoming, or reducing, some of these inhibitory factors, and this chapter outlines some of the computer-based technologies that can be used. The use of technology to support distant learners is well documented, and this chapter concentrates instead on the less well-reported use of technology in the face-to-face classroom. The chapter opens with a brief consideration of collaborative learning and then focuses on the technologies that can be used to support collaborative learning process in a variety of time and place settings. These technologies include audience response systems, electronic meeting systems, and more recently, and rapidly developing, blended versions of these technologies.

COLLABORATIVE LEARNING

Collaborative learning can be considered to be an educational activity that involves two or more students working together in such a way that they can utilise their joint resources, skills, and knowledge to achieve a common educational goal. The goal may be a directly measurable outcome, such as a document, or embodied in the actual process of collaboration itself, in which case a useful definition of collaboration is that it is “... a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (Roschelle & Teasley, 1995). The learners can work in pairs or in larger groups, with five or six members being typical, with the most effective interaction being obtained with pairs. This sharing of learning can assist the discussion and sharing of meaning and has been argued to support higher levels of thinking (Johnson & Johnson, 1986) and to develop critical thinkers and greater retention of learning (Totten, Sills, Digby, & Russ, 1991). Although typically associated with assignment work, collaborative activities can be incorporated into more traditional learning environments such as lectures. For example, Rosenberg, Lorenzo, and Mazur (2006) discuss the role of peer instruction (Mazur, 1997) in science classes as a vehicle for improving students’ conceptual understanding of course materials. The approach makes use of mini-lectures interspersed with tests that are built around individual consideration of a question, followed by a period in which students discuss their views with a neighbour after which formal feedback is given to the instructor. The process provides for collaborative activity between pairs of students, then between all students, and also enables the instructor to be part of the learning process and to adjust pacing of subsequent mini-lectures or repeats of previous materials. Involving students in evaluative judgements relating to their own work and that of their fellow learners is an essential part of the process of higher education and in lifelong learning (Nicol, 2006).

TIME AND PLACE DIMENSIONS OF COLLABORATION

Collaboration may take place in a variety of spaces that can be characterised by reference to the time and place of the activity (DeSanctis & Gallupe, 1985). Web-based delivery systems, for example, may be located in the different time/different place, or asynchronous, learning space. If video and/or audio conferencing or “chat” facilities are utilised this would occupy the same time/different place (synchronous) sector and different
Technology Support for Collaborative Learning

time/same place could be represented by course home pages, wikis, blogs and so on. These spaces are currently commonly used but the same time/same space (face-to-face, or F2F) tools are currently less common and these form the main focus for this chapter. The first technology outlined is the audience response system (ARS).

AUDIENCE RESPONSE SYSTEMS (ARS)

This technology is also known by a variety of aliases, including electronic voting systems, classroom communication systems, classroom performance system, and personal response systems. The basic technology comprises a hand-held input device (keypad) that communicates with a receiver via an infrared or wireless link. Software on the classroom PC is used to display questions or statements and students are invited to use their individual keypads to respond. The response data is aggregated and displayed in a variety of forms on a public screen via a data projector. The software is usually embedded in PowerPoint™ and is simple to use. The system may be set up temporarily each time it is used or may be permanently installed in a room, for example, a large lecture theatre. Keypads may be provided by the institution or bought by students. The systems can be used with groups with as few as five members (Banks, 2006) or with groups up to several hundred.

At first glance the use of a basic numeric keypad may seem to limit the use of the technology to simple response to multiple choice or similar question structures and only support surface learning this is far from the case in practice. The technology certainly can be used for in-class tests and offers the benefit of instant feedback to students, but it can also be used to support a variety of teaching and learning approaches. Greer and Heaney (2004), for example, use this technology to explore quantitative problems, applied reasoning, creative thinking, and “popular misconceptions of science” sessions in their introductory Earth science course. They link images to their presentation, with students applying their understanding of the laws of superposition and cross-cutting relationships to the interpretation of a rock formation image. An exploration of issues surrounding personal decisions by medical personnel was supported by an ARS in work carried out by Freeman and Dobbie (2005). The ARS was used prior to a lecture to obtain views from the participants about ways in which they would react to given situations, and the aggregated views were displayed on the public screen. This ARS session was then followed by a 20-minute lecture, after which the participants were asked to answer the same set of questions, again using the ARS. It was felt that the anonymity offered by the ARS was of considerable value, and that the sharing of colleagues views was helpful, and that the whole process was stimulating and enjoyable. Schackow and Loya (2004), also using ARS in the medical area, reported that ARS-enhanced lectures improved post-lecture performance and factual retention in family medicine residents both immediately after the lecture and up to one month after the lecture. Examples of the use of ARS in a wide range of subjects including mathematics, agriculture, liberal arts, engineering, philosophy, and ethics. In each case, the focus is upon learning goals rather than marks or grades. Using step-by-step learning structures with increasing levels of difficulty at each step accompanied by constant and immediate feedback to the learners can increase confidence and motivation.

As the cost of the technology continues to fall, one would anticipate a higher adoption rate for ARS. The adoption of ARS is now widespread in universities around the world, and those institutions that have used them are tending to expand the range of courses they are used with. For example, Wong (2005) reports that Purdue installed the technology in 215 of its 276 classrooms in its West Lafayette campus, with over 6,000 students using the technology and an anticipation that the usage will eventually extend to as many as 20,000 of the 38,000 students enrolled.

Positive benefits in the use of ARS:

• Creates interest in topics that are not normally exciting for learners (Banks & Bateman, 2004; Freeman & Dobbie, 2005);
• Generates improvements in retention and test scores (Schackow & Loya, 2004);
• Helps students to gauge their level of understanding of course material and reinforce concepts provided in the lecture (Greer & Heaney, 2004);
• Time savings in automatic grading and recording of scores allows quizzes to be given more frequently (Petr, 2005);
• Enhances student confidence and the perceived benefits of learning (Nicol, 2006); and
allows capture of student demographics and interests (Banks & Monday, 2006).

The reported reaction of students to this technology has generally been positive, with most negative comments being related to issues surrounding occasional problems with the technology and delays at the start of sessions if staff were unfamiliar with the set-up procedures.

FURTHER RESEARCH IN THE USE OF ARS

This technology is relatively new in the classroom environment, and although it appears to be producing significant positive outcomes, there is a need to recognise that there may be a number of factors other than the technology itself at work here. The early adopters of this type of technology may well be people who were already focussed on improvements in teaching and learning and their enthusiasm for the technology may account for some of the beneficial outcomes. The literature relating to the use of this type of technology consistently notes that substantial changes have to be made to existing teaching and learning approaches to ensure benefits. It is likely that the process of re-thinking the teaching and learning processes triggered by consideration of the implementation of ARS may itself lead to positive improvements. Improvement in retention rates of lecture information or higher performances in tests may not translate to improvements in, for example, clinical practice (Schackow & Loya, 2004). If an ARS is simply used as a vehicle for testing using multiple-choice questions (MCQ) and is disconnected from the discussion about the resultant data, there is a risk that students will be led to believe that there is a single “right” answer. In some cases, this may be acceptable, but in many courses, the value derives from appreciating multiple perspectives and discussing why those differences of interpretation exist. Considered changes of opinion as a result of feedback are a highly desirable outcome in many circumstances (Read & Gear, 2006). ARS make considerable use of MCQ, but the design of meaningful MCQ is not a simple task if we are to ensure that the student response is the result of deliberation rather than guesswork (Barrow & Blake, 2004).

ELECTRONIC MEETING SYSTEMS

In some circumstances the limitation of the fixed number of numeric keys on an ARS keypad can be a problem. The ARS offers anonymity and thus allows some students who would otherwise not participate as a result of shyness, gender perceptions, cultural backgrounds, and so on may be encouraged to more fully participate in the class. However, if the results of the process are to be explored later through open discussion then clearly these students are only marginally more advantaged. Read and Gear (2006) note that ARS may be particularly suited to “option selection”, rather than “option generation”, types of task in groups. If it is required that a group should participate in discussion, option generation or brainstorming activities and still retain anonymity an electronic meeting system (EMS) may prove to be more appropriate.

EMS comprise linked (cable or wireless) desktop or laptop computers that share the tools offered by the meeting software. One benefit of EMS is that participants can work in parallel when generating ideas and thus quickly produce a rich set of materials that can be explored using evaluative and voting tools within the software. The anonymity afforded by EMS reduces the influences of power, gender or culture, and this “invisibility”. This invisibility allows ideas to be judged on their merits rather than on the basis of personality, gender, or status (Burdett, 2000). EMS offer increased and more equal participation and allow participants to enter comments whenever they need to, thus reducing production blocking that can arise as a result of airtime fragmentation and attention blocking (Davison & Briggs, 1997, 2000). Day and Batson (1995) detail the use of networked computers to support the teaching of in-class collaborative writing that reflects many of these issues.

These systems are more complex than ARS, require greater set-up time, and can cater for smaller numbers of participants, typically not more than 16 at any one time. Ideally the system is permanently established in a dedicated room, but many universities have had to abandon this arrangement due to increased demands for teaching space. Laptops can be temporally established reasonably quickly using either wired or wireless but the limitation of small numbers of participants makes them less attractive than an ARS for regular use. The software tends to be rather expensive but at least one
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vendor (Meetingworks™) offers a trial (five users) system that can form the basis for some interesting group work.

CONVERGENCE

ARS offer a simple, reasonably cheap, and powerful tool for use in classrooms and can cater for very large group sizes. They have some limitations as a communication device and an EMS addresses these concerns, but only for small groups. As would be expected the advent of personal digital assistants (PDAs), Pocket PCs, mobile phones, and other portable devices has led to a range of systems that combine the benefits of ARS and EMS using readily available devices. For example, PDAs can be augmented with audience response software to support teaching in medical schools (Menon, Moffett, Enriquez, Martinez, Dev, & Grappone, 2004). During lessons, questions were posed within a PowerPoint presentation that the students also saw on their PDAs. Students were able to anonymously submit an answer to a Web server via a wireless network, following which the server returned the processed responses to both teacher and students instantaneously.

Pocket PCs (PPCs) are another suitable platform for the development of interactive training and education processes. Jackson, Ganger, Bridge, and Ginsburg (2005) use these devices to support second and third-year medical student education. Uses included attendance tracking, course evaluations, and interactive learning. Content, including medical decision making titles, can also be delivered to student PPCs to build students’ appreciation of bedside diagnoses. PPCs can also offer benefits to instructors, allowing them to leave the podium computer system and roam among the students while still having control over presentations and being able to pose questions and see aggregated responses (Dominick & Bishop, 2006).

The ubiquitous mobile phone also has a place in the converged classroom response technology field. They offer the benefit that many students already own a mobile phone, they are small, portable, easy to link, have screens that can display text, and can be used to send SMS messages. Jones, Marsden, and Gruijters (2006) report positive responses by students to this approach and felt that they were more personally involved in the teaching and learning process.

CONCLUSION

Technology can provide positive benefits for collaborative learners in all time/place dimensions. Specifically in the face-to-face domain, a range of technologies have been developed, and continue to be developed, that can promote improved engagement and understanding for learners and provide instant feedback to both the learning facilitator and the learner to help them understand how the learning is progressing. As these systems continue to develop and become a common tool in education, they will bridge face-to-face and distant learning modes and help develop an integrated learning environment that is challenging, stimulating, flexible, and engaging.

REFERENCES


**KEY TERMS**

Asynchronous: Communication that takes place where participants communication responses are separated in time. The participants may be at the same place or at different places.
Audience Response Systems (ARS): (Also known as classroom voting systems, personal response systems, electronic voting systems, classroom performance system, classroom communication systems) Systems that provide each participant with a handheld input device through which they can communicate anonymously with software that aggregates all participant response data and displays the results on a public screen for subsequent discussion. At their simplest they may only offer numeric keys, but are increasingly making use of a variety of input devices that can provide text and graphics input.

Electronic Meeting Systems (EMS): (Also known as group support systems, group decision support systems, group process support systems) Systems that provide participants with a powerful tool set that can be accessed via a full keyboard. Numeric and textual input is captured and displayed on a public screen for subsequent discussion. Systems typically cater for a small number of participants but the adoption of portable devices that offer numeric, textual, and graphic input is making their use with larger groups possible.

F2F: Face-to-face, (same time, same place) a communication setting where participants are located in the same room and can use of traditional human communication settings as well as being able to make full use of electronic support systems.

Keypad: Handheld device that has facilities for numeric, textual, or graphic input that is then communicated by infrared or wireless link as part of an electronic collaborative support system.

Synchronous: Communication that takes place between participants at the same moment in time. Participants may be at the same place or at different places.
Telementoring: Mentoring Beyond the Constraints of Time and Space

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INTRODUCTION

The practice of online mentoring, known as telementoring, provides a powerful tool to facilitate meaningful learning. It is based upon the traditional roles of mentoring, yet, it goes beyond temporal and spatial boundaries. The majority of telementoring models involve subject matter experts and students who engage in projects to further learning. Successful telementoring projects involve both content-centered processes as well as effective telecommunication processes. When these elements combine, students engage in opportunities for inquiry and deep learning and telementors experience satisfaction for sharing their knowledge and facilitating the growth of student learning.

BACKGROUND


Mentoring programs exist that bring adults into classrooms in person but these have not been widespread. Face-to-face mentoring causes disruptions in the adult’s work environment that poses a hindrance for many potential mentors. Perhaps more mentors would be willing if it were made more convenient (Amill, 2002; O’Neill, 1996).

Telementoring takes the traditional concept of mentoring and applies today’s technology to mentor students through online text-based interchanges or through video-conferencing. Telementoring is online or virtual mentoring. Telementoring facilitates the mentoring relationship when time and place would make face-to-face interaction impractical (Harris, O’Bryan, & Rotenberg, 1996; McGee, 1997; O’Neill, 1996; O’Neill & Harris, 2004/2005).

In addition to the facilitation of a mentoring relationship, research has shown that there is a need for educators to find meaningful uses of technology (Campley, 1992; Male, 1997; Tomei, 2001). Telementoring offers a rich opportunity to integrate technology and learning. O’Neill and Harris (2004/2005) note that curriculum-based telementoring has the capability to change the way that cultural institutions work for the better. O’Neill and Harris state that telementoring provides the potential to serve students by providing opportunities for them to engage in challenging, long-term inquiry and to serve adults who wish to volunteer to work in schools but who cannot otherwise do so because of their work schedules.

Telementoring is largely accomplished through text-based media, such as e-mail. Videoconferencing can be used, although this method of communication is used to a lesser extent. There are software programs available that both support and facilitate the development and implementation of telementoring partnerships (O’Neill, Weiler, & Sha, 2005).

Communication can be synchronous or asynchronous. This capacity for asynchronous communication is one of the most appealing features of telementoring. This capability permits the participants to engage in communication at their convenience instead of a prescribed time.

Telementoring has been implemented with adult learners. Teachers have found that virtual mentoring helps them to further their learning and to collaborate with each other, thus solving the problem of not having enough time to engage in these endeavors (Doyle, 1995; McGee, 1997). Corporations find telementoring
to be a cost-effective means of ongoing training ("New research," 1998; Stokes, 2001).

The predominant use of telementoring is between adult experts and students in the K-12 setting. Kerka (1998) describes telementoring as a way to connect teachers and students with subject matter experts (SMEs) who give advice, feedback, and guidance with learning projects. The SMEs were noted to facilitate learning by modeling and acting as guides. In this capacity as experts, telementors were found to provide authentic learning opportunities and interpersonal relationships.

**SUCCESSFUL TELEMENTORING PROJECTS AND RELATIONSHIPS**

Learning projects are essential to a successful telementoring experience. The literature on telementoring has suggested that telementoring works best when it is combined with a specific task or project (Cobb, 1997; Donker, 1993; Doyle, 1995; Far West Lab., 1995; Harris et al., 1996; Harris & Jones, 1999; Lenert & Harris, 1994; McGee, 1997; O’Neill, 1996; O’Neill & Harris, 2004/2005; O’Neill et al., 1996; Sanchez & Harris, 1996; Wighton, 1993).

One of the most widely-used subject areas for telementoring has been science (Amill, 2002; Dimock, 1996; Far West Lab., 1995; O’Neill, 2001, 2004; O’Neill & Harris, 2004/2005; O’Neill et al., 1996; Weir, 1992). The inquiry-based nature of telementoring lends itself well to the sciences. The arts and humanities provide a rich forum as well and have been used successfully in creating telementoring projects (Sanchez & Harris, 1996; Scigliano, 1999).

There are a number of models that are used in telementoring partnerships. These include one-to-one, small group to one telementor, and whole class to one telementor. The nature of the project and the age of the mentee guide the selection of the model.

Middle grade students and secondary students benefit from the small group or one-to-one telementoring relationship. Younger students work better with the whole class model. The whole class model allows for more teacher guidance and supervision. It should be noted that teacher supervision and monitoring of all students engaged in telementoring partnerships should be ongoing. Online safety needs to be a paramount concern even within a sanctioned telementoring relationship.

One method that can provide a measure of safety is the use of code names for students (Scigliano, 1999). The students’ identities are protected, yet the individuality of each student can be expressed. These pseudonyms can provide an added element of excitement and creativity for the students.

Regardless of the form that the telementoring partnership takes, there are practices that are indicated to promote a dynamic and robust learning experience. Perhaps one of the most essential ingredients to a successful telementoring partnership is the concept of relationship.

The lack of nonverbal interactions can lead to mechanomorphism which is a term used by Caporael (as cited in Lenert & Harris, 1994). This term refers to attributing machine characteristics to people engaged in online text-based communications, such as e-mail.

Shamp (1991) found that when personal content was absent, perceptions of computer-mediated communication partners were similar to computer characteristics. This can be offset by the sharing of personal information.

Sharing information that portrays a personal presence is a vital component that helps to build relationships among the participants. This is an essential ingredient for a successful telementoring experience (Cobb, 1997; Dimock, 1996; Harris et al., 1996; Lenert & Harris, 1994; O’Neill, 1996; Tsikalas, 1997). Harris and Figg (2000) discuss creating electronic personalities that may or may not take the form of a person’s face-to-face personality.

Telementoring does hold the potential to create strong relationships that are conducive to learning. Lenert and Harris (1994) note that one of the greatest benefits to telementoring was developing interpersonal relationships. This connectivity was viewed as a “powerful experience and a natural motivator for learning” (p. 16).

**TOP TEN TELEMENTORING TIPS**

There are a number of best practices that should be employed in order to promote successful telementoring partnerships. The following suggestions offer guidance to make the most of the telementoring venture.
Many of these suggestions center on open and clear communication, especially between the teacher and the telementor as well as between the telementor and the students.

1. **There should be frequency of communication between the students and the telementor and a quick turnaround time for messages.** Tsikalas (1997) notes that frequency of communication was a key component of successful telementoring relationships and advocated a minimum of once-a-week communication. Harris et al. (1996) note that there should be a quick turnaround message flow. This promotes active involvement and keeps the project moving forward.

   The communications should be student-centered with active, inquiry-based interaction. Multidimensional communications should be encouraged combining intellect and emotions. “The exchanges perceived to be most successful are those in which the participants know each other as multidimensional people as well as intellectual compadres” (Harris et al., 1996, p. 56).

2. **The project that is selected should be specific and meaningful.** A project gives focus to the telementoring relationship. It provides the foundation for inquiry-based communication. The project may evolve as the exchanges between the telementor and the mentee progress. The goals of the project should be clearly communicated among all participants. An open atmosphere of communication should be encouraged between the teacher and the telementor.

3. **Telementoring communications should be student-centered with active, inquiry-based interaction.** The telementoring relationship allows for the development of active learning. The telementor, in facilitating thought-provoking questions, encourages the students to engage in deeper learning. This is in contrast to the online “ask-an-expert” services that provide answers but do not allow for the development of complex ideas on the part of the learner (O’Neill & Harris, 2004/2005).

4. **The telementor should serve as a guide, coach, and model.** Training is important for the telementor to be able to understand his role in the project (Salz & Trubowitz, 1992). The telementoring role follows traditional mentoring roles. These traditional roles easily make the transition to telementoring. The telementor asks guiding questions, promotes deep thinking, and encourages the students to take charge and manage their own learning.

5. **An online facilitator who will provide technical assistance is helpful.** The technical aspects of the telementoring relationship can pose challenges. If these are not addressed, disenchantment and frustration with the experience can occur.

   The use of an online facilitator is suggested in order to assist the participants to make the most of the telementoring experience (Harris, 1998; Harris et al., 1996; O’Neill & Harris, 2004/2005). Harris suggests that online facilitators should be in regular contact with each team to offer the necessary technical, pedagogical, organizational, and interpersonal help. Some of the established telementoring programs provide this assistance. If this is not available, the school’s technology coordinator can be asked to fulfill this role.

6. **Before the project, the teacher and telementor should communicate, plan, and agree upon clear project goals, form and intent of the exchanges, and the duration of the project.** This preplanning is key to building the basis for a successful project. Clear communication of the elements of the project facilitates learning for the students. The goals of the project, the frequency of communication and how it will be accomplished, and the end-date for the project’s completion should be established before the students have contact with the telementor.

   When the teacher and the telementor have established the framework for the project, the students can be free to engage in learning with less time appropriated to question matters concerning the delivery of the project. The preplanning, although time-consuming, provides clarity for all of the participants.

7. **Teachers should have regular contact with the telementor.** Frequency of communication between the teacher and the telementor is important to keeping the project moving forward. The teacher can provide the telementor with key information on how the project is working with the students and inquire how the project is working for the telementor. The telementor can give feedback on the project and express any questions, concerns, recommendations, or commendations. This communication allows time to reclarify goals and discuss strategies.

8. **The teacher should talk about teaching strategies and the composition of the students in the class with the telementor.** The teacher plays an essential role in the telementoring process. Lenert and Harris (1994) emphasize the importance of the role of the
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teacher in a telementoring project. Teachers should share information about their curriculum instructional strategies.

Harris et al. (1996) report that their telementors who did not have K-12 teaching experience found suggestions for working with the students to be very helpful.

The teacher is key in ensuring that the feedback from the SME is appropriate for the student’s age and level of learning. The sharing of information, such as teaching strategies, by the teacher to the telementor is important to a successful partnership (Harris et al., 1996, McGee, 1997).

9. Make sure that the telementor’s feedback is appropriate to the student’s age and level of learning. Telementors are usually experts who are not actively engaged in the professional field of teaching. They are experts in a certain field but may need some guidance on providing proper pedagogical feedback to the students.

Sanchez and Harris (1996) discuss a teacher of students with learning disabilities who gave input to the SME who was interacting with her students. She gave him tips on tailoring his presentation for their learning. Because the classroom teacher was informed of role-appropriate behaviors for her interaction with the telementor, the telementor was then able to experience greater success with his mentored students.

10. When the project is completed, some celebration of the students’ work should be conducted. Far West Lab. (1995) reported a science telementoring project that published the students’ work online. It was noted that, “For them, it is rewarding to see the fruits of their labors placed on the network” (p. 117).

After the celebration, there should be concluding communication from the students to the telementor. Final feedback from the telementor should be given then to the students. This provides an end-point for the project for all of the participants.

TELEMENTORING VIGNETTES

Successful telementoring relationships reflect the powerful effect on learning that telementoring has been reported to have with participants. The following examples of telementoring interactions reveal this power in action.

Sanchez and Harris (1996) studied the Electronic Emissary Project. This project is an Internet-based resource to help teachers locate others who are SMEs for the purpose of setting up curriculum-based exchanges online. The researchers detailed the match between a 10-year-old student who was working on an extracurricular project and a 74-year-old English Professor Emeritus. The student enjoyed the interaction. One of her comments was that she felt that she was understood. She contrasted her feelings about the online learning as being different than classroom learning. She liked the immediacy of the feedback. When the professor complimented her on her questions or use of vocabulary, she felt that she was being taken seriously.

The profound effect that the guidance of a telementor can have upon deep student learning was described by O’Neill and Harris (2004/2005). A group of 10th grade Social Studies students in British Columbia and a first-time telementor from Ontario who was a history MA student engaged in a project to build understanding of the Canadian Pacific Railway in the late 19th century. This project was part of an ongoing design experiment entitled “Tracking Canada’s Past.” Students from different cities engage in this project for 10 weeks each year.

One of the mentees developed an interest in a controversial Canadian figure, of mixed French and aboriginal descent, whose arrest and hanging for treason is debated by historians. The telementor wisely asked some guiding questions knowing the material that her mentee would encounter but did not provide clear-cut answers. As a result of this advice, her mentee was able to read the historical accounts and synthesize and evaluate these records for herself.

The following excerpt from the student’s final paper shows the keen insight and challenge that this line of telementoring inquiry afforded this mentee. The first sentence is a quote from a Canadian historian that represents the majority viewpoint of historians. The other words are the mentee’s thoughts as she reflects upon how the building of the Canadian Pacific Railway affected the native peoples of Canada and as she challenges the majority perspective:

The Canadian Pacific Railway linked the hearts of all Canadians….However, is this the real picture of what the CPR brought to ALL Canadians? What about the First Nations?...Did the CPR link their hearts also?...Their
hearts were torn into pieces as Donald Smith drove the last spike of the CPR. (O’Neill & Harris, 2004/2005, p. 115)

The study of a drama telementoring model by Scigliano (1999) indicates the richness of possibilities that exist with telementoring to increase student self-efficacy beliefs; to promote collaboration between students, telementors, and teachers; to permit the integration of the arts into the classroom curriculum; and to provide a meaningful usage of technology. In this study, nine middle school students created and enacted dialogues and scenes with the aid of one drama telementor who was a children’s theater producer/director.

The classroom teacher noted that the students maintained a level of enthusiasm for communicating with the telementor and that the feedback provided by the telementor was helpful. The teacher remarked that learning with a telementor was a plus because it brought in expert help and inspired the students with a new outlook. She stated that it was advantageous to give students access to an expert in a particular field. The reasons given for this were that this adult may bring more experience to the project than the classroom teacher and may offer a dimension of freshness which can be needed, particularly in small schools where students have access to a limited number of teachers.

The students noted increases in their writing efficacy as reflected in their journals and structured interview responses. The telementor’s influence was reported by all participants to be helpful. The students noted that he spurred creative thinking, helped them to develop a solid story line, and kept them on track. One reflection revealed that the telementor helped the student to complete the work with thought and confidence.

The telementor reflected that he felt that the students had grown as writers, being able to clearly define plots, characters, and conclusions. He also described that the students were wonderfully enthusiastic and that they took pride in their work. He encouraged them to make choices and to stand by their choices.

**BENEFITS OF TELEMENTORING**

The benefits of telementoring have been documented in the literature. Increases in self-efficacy, motivation, self-confidence, and self-esteem have been reported. Students have noted that the anonymity of the online interactions helped them not to be as self-conscious as they would be in face-to-face class interactions. These students then expressed that they were more likely to ask questions and to take an active role in their learning during telementoring partnerships.

McGee (1997) reports on the benefits that students gained from their telementoring experiences. The students were motivated to learn about something of interest to them. They felt connected to their SMEs even though physical distance was between them and they enjoyed being listened to by adults. One student who had been struggling academically increased her grade average and began dealing with information that her teacher thought intellectually out of her reach.

One of the greatest benefits of telementoring according to Lenert and Harris (1994) was developing interpersonal relationships. These relationships were most successful when the telementor shared personal information and the teacher shared teaching strategies, curriculum, and pertinent information concerning the students. Lenert and Harris also reported increases in students’ self-esteem.

Male (1997) found that telementoring provided students with risk-free self-expression, focus on content rather than personality or physical attributes, and cross-cultural respect and curiosity. Male reported that increases in self-esteem, cooperative learning skills, leadership, and academic achievement were noticed by teachers, including those who had students with learning disabilities.

Increases in writing self-efficacy were reported by participants in a drama telementoring project (Scigliano, 1999). The student participants reflected that the telementor helped to build their confidence in writing dialogues and scenes. The classroom teacher noted that the telementor provided ideas and expert help which facilitated the teacher’s role in the classroom.

Other benefits that telementoring provides are the freedom and flexibility of interaction. Participants are not bound by time and place. They are free to interact at their convenience. This is especially helpful in an age when time is considered as important a commodity as money.
**CONCLUSION**

Telementoring takes the benefits of the mentoring relationship and extends this beyond time and place. It gives control of learning to students, an opportunity for teachers to provide their students with inquiry-based learning, and a means for sharing expertise and skill on the part of the telementor.

Telementoring provides an opportunity for people with vital skills and knowledge to share their expertise with students when face-to-face interaction would not be feasible due to time constraints. Likewise, it provides an opportunity for students to learn from experts in their chosen field of study who may situated anywhere around the world.

The use of technology to create and support successful telementoring partnerships is continually emerging. The benefits that telementoring brings to all of the participants reflect the possibilities to deepen the connections of knowledge, skills, and relationships, transcendent of time and space. The potential of telementoring to change the world culture for the better is indeed a call and a challenge to mentors, students, and educators to make the best use of this exciting technological relationship.

**REFERENCES**


**KEY TERMS**

**Asynchronous:** Refers to the nature of telecommunications that permits each correspondent to communicate online at separate times, usually at the correspondent’s convenience.

**Mechanomorphism:** Attributing machine characteristics to people involved in text-based online exchanges in the absence of personal identifying information.

**Mentee:** A person who is mentored, also known as a protégé.

**SME:** Subject matter expert. A telementor is a subject matter expert.

**Synchronous:** Refers to the nature of telecommunications that permits participants to communicate online at the same time.

**Telementoring:** Online or virtual mentoring.

**Mentor:** “Any relationship in which a knowledgeable person aids a less knowledgeable person to perform in a new job or a new community of practitioners” (O’Neill, 1996, p. 1).
Thinkquest

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INTRODUCTION

Thinkquest is a worldwide competition funded by the Oracle Foundation that focuses student efforts on project-based learning. Each year students around the world assemble in teams under the guidance of a coach to identify a project and build a Web site to present that topic.

In 1996, Oracle Foundation (http://www.oraclefoundation.org/) began an annual competition that by 2006 had grown to include 30,000 participants and an online library of resulting Web sites, the Thinkquest Library, and projects numbering more than 6,000 (Thinkquest, 2007a, para 2). The age of participating students spans ages 9-19. The team has to have a coach who then enrolls the team through the Thinkquest Web site in order that they are up to date with the requirements, submission process, deadlines, and evaluation criteria for the competition.

In addition, the student team has to select a topic to research and develop a Web site project within one of the educational categories. Reviewing the Thinkquest Web site, it is easy to see that while Thinkquest highlights student fun and competition, the student project and team work is intended to complement and extend academic study (Thinkquest, 2007b, para. Sidebar 1). This point is an important one because it makes the effort much more than an isolated after school program and creates the potential for teachers and coaches to integrate Thinkquest into advanced inquiry. At this time the broad educational categories include:

- Arts & Entertainment
- Books & Literature
- Business & Industry
- Computers & the Internet
- Geography & Travel
- Health & Safety
- History & Government
- Math
- Philosophy, Religion, & Mythology
- Science & Technology
- Social Sciences & Culture
- Sports & Recreation (http://www.thinkquest.org/competition/categories.shtml)

In creating their Web site projects for the Thinkquest competition, student work spans the range of research, writing, critical thinking, collaboration, presentation, design, and technical skills. More impressively, teams with students spanning young grades to high school, many perspectives, insights and technical experience provide a spectrum of variety that is rich because it is so broad. Rather than only seeing one age group represented, by looking at the entries, visitors to the competition and to the resulting Web sites can see such a myriad of experiences that help us appreciate that the world is seen in a very different ways among different digital natives than by adults and that we really should not try to overly generalize this generation.

The competition has been generously supported and been able to award the top 10 teams in each age division laptop computers and the coach’s school receives a cash award.

The pride among the teams as they demonstrate their work is the same as any person in the pride of their creations and accomplishments. And the top three teams compete in the annual Thinkquest Live event which celebrates student potential and accomplishment on a global scale. It is a rare time in which intellect is championed, often with music, banners, and streamers. The extent of the celebration can be glimpsed in this brief description.

In October 2006, the winning teams from the Thinkquest International 2006 competition convened in beautiful San Francisco, California, for four days of learning and fun-filled activities. A gala awards ceremony was the highlight of the week (Thinkquest, 2006, para 2.).
ACCOMPLISHMENTS AND BENEFITS

Briefly summarizing some of the accomplishments and benefits of the Thinkquest array of efforts and resources, educators, parents, and students would most likely find the following characteristics prevalent:

- The international scope of the competition leads to a global awareness
- Guided and plentiful peer collaboration in an academic and fun pursuit
- High energy problem solving
- Maximizing student interest in the online world
- Empowering students to become, or increase their mastery of, online publishing
- Providing an opportunity for students to see their efforts alongside those of other age levels
- Structured training for the coaches
- Rubric-guided evaluation of the student projects
- Cultivation of 21st Century learning skills in an authentic activity
- Much needed integration of technical skills and creativity

CONCLUSION: BEYOND COMPETITION: COLLABORATION

In addition to the Thinkquest competitions, the Oracle Education Foundation also created Think.com, which they describe as an online community for learning. This development extends the work of Thinkquest far beyond the preparation for a contest and a competition day and instead offers a dynamic online collaboration tool and community that can be used for many purposes.

To foster this collaboration and extensive authentic writing experiences, this environment has included an effort to create a safe blogging environment for students and teachers which is password protected. The site includes several interactive tools to facilitate not only blogging but additional collaboration.

An additional feature is that the Oracle Education Foundation has been able to do this ad-free service for accredited primary and secondary schools. As of February 2007, thousands of schools around the world and in eight languages have used the environment and enrollment was still open (see http://www.think.com/en_us/apply/ for enrollment information).

REFERENCES


KEY TERMS

Thinkquest Library (http://www.thinkquest.org/library): Additional innovative learning resources for students of all ages on many different educational topics. This library could be a useful resource for instance in student and teacher research. As of February 2007, the Thinkquest Library included over 6,000 Web sites which were created by students from around the world as part of the Thinkquest competition.

Thinkquest Live (http://www.thinkquest.org/competition/tq_live.shtml): The annual global event honoring the competition’s winning teams. Arriving from around the world, students and coaches celebrate their Thinkquest and academic achievements. In an unusual twist, some of the Thinkquest team members may meet at Thinkquest Live for the first time as they have worked on their online projects in geographically separated locations during the competition.

Thinkquest Winners’ Page from 2006 (http://www.thinkquest.org/aug05may06/): Each year the Thinkquest competition has a Winners’ Page published in order to celebrate the work of the students which have been rated the highest in the competition. This site provides an online portfolio of these authentic representations of their research, creativity, and collaborations.

Think.com (http://www.think.com/en_us/): Think.com is an online collaboration site where educators can select a topic and then have students and others from around the globe engage in discussing and exploring it together.
Towards a Dimensional Model of the Stages of Online Learning

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INTRODUCTION

As technology becomes increasingly pervasive, its role in shaping the context of learning continues to evolve. This requires lecturers to reconsider their pedagogic strategies to effectively integrate the use of technology into learning (Fisher & Baird, 2005). Research into defining student approaches to learning has led to a range of learning models being proposed and widely adopted. Such models have been largely developed in isolation from advances in the use of information communication technology (ICT) in education (Sadler-Smith & Smith, 2004). The use of ICT challenges established learning models, in the same way that businesses have had to adapt to the changing needs and demands of the e-consumer. This article seeks to explore the challenges that ICT poses to learning models and considers future trends in defining the stages of online learning.

BACKGROUND

Bloom and Krathwohl (1956) identify three domains of learning. The cognitive domain relates to the development of intellectual skills from recalling to evaluating data. The affective domain relates to the development of attitudes and behaviour from being willing to listen to different views through to ethical conduct. The psychomotor domain relates to the development of levels of perception and physical abilities (Anderson & Krathwohl, 2001). Although other learning theories have been developed that relate to learning styles, motivations, cognitive styles, and learning strategies, the model proposed by Bloom and Krathwohl (1956) considers development of both knowledge and behaviour. This is particularly relevant as shifts in educational policy place greater emphasis on employability (Dear-
clues embodied in icons and menu structures based on the underlying values.

Different skills need to be developed in online environments, emphasising the social and ethical communication skills of the affective domain. For example, Perkins and Cox (2005) report that following the introduction of e-collaboration systems in a company, face-to-face negotiation was replaced by negotiation using an online system which required workers to develop a different set of communication skills. Traditional teaching methods emphasise verbal learning (Smith, 2002), however, more visual approaches can be encouraged in online environments. For example, holistic learning methods, more appropriate in learning within the affective domain, can be used (Smith, 2002). This change in learning approach will appeal to some students (and lecturers) but not to all.

Technology therefore adds further dimensions that need to be considered in the stages of online learning. These dimensions are considered from the lecturer and student perspectives in the following sections.

**Lecturer Perspective**

The use of ICT in education is effective if the lecturer is receptive, primed, and capable of adapting (Rieber & Welliver, 1989). Initial e-learning solutions were adaptations of text-based learning delivered electronically but now delivery has become embedded in the Internet environment (Wang & Hwang, 2004). Dalsaard (2005) argues that learning technology is considered to be pedagogically neutral and that a theoretical grounding is needed for e-learning to avoid remediation (the transfer of existing activities online). This recognises the issue of stages of staff development in creating, maintaining, and facilitating online learning environments. Typically lecturers first use ICT to form electronically accessible repositories of existing learning materials, such as lecture slides, before adapting teaching styles to incorporate aspects of interaction, discussion, and collaboration online.

Dawson and Heinecke (2004) outline the following four stages of lecturer adoption of technology. The lecturer:

1. Seeks to develop a comfort level with technology (both for themselves and students) by using ICT for entertainment.
2. Moves towards the use of technology linked to the curriculum but not in ways essential to teaching, learning, or assessment.
3. Strategically plans meaningful uses of technology that are student-centred.
4. Adopts instructional strategies emphasising content rather than technology as technology becomes accepted as part of the teaching resources.

These stages represent an incremental approach to enable the lecturer to gain familiarity and confidence in using technology within the learning context, and provide a staged approach for engaging the student in online delivery.

**Student Perspective**

Students’ approaches to learning are affected by their prior educational and personal histories which produce habitual patterns of study (Entwistle, 2001). Stoel and Lee (2003) recognise that a key issue is how to get students to accept and use technology as their prior experience with courseware will influence their perceptions of ease of use.

As computers are used more widely in education, as well as society at large, the issue of computer literacy diminishes. Indeed, students may now have a greater awareness of computer technology than their lecturers (Furnell & Karweni, 2001). This is significant because studies in the use of e-learning have shown that those students with more computer experience achieve better results than their peers (Dutton, 2002).

Lecturers are faced with students who have no prior experience of online learning and students who have some previous experience of online learning and will have established positive or negative attitudes to learning in this context based on that experience. Lu, Yu, Liu, and Yao (2004) report that with the proliferation of technology in society, people are exposed to a range of technology and will form opinions about the technology even if they have not used it themselves. Cultural differences such as societal, personal, organisational, and disciplinary issues also impact upon a student’s response to technology (Lum, 2006).

Research into the cognitive styles and learning preferences of students is well established, recognising the need to understand how students learn and how learning methods can be used to respond to and challenge the different ways in which a student learns.
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Differences in learning styles of both students and lecturer need to be considered in online learning environments (Vincent & Ross, 2001). For example, Lum (2006) suggests that online learning environments are more suited to independent learning and visual learners, and therefore may create a barrier for auditory, kinaesthetic learners or those preferring face-to-face contact.

MODELLING THE STAGES OF ONLINE LEARNING

A widely accepted model of the stages of online learning was developed by Salmon (2000, 2001). The model comprises of the following five stages.

Stage 1: Access and Motivation

Thorndike (1914) defined the law of readiness, in which people learn best when they are ready and motivated to learn. In this first stage of Salmon’s model, the focus for the participant is on becoming connected to the online community and becoming confident in accessing both the learning materials, and being able to participate in online forums (either synchronous or asynchronous). Initially, this stage was concerned with the physical connection to the host service, and concerns about access times associated with dial-up modem connections. This is becoming less of an issue as broadband speeds of at least 512 kbps become ubiquitous in the developed world.

Once connected, participants need to be motivated to use online learning. The format of this motivation will depend upon the learning environment but it can be achieved by demonstrating the advantages online learning offers (Stoel & Lee, 2003). The nature of this initial task is important in establishing a participant’s perceived usefulness and relevance of the system.

Stage 2: Online Socialisation

Within the second stage of online learning, participants become familiar with the online environment, and create a social community which may also contain a nonacademic as well as an academic focus. For learning environments with an international cohort of participants this can cause difficulties, as even ‘safe’ discussions (e.g., weather, holiday, and sport) cannot be easily shared because of the wide range of experiences. Goodfellow, Lea, Gonzalez, and Mason (2001) classify this new virtual learning community as a ‘third culture,’ where (at least) two different social and cultural experiences combine to create a third, unique (albeit temporary) cultural experience for the participants.

The development of the sense of community within an online environment cannot happen automatically, and the e-moderator needs to create online activities which help this development. The e-moderator must define ground rules on which the community can establish itself which will cover the expectations of both the participants and e-moderator with regards to the frequency and intensity of support available. An important feature of this stage is the creation of an atmosphere of respect and this may require intervention on behalf of the e-moderator.

One approach to create a community frequently used in online learning environments is the creation of small groups of (four to six) participants, to work on a task collaboratively. Many of the classical theories of group formation then come into play, but a large cohort of students does provide benefits and economies of scale (Hollyhead, 2004) with exponentially more opportunities for interaction.

Lou, Luo, and Strong (2000) suggest that perceived critical mass is a key determinant in groupware acceptance. Groupware differs from other forms of ICT in that it aims to support collaboration rather than individual productivity. Online learning environments share many features of groupware and a participant’s decision to actively engage in the learning environment may be influenced by the extent to which they perceive their peers to be participating.

Stage 3: Information Exchange

The key features of the third stage incorporate the skills of information management and information exchange, through two sources of interaction:

a. Interaction with course materials and learning objects, such as suitably evaluated Web sites, and specially commissioned audio and video material.

b. Interaction with participants and e-moderators.

The learning that comes from these interactions is analogous to the discussions in traditional learning
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environments. Management of the large amount of information which is generated by this discussion requires patience on behalf of the participants and e-moderator. The participants can quickly become overwhelmed, and develop their own personal strategies to cope with the information overload. These strategies can include lurking within the computer mediated forums, whereby the participant reads the contributions of others, but fails to contribute anything themselves.

The role of the e-moderator at this stage is to summarise arguments and discussions, and provide a focus for the learning experience. Depending upon the virtual learning environment being used, this can include moving discussion topics, archiving old conversations, or summarising and combining message postings together.

Stage 4: Knowledge Construction

As participants learn to function in this environment, they begin to create their own knowledge, and go beyond the expectations of the e-moderator. However, not all participants will reach this stage of online learning, being overwhelmed by the depth and amount of information that happens in the preceding stage (Salmon, 2000).

The skills of the e-moderator at this stage are complex, demanding strong knowledge of the subject area as well as the ability to summarise and consolidate knowledge, referred to by Feenberg (1989) as ‘weaving.’ This process combines the course materials provided and the contributions by the participants to provide new summary postings. As activities finish, the e-moderator should ‘close the loop’ and through a plenary process allow participants to move forward onto the next activity and the next stage of learning.

Stage 5: Development

The final stage of online learning moves participants from concerns about the learning environment itself, and their use of it, to become critical and self-reflective about their learning journey. The always-available archive of electronic activities which have taken place, make longitudinal reflection much easier.

The e-moderator’s role is to encourage personal reflection and to work with participants who are now confident, and may be more questioning of activities which previously they simply accepted. The e-moderator should also be prepared to accept some criticism of the online learning context from these now ‘expert users,’ which can be used to enhance the learning experience of the next cohort of participants.

It is important to note that different participants will be studying at a different pace. The use of informal deadlines within the delivery of materials will help to create a sense of urgency, though care needs to be taken that the feelings of being ‘overwhelmed,’ discussed within information exchange, is not reinforced by limiting the discussion by time.

CASE STUDY

Hollyhead and Cox (2006) report the use of a commercial blogging tool to encourage students to develop reflective skills throughout the delivery of an undergraduate module. This case study provides an example of how students progress through Salmon’s five stages of online learning.

Stage 1: Access and Motivation

Students were provided with detailed instructions on how to access a commercial blogging tool. While some students were familiar with the concept of online registration and forms navigation, for others this was a challenge. Support was offered by the lecturers through face-to-face contact and e-mail; however the strongest support came from the student cohort.

Stage 2: Online Socialisation

Online socialisation was not a key factor in this exercise; the information delivery was a one-too-many relationship between the lecturer and the students. However, the open nature of blogs allowed for information dissemination if the students were willing to make the Web address of their blog available to others.

Stage 3: Information Exchange

Lecturers provided general feedback to students on their blog postings which provided support to students in completing the weekly tasks.

Stage 4: Knowledge Construction

Knowledge construction was fostered through blog postings towards the end of the module presentation.
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by asking students to reflect upon their earlier postings, and consider how their views on key issues had changed. Through this, students were able to construct their own knowledge through the classical reflective model as supported by Kolb and Fry (1975).

Stage 5: Development

The development stage within this case study is demonstrated by some students continuing to use the blogging tool to reflect on their learning experiences after the formal evaluation of their blogs was completed. This demonstrates the view in the development stage that students start to find new uses for the technology.

REFLECTION ON THE STAGES OF ONLINE INTERACTION

Salmon’s (2000) model maps a student’s learning journey from initial introduction to the technology through to mature reflection on the experience and continued use of the technology after compulsory demands have ended. The journey broadly follows the anthropological phases experienced by a stranger entering a new cultural environment, defined by Hofstede (1991). Initially, the participant may experience a short period of excitement (or apprehension) at entering a new territory. This is followed by a period of disorientation as real-life starts in the new context. Acculturation then occurs as the participant learns to function in the new environment and finally a ‘stable state’ is reached (akin to Salmon’s development stage) where the participant can compare the new context against previous experiences.

In Salmon’s model, participants are encouraged to establish their presence in the online environment at an early stage. This contrasts to the way in which online initiatives develop within e-business. Cox, Perkins, and Green (2001) report that e-business maturity models start with ‘one-way’ communication between the company and customers, through, for example, the introduction of a static Web page. As experience with technology develops, asynchronous communication is sought (e.g., accepting online orders or customer queries). As customer and business confidence develops, synchronous communication is encouraged through collaborative systems. In e-business, access to information is first given before interaction from the customer is sought. This is akin to the initial stages adopted by a lecturer, first posting existing lecture notes before engaging in online interaction.

TOWARDS A DIMENSIONAL MODEL OF THE STAGES OF ONLINE LEARNING

During the learning process, the lecturer seeks to provide information, activities, and feedback to enable a student to progress through stages of cognitive development. In developing the learning activities, consideration is
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given to the cognitive styles and learning preferences of students to facilitate and encourage developments in the cognitive, affective, and psychomotor domains of learning.

Within an online learning environment, students (and lecturers) progress through stages of technology acceptance and confidence in using the technology. Prior experience (positive or negative) with ICT-based courseware or technology in general will influence the initial attitude to online learning. Lecturers may be motivated to engage with technology, anxious about their abilities to use it and sceptical of its usefulness or forced to conform to the use of technology. These attitudes will reflect the stages of confidence with which lecturers use the technology; for example, whether they adopt strategies of remediation or embrace the opportunities of the multimodal environment.

The perceptions that lecturers and students hold regarding online learning evolve through personal learning journeys, however, these journeys are rarely taken together. The experiences of ICT courseware which contribute to the formation of perceptions often take place simultaneously with different modules, lecturers, and cohorts. For example, a student may be critical about the restrained use of e-learning in a particular module following previous experience of a module which made extensive use of interactive multimedia resources.

Stages of online learning therefore consist of a number of interrelated dimensions, depicted in Figure 1. Looking down from the top of they pyramid, the dimensions form stages of:

1. Cognitive, affective, and psychomotor development within the subject domain.
2. Technology acceptance and confidence in using the technology by the student.
3. Technology acceptance and confidence in using the technology by the lecturer.

Together, the interplay between these dimensions inform the selection of learning methods to be used within an online environment, within the context of learning strategies, learning objectives, and learning styles.

FUTURE TRENDS

Developments in pervasive computing, mobile computing, and the ability for a single log on to enable access for all services across devices provide new challenges for lecturers and students. For example, students are now able to access online learning through personal digital assistants (PDAs) and mobile phones. Each new technology initiates new learning cycles through which lecturers and students must progress through issues of familiarity, acceptance, and competence.

The growing proliferation of wireless devices also provides opportunities for ubiquity and personalisation (Lu et al., 2004). Widening accessibility offers further challenges for gaining acceptance and confidence in the device, and then creating learning activities that can be used on a range of devices, to meet diverse student cognitive, technological, and affective learning needs. Such complexities of technology and issues of trust need to be added to the TAM model (Lu et al., 2004).

Context-sensitive computing offers opportunities to tailor learning to personal needs within the complexities of the model shown in Figure 1. Technological learner profiling is a promising avenue for enquiry (Evans & Sadler-Smith, 2006) to enable stages of learning to be adapted to situated learning contexts that comprise of multiple technological devices.

CONCLUSION

Traditionally, models of learning have followed the stages of cognitive progression through a subject from novice to expert. Within this cognitive progression there is recognition of the role of cognitive styles and learning preferences of the individual student (Sadler-Smith, Allinson, & Hayes, 2000) and of the potential impact of the cognitive styles and preferences of the instructor (Poon & Fatt, 1993). This requires issues of motivation and modes of learning to be considered. ICT adds further dimensions to the learning process. Attitudes towards the acceptance of technology and its perceived usefulness in learning impact the learning process and require further dimensions to be considered to encourage interaction within online environments. Positioned among these dimensions are the individual participants and lecturers with their own personalities, needs, and preferences which they adapt within the learning context. Online learning offers the
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opportunity to empower the individual learner, but to do so, an understanding of the individual needs to be established within the multiple dimensions of online learning environments. A more holistic appreciation of the learning context is needed to guide an individual’s learning journey through the multiple dimensions of the stages of online learning.

REFERENCES


**KEY TERMS**

**Asynchronous Communication:** Communication through a technology system (computer and communication network) which permit the sender and the receiver to be separated by time. This results in a delay between sending and responding to the communication. Examples of asynchronous communication systems include e-mail, online forums, and cell phone short message service (SMS) text messaging.

**Blog:** An online personal diary, usually hosted by a commercial service, which provides a simple user interface to make and amend postings. A development of blogs and ‘blogging’ is the ability for other people to comment upon the postings of the ‘blogger.’

**Context Sensitive Computing:** Access, delivery, and presentation of resources and content using communication technology adapted to situational and personalisation factors. The system tailors the selection of material to be presented to the student to meet the particular needs and preferences of the specific student and the device being used. For example, the
learning system recognises that a student is accessing the environment using a mobile phone rather than a computer. It selects material that is directly relevant to the specific student and to presentation via a mobile phone, rather than a computer (e.g., not presenting large documents).

**E-Moderator:** Someone who maintains an online learning environment for the benefit of participators. The e-moderator should be familiar with the capabilities of the learning environment, and may have additional privileges to participants, for example, the loading of learning material and learning objects and the creation and moderation of forums (i.e., deleting inappropriate postings and the enrolling/unenrolling of students).

**Managed Learning Environment:** A managed learning environment combines all of the aspects of a virtual learning environment with a management system to hold extended information about participants and e-moderators. A managed learning environment can contain student contact information, details about courses and modules which the student has enrolled on, and grades/awards achieved as well as course materials and asynchronous forums.

**Participator:** Someone who participates in online learning. The term participator prevents the categorisation of the person into a term such as student, trainee, or delegate, which some participants may feel uncomfortable with.

**Synchronous Communication:** The sender and receiver are using the communication device at the same time, enabling an immediate ‘conversational’ response to be given, as if they were in the same room at the same time. A telephone call is an example of synchronous communication system.

**Virtual Learning Environment (VLE):** A VLE is an environment which is accessed using Web based technologies, either across the Internet or a corporate Intranet. The learning environment typically provides areas for participants to engage in asynchronous communication, allow assessment of the students, and provide learning material in html or other Web technologies (such as Flash or Shockwave).
INTRODUCTION

Mention of transformative learning immediately reminds scholars and learners of its chief proponent, Jack Mezirow, who is Emeritus Professor of Adult and Continuing Education, Teachers College, Columbia University, Former Chairman, Department of Higher and Adult Education, and Director for Adult Education. It was Mezirow who popularized the theory of transformative learning in the early 1980s. Mezirow’s theory is such that individuals’ meaning perspectives are transformed through a process of construing and appropriating new or revised interpretations of the meaning of an experience as a guide to awareness, feeling, and action (Jarvis, 2002, p. 188). Later, scholars such as Cranton and King, expanded this theory of transformative learning by publishing two more books in this area. Cranton (1994) published a book titled Understanding and Promoting Transformative Learning. King (2005) published another titled Bringing Transformative Learning to Life. Both books, including Mezirow’s original books, have greatly enhanced the theory in the field of adult learning.

According to Wang (2004, 2007), Mezirow’s theory of transformative learning has been widely criticized for focusing too narrowly on individual transformation. However, this theory of transformative learning (Mezirow, 1978, 1990, 1991, 1997, 2000) has been widely applied to various groups of adult learners simply because this theory is capable of explaining how adult learners make sense or meaning of their experiences; hence perspective transformation, which is the heart and soul of this very popular theory in the field. Not only is this transformative learning popular in North America, it is also welcomed in Europe as it has been interpreted as the theory of reflectivity.

Over the years, multiple journal articles and international conferences have examined and critiqued transformative learning in an effort to further apply it in practice. However, little has been written regarding how scholars have turned to theory of transformative learning. Were there similar theories prior to its existence in the field of adult learning?

BACKGROUND

Another popular theory prior to the emergence of transformative learning was the theory of andragogy, which addresses how adults learn and how their instructors can better help them learn. Andragogy was first coined by a German grammar school teacher by the name of Alexander Kapp in 1833 and was later popularized by the father of adult education, Malcolm Knowles (1970, 1975) in the United States. Although a popular theory in the field, it is not without criticisms. One of the criticisms is that it fails to take into consideration social settings that adult learners are engaged in their learning (Wang & Bott, 2003-2004). Because of these criticisms, some scholars have turned to other theories. Mezirow took the initiative and launched the study of transformative learning in the 1980s. Thereafter, a provocative theory of transformative learning was advanced.

However, it must be pointed out that Mezirow based his theory on his interpretation of Habermasian critical theory and Marxist socialism (as cited in Wang, 2004-2005, p. 17). As scholars further probed the theory of transformative learning, it was discovered that transformative learning was contained in Confucian seminal humanism advanced 25 centuries ago (Wang & King, 2006, 2007). It was in the The Great Learning (Zhu, 1992) that Confucius addressed self-transformation in order for humans to realize not only the moral goodness and the cosmic creativity that embraces the universe in its entirety (Tu, 1979). Although such is the case, Mezirow never mentioned Confucius in his publications. It was Wang and King (2006, 2007) who made a bold comparison between Confucius and Mezirow. Thereafter, a connection between Mezirow’s theory of transformative learning and Confucianism was discovered. Both Confucianism and Mezirow’s theory of
Transformative learning strive to help learners achieve growth and development (Merriam, 2004). Growth and development of learners are explained differently by Confucius and Mezirow. To Confucius, this may mean authentic persons or sages and one’s sagehood may be realized via self-criticism or the rectification of the mind. To Confucius, learning could not occur without silent reflection (as cited in Wang & King, 2006, 2007). Without making any reference to Confucianism, Mezirow suggested that critical reflection is key in the theory of transformative learning. Mezirow was interested in fundamental change in perspective (or perspective transformation) that transforms the way that an adult understands and interacts with his or her world. Therefore, critical reflection or reflective thinking is the foundational activity that supports and cultivates such “perspective transformations” (as cited in Wang & King, 2006, 2007).

While both Confucius and Mezirow interpreted transformative learning from different angles, the goal is the same, that is, to help learners achieve growth and development in Merriam’s terms. As Wang and King (2006, 2007) note, “although Confucius was the first educator and/or philosopher to define reflection 25 centuries ago, Mezirow should be credited with categorizing three types of reflection and seven levels of reflectivity” (p. 261). Without Mezirow’s groundbreaking efforts, both adult educators and learners would find it hard to apply the theory of transformative learning to life. The next section will help readers better understand the theory of transformative learning.

THREE TYPES AND SEVEN LEVELS OF TRANSFORMATIVE LEARNING

Through extensive research, Mezirow identified three types of reflection: content reflection (i.e., an examination of the content or description of a problem); process reflection (i.e., checking on the problem-solving strategies); and premise reflection (i.e., questioning the problem). In other words, content reflection relates to “what,” process reflection relates to “how,” and premise reflection relates to “why.” Indeed, critical reflection cannot occur without learners asking questions using such words as “what,” “how,” and “why.” According to Mezirow, the three types of reflection help learners think reflectively upon their external situations. How about one’s inner experience as addressed by Confucius 25 centuries ago? Mezirow put forward seven levels of reflectivity that focus and explain learners’ inner experiences. As noted by Jarvis (1987, p. 91), the seven levels of reflectivity include:

1. **Reflectivity**: An awareness of a specific perception, meaning, behavior, or habit
2. **Affective reflectivity**: Awareness of how the individual feels about what is being perceived, thought, or acted upon
3. **Discriminant reflectivity**: The assessment of the efficacy of perception, thought, action, or habit
4. **Judgmental reflectivity**: Making and becoming aware of value judgments about perception, thought, action, or habit
5. **Conceptual reflectivity**: Self-reflection which might lead to questioning of whether good, bad, or adequate concepts were employed for understanding or judgment
6. **Psychic reflectivity**: Recognition of the habit of making percipient judgments on the basis of limited information
7. **Theoretical reflectivity**: Awareness that the habit for percipient judgment or for conceptual inadequacy lies in a set of taken-for-granted cultural or psychological assumptions which explain personal experience less satisfactorily than another perspective with more functional criteria for seeing, thinking, or acting

A closer examination of Mezirow’s seven levels of reflectivity implies reflection involves only affective and cognitive aspects. On the other hand, Confucius’s silent reflection involves the whole person. It seems that Confucius’s silent reflection is even closer to the three commonly accepted objectives of learning: learning results in change in cognitive domain, affective domain, and psychomotor domain. Yet, Mezirow’s perspective transformation is even more important in the field of adult learning simply because perspective transformation may lead to further change in one’s cognitive domain, affective domain, and psychomotor domain. This is probably why people say “change your thought and you change your world.” It is obvious such a saying is closely related to Mezirow’s perspective transformation. Perspective transformation is a prerequisite for change in other domains as a result of learning on the part of the learners.
CONCLUSION

The theory of transformative learning is such an important development in the field of adult learning. One may ask, “Is it better than the theory of andragogy?” No single theory is the best theory in the field of adult learning. As one theory fails to guide one’s action in the field, an alternative theory should be sought. Upon this basis of thinking, the theory of transformative learning does bring synergy to the field of adult learning.

To better understand the theory of andragogy, one has to make the distinction between the education of adults (andragogy) and the education of children. To understand and apply the theory of transformative learning, one does not need to make such a distinction because such a theory applies to both children and adults. Teachers are charged with the responsibility of teaching students “critical thinking skills.” Critical thinking would not be possible without critical reflection. These two are so intertwined that one cannot occur without the other. Therefore, it is safe to claim, “Like the theory of andragogy, the theory of transformative learning is such a useful and powerful theory that it helps learners achieve growth and development.” More importantly, the theory of transformative learning leads to the possibility of creating new knowledge and skills via critical reflection. Therefore, the value of such a theory is self-explanatory.

REFERENCES


KEY TERMS

Confucius: Confucius (551 – 479 BC), Chinese “Master Kong,” but most frequently referred to as Kongzi, was a famous Chinese thinker and social philosopher, whose teachings and philosophy have deeply influenced East Asian life and thought. His philosophy emphasized personal and governmental morality, correctness of social relationships, justice, and sincerity. These values gained prominence in China over other doctrines, such as Legalism or Daoism during the Han Dynasty. Confucius’s thoughts have been developed into a system of philosophy known as Confucianism. His teachings are known primarily through the Analects of Confucius, a collection of “brief aphoristic fragments,” which was compiled many years after his death. Modern historians do not believe that any specific documents can be said to have been written by Confucius, but for nearly 2,000 years he was thought to be the editor or author of all the Five Classics such as the Classic of Rites (editor), and the Spring and Autumn Annals (author). From his books, one can tell that Confucius launched the theory of transformative learning 25 centuries ago in China. He taught his followers to be authentic human beings and he emphasized “silent reflection” and “the rectification of the mind,” and “one’s inner experience.” These concepts are closely related to Mezirow’s “critical reflection” in the theory of transformative learning.

Jack Mezirow: He was professor of adult education and former chairman in Teacher’s College, Columbia University in New York. He is the major exponent of transformative learning theory. His extensive research involved 83 women returning to community colleges. His theory was based upon Habermasian critical theory and Freire’s interpretation of Marxist socialism. The theory of transformative learning is considered an important development of adult education theory. Mezirow’s research sparked subsequent research in this area and he still continues to write articles and books in an effort to expand and popularize this theory.

Knowles: Malcolm Knowles (1913-1997) is considered by many the father of adult education. He was an American adult educator who had popularized andragogy by publishing numerous journal articles and books. He was also executive director of the Adult Education Association of the United States of America, and thereafter a professor of adult education for several universities. He died at the University of Arkansas, Fayetteville where he was a professor of adult education. Knowles is one of the most frequently quoted authors in the field of adult education.

Marx: Karl Heinrich Marx (1818-1883) was a German philosopher, political economist, and revolutionary. Marx addressed a wide range of issues; he is most famous for his analysis of history, summed up in the opening line of the introduction to the Communist Manifesto: “The history of all hitherto existing society is the history of class struggles.” Marx believed that the downfall of capitalism was inevitable, and that it would be replaced by communism. Marx has a big following in communist countries such as the former Soviet Union, China, Cuba, North Korea, and Vietnam. As most countries have turned a market economy, his influence has dwindled to a certain extent. As a scholar, Marx has influenced learners. His socialism has inspired Jack Mezirow who successfully advanced the theory of transformative learning.

Sagehood: Sagehood is defined as striving to become a genuine human being who through self-transformation, a kind of inner illumination, realizes not only the moral goodness that is intrinsic to human nature but also the cosmic creativity that embraces the universe in its entirety (Tu, 1979). In this journey, the “rectification of the mind” is a crucial step to extending knowledge of the self (Confucius, 500BCEc). The rectification of the mind is the phrase used to refer to the meditative practice that cultivates and furthers the devotee’s pursuit of self-control and integration with nature. Based on the philosophy and teachings of The Great Learning, self-directed learning is the primary adult learning method used in the quest to become fully human or a sage.
**Transformative Learning**

**Transformation:** Transformation refers to pervasive forms of development that occur in every culture as an aspect of every rite of passage in the grand movements from one social paradigm to the next. All transformations have a beginning, a middle, and an end. There are conditions that support changes, processes that initiate them, and ones that complete the changes. Typically, a transformation is considered irreversible, although there are conditions that drive a situation back to an earlier form. Transformation is a possibility in the mind of every social revolution and the awakening of consciousness that gives meaning to life for many people.

**Transformative Learning:** It often refers to the theory of reflectivity as it is currently used in Europe. The key concept in transformative learning is critical reflection. According to its chief proponent, Jack Mezirow, individuals’ meaning perspectives are transformed through a process of construing and appropriating new or revised interpretations of the meaning of an experience as a guide to awareness, feeling, and action. Transformative learning can simply be explained as learners making sense or meaning of their experiences. Both inner experience and external situations are important to critical reflection. However, the chief proponent of this theory was primarily interested in perspective transformation, which may lead to change in cognitive domain, affective domain, and psychomotor domain of learning. Transformative learning became popular in North America since its inception in the early 1980s. More and more universities in North America offer a course in this area. It is said that the theory has been applied to various groups of learners although it has been criticized for lack of social attention. Transformative learning was later expanded by scholars such as Patricia Cranton in Canada and Kathleen P. King in the United States. Finally, Wang and King (2006, 2007) made a connection between Mezirow’s transformative learning and Confucianism by publishing a journal article and a book chapter. Despite criticisms, the theory of transformative learning has remained a useful and powerful theory in the field of adult learning and it does help explain how learners achieve perspective transformation via its three types and seven levels of reflectivity. The three types and seven levels of reflectivity do not deviate very far from Confucianism, which emphasizes silent reflection and the rectification of the mind in order to reach sagehood.
Understanding Computer Security

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INTRODUCTION

During the last several years a great deal has been written in academic and trade journals that has focused on security. There are several different terms often used, but the following—information security (InfoSec), computer security, and information assurance—are typically meant to be the same, that is, the protection of data, although information assurance is also expanded to include aspects such as personnel, plant, and equipment. While one main theme that has been written has been to improve the effectiveness and understanding of security, apply the various security concepts learned and understand the technologies developed, it is important to recognize that computer security may take on different meanings, dependent on the context that it is being discussed.

Computer security is a very large field, and one that is often misunderstood. When we discuss computer security, are we discussing our personal computer at work or home? Are we discussing portable devices, such as mobile devices like Blackberries, PDAs, or laptops? Are we discussing security laws and regulations that might impact the safeguard of personal information, or could we be discussing, designing, and implementing, a risk-based security plan for an organization?

It is therefore difficult to discuss computer security unless it is discussed in a frame of reference. Therefore, this paper will discuss some of the issues and concerns of computer security in different frames of reference, and the importance of teaching security with that focus in mind.

BACKGROUND

The term computer security was first used as a discipline in the early 1970s. While previous studies existed before that time, they were more practical, and it was not until the 1970s that it was introduced as an educational tool. Bell and LaPadula (1973) introduced the idea of a framework of a secure computer system. This model which was abstract in nature led to the development of other security models such as the protection analysis project which was designed to detect vulnerabilities in operating system software (Bisbey & Hollingworth, 1978). The results of these earlier studies and models led to the U.S. Department of Defense (1985) publishing the Trusted Computer System Evaluation Criteria (TCSEC), which were normally known in the industry by the color of the book, for example, the orange book. This model classified systems into four broad hierarchical divisions, each of enhancing security. The orange book provided a benchmark to gauge other systems.

These earlier models started in the 1970s have led the way to many models and theories on some of the best ways to protect computer systems, and in teaching computer security, a historical perspective is very important. To begin to understand computer security, one must understand its definition. Scholars and researchers have proposed several definitions of computer security, the Alliance for Telecommunications Industry Solutions (ATIS) Committee T1A1 (2001) defines it as:

1. Measures and controls that ensure confidentiality, integrity, and availability of information-system (IS) assets including hardware, software, firmware, and information being processed, stored, and communicated. Synonym automated information systems security.
2. The application of hardware, firmware, and software security features to a computer system in order to protect against, or prevent, the unauthorized disclosure, manipulation, deletion of information, or denial of service.
3. The protection resulting from all measures to deny unauthorized access and exploitation of friendly computer systems (p. 1).

In discussing computer security, it is important that the discussion is focused in the context. In discussing data privacy it is important to discuss privacy in some context; for example, if we are discussing transporting data safely, then we might discuss encryption, if the
discussion is on penalties for data disclosure, in that case, we might be discussing legislation. Therefore, it is important to look at some of the leading frames of reference surrounding computer security.

**Home Computer Security**

Securing a home computing environment starts with awareness. Individuals must be aware that they have very valuable pieces of information contained on their computer system that is attractive to criminals. Personal data, such as credit card numbers, passwords, and bank information, are just some of the areas where intruders seek to gain access. Individuals must also be aware that innocent looking e-mails and requests for personal information are simply phishing attempts, and that computer users should not give out personal information just for the asking. Further, people are creatures of habit, and it is quite common that the password we use for one account is the same password we use for multiple accounts. If an intruder was able to secure that password, and identify sites you have visited, which is not hard due to computer cookies, they would have access to a number of your accounts. Criminals also look at the computer itself as a resource; many hackers will use someone else’s computer as a jumping off point, and conduct their illegal activities from the target host.

There are some guidelines that could help a computer user secure their system more. Carnegie Mellon (2002) University’s Computer Emergency Response Team (CERT, 2002) offers some valuable training tips on securing a home computer environment, which include:

1. Install and use anti-virus programs.
2. Keep your system patched.
3. Use care when reading e-mail with attachments.
4. Install and use a firewall program.
5. Make backups of important files and folders.
6. Use strong passwords.
7. Use care when downloading and installing programs.
8. Install and use a hardware firewall.
9. Install and use a file encryption program and access controls (para 31).

In teaching home security concepts, it is important to understand that not all individuals are capable of understanding the complexities of using technology, for example, item nine, using an encryption program. It is more important to make the home computer user aware that such technologies exist, what they can be used for, and how they help to secure an environment. While users may not implement all nine items as suggested by CERT, they may implement some, thereby reducing their exposure to potentially troublesome viruses and hackers, and when they become more proficient expand on the additional countermeasures.

**Wireless Security**

Many individuals, who are worried about the security of their work or home computers, are less concerned when they are using their laptops and connecting to the Internet wirelessly. Again, this may come simply from a lack of awareness, and not realizing the dangers that are posed when using wireless technology. It is reported that while attackers are using sophisticated attacks to uncover information, humans are often more fooled by the simpler attacks, and at times even ignore warnings from their own security software loaded on the personal computer (Cranor, 2006).

In a typical land-based network environment, a computer has to physically be plugged into an outlet, for example, a CAT5 Ethernet outlet, but in a wireless environment, a system can connect to any wireless access point it receives a signal from. These so-called hot-spots allow wireless communications to take place. There are no national standards on these hot-spots. In some cases users are charged a fee and use specific authentication methods, and in other places, there are no charges and no authorization mechanisms in place.

In wireless security attacks, it is important to understand the importance of the seven-layer open systems interconnect (OSI) model which describes different layers and functions of computer communications, access, and the flow of data packets. The first layer is the physical layer, where security attacks usually happen, and is also the most susceptible and easiest for attackers. The most common form of attack is a rogue access point, where an attacker actually offers a signal from their own access point that allows Internet connectivity. It convinces the wireless client to use this access point, and once that client is attached to that access point, an
attacker has a multiple of options, for example, faking DNS information, presenting fake Web sites, such as financial and major portals, and at this time attempts to steal as much personal information from the user on that client (Potter, 2006).

Another term often used is war-driving, where a perpetrator drives around in an automobile and using a simple device like a laptop attempts to piggyback on unsuspecting users wireless network access point, that they have left open and unsecured. There are Web sites that actually show the local geographical area where wireless access points are open and unsecured, and others can access these open wireless connections.

Wireless communication protocols have tried to secure its signal, for example, in 1999 the protocol Wired Equivalent Privacy (WEP) attempted to provide security in the same way that wired networks achieve. However, WEP was found to be ineffective, even against novice attackers (Potter, 2006). Newer security protocols developed by the IEEE, for example, 802.11i, consist of a suite of three different security protocols which enhance authentication and confidentiality.

Protection of Personal Data

One of the leading concerns today is the safeguard of personal data. In corporate America, it is the duty of company officials to safeguard personal data from threats. There are legal and cost issues involved with the protection of electronic data, and potentially bad public relations issues that follow when customer data is stolen. It becomes worse if it is found out that the company did very little to protect that data, or they knew about the breach but kept it hidden.

In discussing security from a cost perspective, how much money should companies allocate to protect electronic data? Surprisingly, even though security breaches are common, very little is known about the budgeting process for information security (Gordon & Loeb, 2006). When discussing security from a cost perspective, again we could be discussing a host of items, for example, hardware, software, personnel, buildings, and so forth. When we discuss security as a business function, we must discuss security in terms of the return on investment. Many organizations use a risk-based net present value approach. An estimation of risk adjusted discounted dollar value with the expected costs of actual losses. However, while companies can estimate the expected losses with some degree of accuracy, companies cannot easily estimate the expected benefits since this according Gordon and Loeb (2006) would require “users to have information on potential losses from security breaches and the probability of such breaches (p. 122). These researchers do suggest that a net present value approach can work just as long as “the monetary value of the anticipated incremental benefits exceeds the incremental expenditures, additional expenditures would be warranted” (p. 122). Therefore, in discussing protection of data, companies need to understand and utilize some form of cost modeling approach and how to allocate dollars with both the risks and benefits justified.

In discussing security from a legal perspective, we need to understand court rulings and legal precedents. In a legal opinion written by Arizona’s state bar, it was mandated that a law firm must take competent and reasonable steps to safeguard client information (Comerford, 2006). One may argue what are the reasonable steps, that is, how many lawyers have technology expertise? Therefore, Arizona’s state bar requires attorneys who are not knowledgeable to hire outside expert consultants. Moreover, since client information is protected by attorney-client privilege, this information must be protected and cannot be waived due to negligent handling of personal data in electronic form. The fact that a state’s bar has issued this ruling, might lead to other state bars issuing similar rulings, and could become mandated legislation in the future. Therefore, in discussing the protection of data, it is important for organizations to examine current and proposed legislation from the state and federal levels.

Workplace Privacy

While employees expect the organization to protect his or her personal data, is the same expectations expected of their viewing habits? Is the protection of personal data and employee monitoring data separate things? What are employees’ expectations of privacy?

Do employees expect that their phone and e-mail correspondence to remain private to them, but other types of data, for example, age, race, social security numbers, be available to their employer, but in no instance should outsiders see any of this information? Electronic data, whether stored in a database, e-mail server, or phone log, is digital data that can be saved, examined, and analyzed.
Employees believe that they have a right to privacy protected by the Constitution, even at work. Unfortunately, courts have upheld that employers have the right to monitor employees workplace habits, and the U.S. Constitution’s Fourth Amendment rights from unreasonable search and seizure only applies to state-sponsored actions, not of private workplace, and therefore privacy is not protected (Nord, Tipton, & Nord, 2006). Because of these rulings, employers have not shown any reluctance to monitor and record their employee’s electronic conversations, and more than three quarters of U.S. firm’s record employee’s e-mails, phone conversations, Internet surfing habits, and what is stored on his or her computer (Downs, 2006). Employers may simply be doing this to avoid legal liability issues. In 2001, 10% of companies received subpoenas stemming from employee e-mail, and 8% of U.S. firms have had legal trouble with sexual harassment or sexual discrimination claims, which again stemmed from employees’ e-mails or Internet use (Nord, Tipton, & Nord, 2006).

Even U.S. federal judges are not immune from monitoring. The 9th U.S. Circuit Court of Appeals in San Francisco found out that their own e-mails and Internet Web use was being monitored, and subsequently ordered staff to remove the monitoring software. Their request was turned down by the Committee on Automation and Technology of the U.S. Judicial Conference which stated, “Federal employees—including judges—should continue to be monitored for Internet misuse and should be blocked from such activities as downloading music” (Crimmins, 2001, p. 1).

This situation and that of many others around the country is not so much monitoring, as it is the employee’s lack of awareness of such monitoring. The judges’ argument was that they were not told of such surveillance, and that this action was improper and illegal. Therefore, employee monitoring is most likely to continue, and organizations should protect themselves from legal action by notifying employees that such monitoring is being conducted.

**TEACHING COMPUTER SECURITY**

In many universities’ curriculum, information security was first introduced at the Master’s level. It was originally designed around working individuals who had practical experience in the field, but as demand grew for information system professionals, it became more commonplace in the Bachelor’s programs. As demand for security professionals continues to grow, universities are creating separate curricula for information security education (Surendran, Kim, & Harris, 2002). As the Internet grows, so will e-commerce, and given the amounts of money involved in e-commerce transaction models, for example, business-to-business (B2B), consumer-to-business (C2B), business-to-consumer (B2C), and so forth, the rise in attacks against e-commerce sites will continue to rapidly increase. It is therefore important that security curricula include a thorough understanding of e-commerce attacks, countermeasures, and its technical and non-technical nature (Kim, Han, Kim, & Choi, 2005).

Part of teaching computer security is social responsibility, for example, teaching in a course room about computer security would entail teaching about tools that are used to investigate computer crimes, but these same tools can be used for ethical and unethical use (Sander, 2003). Being a security expert means that the individual is entrusted with the tools and techniques of computer security and therefore must abide by some ethical standards, otherwise they become no better than those they are trying to protect against. It is important that in teaching computer security, for example, hacking techniques, lectures discuss ethical consequences of individuals’ actions. There are even several courses taught by educational centers and certifications that cover the ethical hacker. It is important to understand that while there is a technical side to security, it cannot simply be taught as a technical skill. It must encompass elements of human nature, and why certain individuals commit illegal activities. While it is easy to spot if an employee has unauthorized software on his or her computer, it is another thing to know why. Information security has to deal with people, not just bits of data.

Computer security presents other challenges as this field is changing rapidly. As suggested earlier, teaching computer security is dependent on its frame of reference. Therefore, some researchers such as Baker (2003) recommend a learning log approach. An instructor would dictate a range of topics, and each student would be tasked with one topic and become the expert on the subject material. Instead of simply reporting on a topic at the end of the time period, a learning log is created, and reveals the learning, insights, and how the student has experienced understanding this topic. This learning log is a document that changes as the topic is
researched, and gives the professor a way to probe the student for more insights into the research they have done, the questions they have asked, and maybe the people they have interviewed. Other models also exist in teaching computer security. Hsu and Backhouse (2002) have suggested that situated learning strategy may be a good model to teach information security. They argue that it is the learning environment that is key to successful teaching strategies. The main concept is to challenge the belief that a separation of knowing and doing was in place. The inability to apply teaching techniques in a real-world setting was a consequence of this separation problem. It was the opposite approach that Harley (1993) advocated that teachers should replace rigid instruction with social interaction, collaboration, and real-world events as individuals would find in a real-world setting. Hsu and Backhouse (2002) argue that because of the nature of technology and the speed of change that educators must go beyond normal textbooks and help students understand, assimilate, and apply learning concepts. These types of training models may become very valuable in the future in a very dynamic field.

CONCLUSION

This paper reported on the concept of computer security, its beginnings, and some major findings in the field. As suggested, computer security is a very large and dynamic field that undergoes constant change, and in order to understand computer security, one must discuss the concept relevant to some unique classification, such as ethics. Moreover, teaching computer security also presents some unique challenges since individuals, even with practical experience and advanced degrees, would find it hard to be an expert in all classifications of the field. Further, it is important to expand on the social issues, the impact of human behavior, trying to understand why criminals act in the way they do to commit their activities. This may help to understand why computer security is important, and why certain and often strong security steps are necessary.

REFERENCES


Understanding Computer Security


KEY TERMS

Computer Security: An information technology definition term often referred to by several names, for example, information security (InfoSec), computer security, and information assurance. It includes the protection of personal and organization assets, which includes hardware and software. It includes the data that is stored on systems and the data in transit. It also includes management processes, procedures, and policies that are developed to protect these resources, for example, a disaster recover plan, a business continuity plan, and so forth.

Identify Theft: An activity where a perpetrator uses someone else’s personal information without their permission for financial gain. Examples could be credit card and mortgage fraud, where credit is issued to the perpetrator based upon the financial rating of the victim. Perpetrators steal identities in numerous ways: e-mails, key loggers, impersonations, phone calls, and stealing trash from an individual’s home.

Information Systems Curriculum: An information systems curriculum is a model curriculum consisting of a fundamental body of knowledge in the information systems area. It is a consensus of the information system community of scholars, researchers, and practitioners who lead the field. It consists of the five majors areas in IS, namely: information systems fundamentals, information systems theory and practice, information technology, information systems development, and information systems deployment and management processes.

Phishing: An activity based upon social engineering, where perpetuators or phishers attempt to exploit the trustworthiness of individuals to reveal personal information, such as user name, passwords, credit card numbers, banking information, and so forth. Communications are attempted by several means—e-mail, phone, letters—but most often carried out by e-mail due to the ease and relative ease in which phishers can obtain mailing lists with thousands of e-mail addresses. Phishing techniques are varied and often very business looking stating that your financial institution needs you to update your records immediately or your account will be locked. Phishers do not really know your banking institution, but after they send out 10,000 e-mails, the chances are good that some of those e-mail addresses actually conduct business with the named institution in the e-mail. It is the unsuspected individual who does not identify this as such, and instead of calling his or her financial institution, offers their valuable information, often at a Web site that looks identical to their main institution.

Security Model: A security model is a framework in which a security policy is developed. The development of this security policy is geared to a particular setting or instance of a policy, for example, a security policy based upon authentication, but built within the confines of a security model. For example, designing a security model based upon authentication and authorization, one would consider the 4-factor model of security, that is, authentication, authorization, availability, and authenticity.

Social Engineering: An activity that is conducted by perpetrators on individuals in the hopes of gaining some personal information, such as credit card numbers, banking information, user names, passwords, and so forth. Social engineering can take the form of e-mails, mail, and phone calls. The authors of social engineering activities exploit individuals willing to trust, often with bad consequences. It often relies on non-technical means and involves tricking individuals to give up personal information. Social engineering perpetrators often rely on the goodness and natural tendency of people to help others.
Trusted Computer System Evaluation Criteria (TCSEC): The Trusted Computer System Evaluation Criteria (TCSEC) was issued by the U.S. Department of Defense (1985) directive DoD 5200.28-STD in December 1985. It was one of the first models to evaluate information systems in increasing terms of security. Its main goal was to provide hardware and software criteria and evaluation methodologies. It was contained in a set of documents called the rainbow series, and widely referred to by the color of the document, for example, the orange book.
The Use of Technology in Urban Populations: Issues, Trends, and Discussions for Schools

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INTRODUCTION

The introduction of microcomputers into classrooms during the 1980s was heralded by many as the dawn of a new era in American education. Proponents argued that technology had the potential to fundamentally transform the nature of teaching and learning (Papert, 1980; U.S. Congress, Office of Technology Assessment, 1988). However, over time, it has become apparent that it is far easier to acquire hardware, software, and Internet access (Becker, 1991; Dividing lines, 2001) than it is to capture the potential of technology in significantly meaningful outcomes (Cuban, 2001). Likewise, educators concerned about the chronic underachievement of urban learners often fall prey to the allure of technology as a tool for reversing the historical influences of poverty, discrimination, inequity, chronic underachievement, and lack of opportunity. However, 25 years after the introduction of the computer into the classroom, many of the expectations associated with technology in education remain unrealized. In this article, we discuss new technological horizons for urban learners, and highlight issues relating to the socioeconomic trends of technology in schools. In addition, we provide specific examples of technology interventions that can be implemented to engage urban students in meaningful learning activities.

The Socioeconomics of Technology in the Urban Environment

Within the past decade, a growing body of evidence supports the ever-widening technological gap among members of society, in particular children and the elderly (NTIA, 1995, 1997, 1999), in particular, urban school environments with the inner cities. This “Digital Divide” has become a leading economic and civil rights issue. The Digital Divide is referred to as a social/political issue encompassing the socioeconomic gap between communities that have access to computers, the Internet, and other information-technology-related services and those who do not. The term also refers to gaps that exist between groups regarding their ability to use ICTs (information and communications technologies) effectively, and the gap between those groups in urban environments that have access to quality, useful digital content and those that do not. Disparities in computer and information technology use can be found among individuals in rural and urban locations, with the division drawn upon socioeconomic lines. This trend indicates that those who have the means only become more information rich, while those who are poor and of the working class, mostly those in the inner city/urban environments, are lagging even further behind. The groups identified who lack access to information and technological resources include minorities, specifically African American and Hispanic Americans; those who are poor and of the working class; individuals of low income; those who possess less than a high school level of education; children of single parents; residents of inner cities and rural areas; and the elderly (NTIA, 1995, 1997, 1999). Despite, the current literature on this issue and the efforts of state and local government agencies, the current literature indicates that outside of a person’s workplace, educational institutions are the second most frequent place where individuals have access to the Internet. Since many in society do not have adequate knowledge of technology to pass on to their society, community, or children, educational institutions will serve as the catalyst for preparing America’s community for the age of technology. Since urban educational institutions are important for information and technology literacy and access, the federal government has arranged for funds to aid America’s urban schools in purchasing technology infrastructure and professional developments. Educators, community
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development personnel, and technologists should be aware of the government initiative to help bridge the information and technological divide.

Since, the National Telecommunications and Information Administration (NTIA) in the U.S. Department of Commerce has released five reports examining this problem, all under the heading “Falling Through the Net” (NTIA, 1995, 1997, 1999, 2000). Each study has reached the same glaring conclusion: the digitally divided are becoming more divided. For example, in their most recent report, the NTIA (1999) writes:

Excerpts from 1999 NTIA report include the following information that reveals the disparity in the information, communication, and technology access and utilization:

- **Income:** Households with incomes of $75,000 and higher are more than 9 times as likely to have a computer at home, and more than 20 times more likely to have access to the Internet than those with incomes of $50,000 or less, which is prevalent in the inner city. Between 1997 and 1998, the Digital Divide between those at the highest and lowest education levels increased 25%.

- **Education:** The percentage-point difference between those with a college education or better, when compared to those with an elementary school education, is as high as 63% for computer penetration, and 45% for Internet penetration. Between 1997 and 1998, the Digital Divide between those at the highest and lowest education levels increased 2%.

- **Race:** African Americans and Hispanic households are approximately one-half as likely as households of Asian/Pacific Islander descent, as well as White households, to have a home computer, and approximately one-third as likely as households of Asian/Pacific Islander descent, and roughly two-fifths as likely as White households, to have home Internet access. The gaps between White and Hispanic households, and between White and African American households, are larger than 23 percentage points (computers) and 13 percentage points (Internet), which is more than 6 percentage points (computers) and 10 percentage points (Internet) larger than they were in 1994.

- **Income and race:** For households earning between $35,000 and $74,999, 40.2% of African Americans and 36.8% of Hispanics owned a computer, compared to 55.1% of Whites, while for households earning between $15,000 and $34,999, 7.9% of African Americans and 7.6% of Hispanics had Internet access, compared to 17% of Whites. A similar pattern emerges in each income category. What has been discovered is that minorities in the urban inner cities are lagging behind non-minorities even at the same level of income.

Clearly, according to a variety of demographic indicators, income, education, race, and more, there are significant disparities in the ability of Americans to access and use modern technologies. However, regardless of the social, economic, or racial characteristics one attributes to the Digital Divide, it is clear that there are two distinct groups that have emerged as a result of the information age: those who have the ability to access information and technology at will and those who do not have the means, access, or support to acquire and utilize information and technology. By defining the Digital Divide in these terms, one should draw attention away from the mere concepts of technology infrastructure and training and move towards a more holistic conceptualization that looks at how new technologies can serve to empower individuals, families, and communities. The biggest impact of this divide has been identified in low-income urban areas where schools and the community have been affected.

Adoption and Use of Technology in Urban Schools

Left undefined, the term “technology” is often synonymous with “computers.” Indeed, most discussions of educational technology focus on computers. However, in this paper, we use the term technology to describe and include a large arena of classroom possibilities including hardware like computers, peripheral such
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as printers, projection devices, video cameras, and networks; software, such as CD-ROMs, and DVDs; Internet-based resources like Web sites, streaming video, and Web authoring tools; as well as stand-alone tools like personal digital appliances (PDAs), MP3 players, and IPODs. It is important to utilize an all-inclusive definition of technology in order to understand the array of possibilities an educator may use to enables the urban learners to achieve high academic standards.

Defining the Urban Learner

Within the past decade, the restructuring of the educational learning environment has produced a growing emphasis on a type of learner that is different from those characterized by society. These learners have been characterized as the urban learner. The urban learner is described as a student being an active participant in an urban educational and learning environment. The urban learner includes such racial minorities as Native Americans, African Americans, Mexican Americans, Puerto Ricans, and a substantial number of poor Whites (Martin, 1975). Data is now available to the public to provide a glimpse into this environment, particularly in such areas as the inner city. Within in this context, the urban learner remains a difficult concept to define and understand. Related to the discussion of the urban learner is the context of socially related problems including poverty, structural and institutional racism, class, and gender bias (Obiakor & Beachum, 2005). With regards to the structural education environment for the urban learner, these students tend to fall behind socially, developmentally, economically, and academically (Obiakor & Beachum, 2005). Further, urban students bring fewer traditional resources (e.g., they have less-educated parents, more poverty, and poorer health) to the school setting, and this can ultimately hinder their educational future. When one takes a look into the urban learners learning environment, we see an environment that has been poorly funded, poorly equipped, and poorly staffed. It is not surprising that the urban learner in this environment lacks the resources to forge ahead socially and academically. Understanding urban learners and engaging in productive urban school reform calls for an analysis of the urban learner, including their families, schools, and environments. What hope does this person have for the future; what can be done to help spearhead change in this environment, giving the urban learner hope for the future; the promise lies in educational technology interventions.

Urban Education Academic Underachievement

The educational and academic underachievement of students in urban schools is well documented (Council of Great City Schools, 2004; Johnson, 2002; Olson & Gerald, 1998). The typical scenario, as described by the Council of Great City Schools, is that achievement for many underperforming students (ethnically diverse students, students with disabilities, students whose first language is not English) reveals that this is a great concern for underachievement. This concern over persistent underachievement is one of the tenets of the No Child Left Behind Act (http://www.ed.gov/nclb/). Essentially, each school, district, and state must report annually on the achievement of its students. In the past, aggregate scores masked the persistent low achievement of some groups of students. As a result, the new law requires that scores be disaggregated to show the achievement of four specific groups: economic background, race and ethnicity, English proficiency, and disability. This mandate has brought increased attention to the issue of underachievement, given other provisions in the law that triggers sanctions for consecutive failure to achieve adequate progress of the students. As a result, this legislation has important implications for the use of technology in schools. Indeed, while much of the literature in the 1980s and 1990s focused on technology as an object of study (International Society for Technology in Education, 2004), in the 21st century, attention has been shifted to harnessing the potential of technology to enhance student learning in the teaching and learning process.

Adoption of Technology in Urban Schools

Despite the constraints on school funding in most states, schools have devoted an increasing percentage of their annual budgets to technology. The majority of the efforts of the educational community over the past decade to acquire hardware, software, and Internet access have been successful (Dividing Lines, 2001; Education Week, 2004). However, clear evidence of a digital divide, parallel to historical disparities, continues to distinguish urban schools from their affluent counterparts (Chen & Thielemann, 2001; Guttentag &
The Use of Technology in Urban Populations

Historical measures of digital equity have been based on the ratio of the number of computers divided by the number of students. A more recent measure involves determining levels of Internet access. Another dimension of this problem relates to questions about differences in home access to technology, therefore, impacting urban student achievement associated with homework.

Finally, educational reform programs such as the No Child Left Behind Act of 2001, have focused on accountability and high-stakes testing. The renewed importance of test scores will fundamentally alter the attention and activities of low-achieving schools as they seek to achieve the required benchmark scores. As a result, it was anticipated that previous technology buying sprees would be redirected. One approach to this redirection is that there is new emphasis placed on technology initiatives that enhance schools’ assessment and early intervention efforts (Education Week, 2003) that feature learning activities with instructional objectives and record keeping.

Use of Technology in Urban Schools

In contrast to the indicators that profile the acquisition of technology, less information is typically available to reflect progress toward implementing technology applications that enhance the teaching and learning process (CEO Forum, 1997; NTIA, 1995, 1997, 1999, 2000; 2002). It is rather a task of ease to promote and profile computer-to-student ratios in school reform experiments with little regard to how technology is used in the urban classroom (Brainbridge, Lasley, & Sundre, 2004; Guttentag & Eilers, 2004). The use of technology in the classroom has moved through definable periods involving programming, computer-assisted instruction, problem-solving environments, personal productivity, Web-based instruction, and hypermedia. Problems associated with limited opportunities for teacher professional development to learn about new innovations (Lonergan, 2001), as well as limited funds for new hardware and software, often result in the routine use of student learning activities that have been abandoned by high-performing schools (Burnett, 1994).

As a result, it is essential that questions be raised about the nature of technology learning activities in urban schools when expectations are held that technology is used to enhance academic achievement. While looking into the use of technology in the urban school environment, it has been noted that the use of these tools does not reflect innovative uses in integration into the curriculum for active student learning, engagement, or to enhance the teaching process. Typically, urban schools have antiquated resources and inadequate technological support for the use of technology in classroom.

Implementing Technology in Urban Schools

One of the major concerns for urban teachers when integrating educational technology in the classroom is the identification of appropriate principles that help achieve high student learning outcomes. Recent research synthesis efforts by the Center for Applied Research in Educational Technology (2006), the International Society for Technology in Education (2003), and Robyer (2006) provide principles for appropriate ways to use education technology in urban schools as supported by the education technology research. The following sections highlight selected principles and their implications for classroom application.

Educational Technology Can Influence Student Academic Performance

Recent research in educational technology (Boster, Meyer, Roberto, & Inge, 2002; Bracewell & Laferriere, 1996; Coley, Cradler, & Engel, 1997; Cradler & Cradler, 1999; Koedinger & Anderson, 1999; Kulik, 2003; White & Frederiksen, 1998) has shown that the effective use of educational technology occurs when the application directly (a) supports the curriculum objectives being assessed; (b) provides opportunities for student collaboration and project/inquiry-based learning; (c) adjusts for student ability and prior experience, and provides feedback to the student and teacher about student performance; (d) is integrated throughout the lesson; (e) provides opportunities for students to design and implement projects that extend the curriculum content being assessed; and (f) is used in environments where the organization leadership supports technological innovation.

Some examples of the strategies that have proved successful in influencing student academic performance include students working in pairs on lessons, at the computer, with assisted instruction through social interactions and teamwork (Bracewell & Laferriere, 1996);
digital video clips, audio, and graphics to supplement instruction (Boster et al., 2002); mathematics curricula focusing on mathematical analysis of real-world situations supported by computer-assisted instructional software programs (Koedinger & Anderson, 1999); multimedia creation involving research skills to locate content resources, capability to apply learning to real-world situations, organizational skills, and interest in content (Cradler & Cradler, 1999); software programs that allow students to be aware where they are in the inquiry process, and to reflect upon their own and other students’ inquiries (White & Frederiksen, 1998); word-processing software that utilizes writing prompts (Kulik, 2003); and online feedback among peers who know one another allows learners to feel more comfortable with, and adept at, critiquing and editing written work (Coley et al., 1997).

**Educational Technology can Develop Higher-Order Thinking and Metacognition Skills**

Research indicates that educational technology can facilitate the development of students’ higher order thinking and metacognition skills when learners are taught to apply the process of problem solving, and are allowed opportunities to utilize technology in development of solutions. A number of studies (Brush, 1997; Clements & Nastasi, 1999; Coley et al., 1997; Lehrer, Erickson, & Connell, 1994; Pogrow, 1996; Rockman & Sloan, 1995) have demonstrated the effectiveness of educational technology when students work in collaborative groups while using computers to solve problems, and when students utilize technology presentation and communication tools to present, publish, and share results of projects (e.g., WebQuests).

Some examples of effective practices using education technology to develop student higher-order thinking and metacognition skills include the use of the Web quests, and computer assistant instructional activities, such as Jasper and Quest Atlantis, with the intent to develop the thinking skills of students through the use of a combination of computers, drama, activities that cause for collaboration, thinking, reflection, and dialogue (Coley et al., 1997; Pogrow, 1996). In addition educational technology and development of hypermedia presentations on grade-level topics develop planning and skills such as taking notes, finding information, coordinating their work with other team members, writing interpretations, and designing presentations (Lehrer et al., 1994).

**Educational Technology can Improve Student Motivation, Attitude, and Interest in Learning**

There is evidence in the literature that educational technology can improve student motivation, attitude, and interest in learning when students use (a) computer applications that adjust problems and tasks to maximize students’ experience of success; (b) technology applications to produce, demonstrate, and share their work with peers, teachers, and parents; and (c) challenging, game-like programs and technology applications designed to develop basic skills and knowledge such as Jasper and Webquests. Coley et al. (1997) found that computer-based instruction can individualize learning and increase student motivation to learn. This increased motivation for learning is related to the ability to work in a semiprivate environment, increased self-esteem, active control of their immediate environment, and ability to work at their own pace (Underwood & Brown, 1997). Computer-assisted instruction helps to improve student attitudes towards (a) themselves as learners, (b) the use of computers in education, (c) computers in general, (d) course subject matter, (e) quality of instruction, and (f) school in general (Cotton, 1992). Sivin-Kachala and Bialo (1994) also found that the improvement in student attitude and self-concept increases in a technology-rich environment. Students who participate in online communication with peers, and who are experts in other geographical areas, demonstrate higher knowledge and skill levels (Means, Coleman, Klewis, Quellamlz, Marder, & Valdes, 1997).

**Educational Technology can Address the Needs of Low Performing, At-Risk Students**

A variety of studies (Bos & Vaughn, 1994; Hofmeister & Lubke, 1988; Saklofske, 1988; Weir, 1987) have reported that instructional technology can be effective for low-performing, at-risk students, when they use programs that assess individual performance by adjusting the difficulty of the task to the knowledge and skill level of the student. Instructional technology shows effectiveness when employed by learners
to address their unique needs, strengths, and weaknesses; when it is used at the proper language level of the learner; and when it is guided by educational assessments to establish which programs are associated with learners’ educational needs. Further, studies (Goldenberg, Russell, & Carter, 1984) have indicated that educational technology interventions that provide immediate feedback and monitor progress can be more valuable than regular group instruction for educationally handicapped students.

Another type of barrier to equity that arises for the urban learners in relation to the digital divide is from physical challenges that some people face. Potential students and instructors may have mobility, visual, hearing, speech, and other disabilities that could influence their participation in courses as they are currently designed (Chen, Nath, & Parker, 2005). Adaptive technologies for low vision and blind users are available. The process called “universal design” is to assure that a course is accessible to students and instructors with a wide range of abilities and disabilities. Although not all courses must comply with these standards, they provide a good model for the design of accessible materials (Chen, Nath, & Parker, 2005).

Strategies using digital video have shown to facilitate student learning of real-world problem situations by providing opportunities to view the situation from a different perspective (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990). Students with physical disabilities can engage in successful learning experiences using computer-based assistive technology (Hayes, Schuck, Dega, & Dwyer, 2001). These experiences increase students’ independence. The use of computer-assisted instruction improves phonological awareness and word identification (MacArthur, Graham, Schwartz, & Schafer, 1995; MacArthur, Graham, & Schwartz, 1991b; MacArthur, Schwartz, & Graham, 1991a). Word processing is also effective in assisting students to learn to revise and improve their writing. Other features such as spell checkers, along with specially designed instruction, have been effective in assisting students with spelling problems (MacArthur, 1998). Clearly, the effectiveness use of education technology can be an effective tool for classroom management purposes and for diagnosing educational assessments.

**CONCLUSION**

As educators and educational technology professionals demand for research-based evidence about the effectiveness of specific instructional practices has created renewed interest in educational research (Edyburn, Higgins, & Boone, 2005). As a result, there is an urgent need for research that provides evidence about the effectiveness of various educational interventions. A critical need for research to solve the achievement gap of students in urban communities is vital. While research is a critical piece of the puzzle for understanding the impact of technology on student achievement, performance, motivation, and so forth, it cannot be the only research effort. As a result, larger research efforts will be needed to assess the following questions:

- What instructional design models will help instructors design effective strategies for student learning success?
- What type of professional development experiences do educators need in order to design successful learning experiences for urban students?
- How can educators locate innovative and effective interventions for enabling urban students to achieve high academic standards through the use of educational technology?
- What is the impact of race, ethnicity, culture, and language as it relates to the use of technology in urban environments?
- What works, for whom, and what conditions does technology impact for student achievement in urban environments?
- What new technologies are needed for routine classroom activities for urban learners?
- How can effective strategies be developed to enhance the teaching and student learning process to reflect active learning in an inquiry/project based environment?

Technology is often viewed as an enticing means of closing the achievement gap. It is seen as a magic bullet to solve all instructional and learning-related issues in an educational environment. However, this is not the reality. Statistics on the digital divide have shown that the use of technology is often based on simple computer-to-student ratios that have little relevance in describing the quality of the technology experience of the use of the intervention in the classroom. Recent
advances in educational technology have the potential to significantly enhance the learning and achievement for all students in the urban environment. However, these contributions hold for diverse urban learners, suggesting unlimited potential for their application in urban schools. Finally, the current accountability environment demands significant attention to questions of efficacy, which must be addressed in the context of using technology to enhance student achievement.

The current literature implies that innovative approaches used in teaching with technology leaves students with a more effective learning environment that promotes quality teaching and active student learning. Consequently, education planners and policy makers must think beyond providing more hardware, software, and connecting schools to the Internet, but instead thinking about keeping urban schools and teachers well-informed and trained in the effective use of technology for educational purposes. One of these investments is meaningless without the other. High-speed connections, complete digital services, and modern computers are basic to every professional workplace and are essential to student learning in the 21st century. However, technology will fail to meet its educational promise if we neglect to equip teachers with the skills they need to understand and use it, and transmit this knowledge and skills to the urban learner.

With the proper environment, technology and teachers can make the following atmosphere for the urban learner:

• Create relationships between active learning and active teaching
• Develop an appreciation and an understanding of the potential of technology
• Learn to be effective technologist and instructors.
• Develop leadership skills and become role models for successful integration.
• Understand the power of technology adoption and integration.
• Design integrated curriculum activities.
• Learn the benefits of technology in the classroom.
• Develop ownership of the technology through authentic experiences.
• Learn to motivate students with technology.
• Achieve success by becoming informed and reflective decision makers.

• Become advocates for technology integration and usage

Adhering to these procedures, educators will be able to grow as practitioners in the field and use educational technology to support quality teaching and active student learning. The research examined in this discussion provides teachers with a relevant framework to understand the factors that affect the urban learner, and the power of technology in the teaching and learning process can offer the urban learner, thus leading our educational system to fulfill the promise of providing quality teaching and student learning for a more consistent and dynamic educational learning environment that continues to support the ideals and concepts of the great American education system.

REFERENCES


The Use of Technology in Urban Populations


Saklofske, 1988


**KEY WORDS**

**Digital Divide:** The “digital divide” is the term used to describe the growing gap, or social exclusion, between those who have access to the new services of the information society, and those who do not.

**Educational Technology:** a complex set of integrated processes involving people, procedures, strategies, ideas, devices/tools, and organization dynamics, for analyzing learning and learning environment challenges. Based on that analysis, educational technology is then aimed at devising, implementing, evaluating, and managing solutions to those challenges and thus, helps facilitate active learning and student engagement that produces quality and effective teaching and learning.

**Higher Order Thinking:** A complex level of thinking that entails analyzing and classifying or organizing perceived qualities or relationships, meaningfully combining concepts and principles verbally or in the production of art works or performances, and then synthesizing ideas into supportable, encompassing thoughts or generalizations that hold true for many situations.

**ICTs:** Information and communication technology is the term used to describe exciting and innovative ways to provide lifelong learners with global access to information, learning and support.

**Metacognition:** Metacognition is the ability to evaluate one’s own comprehension and understanding of subject matter, and use that evaluation to predict how well one might perform on a task.

**Socioeconomics:** Socioeconomics is the study of the relationship between economic activity and social life.

**Urban Learner:** The urban learner is described as a student being an active participant in an urban educational and learning environment. The urban learner includes such racial minorities as Native Americans, African Americans, Mexican Americans, Puerto Ricans, and a substantial number of poor Whites (Martin, 1975).
INTRODUCTION

The need for effective assessments has been recognized since the earliest days of public education. Student testing provides rationales and support for many activities, including instructional feedback, system monitoring, appropriate selection and placement of students, and certification of skills (U.S. Congress, Office of Technology Assessment, 1992). With the growing recognition that learning is an individual accomplishment and that learning takes place in context, traditional testing methods need to be supplemented to accurately assess achievement (Brown, Collins, & Duguid, 1989; Eisner, 1999). Authentic assessments are designed to accurately reflect the real world situations in which the skills and knowledge that students developed would be applied. Although there are a variety of authentic assessment methods, each method encourages linkages between the classroom experience and real world applications. This does not mean that traditional forms of testing are obsolete, rather that these methods should be supplemented by information gathered from more situational methods.

BACKGROUND

With the advent of the scientific management movement, evaluation entered a new era of sophistication (Taylor, 1911; Tyler, 1983). The social purposes of educational testing shifted from interest in the achievement of an individual to interest in the achievement of groups. This system tended to ignore differences between individual and group achievements in favor of a standardized score which all students were expected to meet or exceed. Factors such as testing bias due to cultural factors were not considered in the system. It would take the intervention of the Supreme Court in 1967 in Hopson vs. Hansen to recognize that using testing to sort students created a bias in the educational system since standardized tests were normalized only on middle-class Caucasian students.

Assessment systems took on two roles. Since effective assessment served student needs as well as the needs of the educational system, traditional paper and pencil testing methods were heavily criticized and considered less than adequate as the sole testing tool in the educational system (Wiggins, 1990). The concept of authentic achievement developed in response to this need and the first use of this term is generally credited to D. Archbald and F. Newmann in 1988 (Terwilliger, 1998). Authentic assessment is an evaluation method that requires a student to competently perform a task in conditions as close as possible to the conditions that he or she will face outside of the educational system. These methods have steadily gained acceptance in the last two decades despite some significant concerns in the testing community.

These concerns are related to the validity and reliability of authentic assessments. Since authentic assessments evaluate learning in context, how well that learning transfers to other contexts is one method of judging the quality of authentic assessment. The effectiveness of academic and experimental learning approaches on vocational education were found to be context specific (Parnell, 1999; Stavenga de Jong, Wierstra, & Hermanussen, 2006). Neither the contextual approach nor more traditional classroom presentation methods have been proven superior. It may be that different skills require different learning contexts. Assessment is understood to be relational; the context of the assessment affects the quality of the assessment (Fox-Turnbull, 2006). For this reason, some researchers propose that authentic assessment methods are as much an instructional method as an assessment method and that their effectiveness should be judged as part of the whole program rather than as a separate element (Van der Vleuten & Schuwirth, 2005).

In response to the larger debate concerning the role and effectiveness of authentic experiences, standards are proposed for authentic assessment. In one example, Linn, Baker, and Dunbar (1991) examined the need for authentic assessment criteria and proposed eight factors for consideration:
Varieties of Authentic Assessment

- Consequences (intended and unintended and time spent on perfecting artifacts)
- Fairness issues such cultural bias and scoring variation
- Transfer and generalizability as a measure of reliability
- Cognitive complexity
- Content quality and completeness
- Meaningfulness of the required tasks
- Cost

The majority of these standards mirror traditional evaluation standards. The identification of the consequences of assessment as having an effect on authentic learning environments highlights a particular issue in authentic assessment. Elements such as the time spent perfecting portfolios can expand beyond the original intent of the assignment. Unfamiliar assessments increase the likelihood that students and teachers will misinterpret the purpose of the assessment. Since the purpose of authentic assessment is to mirror real world applications, the identification of such consequences is particularly important.

Beyond validity and reliability issues, authentic assessment appears to be difficult to use on a large scale. Torrance (1993) found that large scale authentic assessment significantly increased teacher work loads. Teachers treated the assessment materials as a separate instructional activity to be added to existing materials and many of the materials were too complex for the teachers to easily implement. This implies that teachers need additional training to effectively integrate these assessments into their existing programs.

As asserted by Newman, Brandt, and Wiggins (1998), authentic assessments focus on disciplined inquiry and value beyond success in school and this is a different perspective than traditional assessment methods. It may be that authentic assessments can be effectively combined with traditional approaches to enhance learning. Hybrid models that combine required content with authentic methods and assessments have significantly raised standardized test scores in two Chicago high schools serving low income urban students (Ferrero, 2006). Test formats such as multiple-choice testing, short answer testing, item completion, and matching still have a significant place in the educational testing system. The first step in implementing an effective authentic assessment program is to recognize when traditional testing is more appropriate and when an authentic assessment would be preferable.

AUTHENTIC ASSESSMENT METHODS

The first step in selecting any evaluation method is to refer to the objectives for the instructional element or elements to be evaluated. There are numerous taxonomies for objectives, many of which are based on the work of Bloom (1956), Krathwohl, Bloom, and Bertram, (1973), and Simpson (1972). Objectives were divided into three categories, cognitive, affective, and psychomotor that were called domains. Each of these categories were further divided into subcategories ranked in order of complexity which were called levels.

This categorization of objectives is important because it highlights the degree of expertise that the student should achieve in the final product. For example, if the goal of the activity is for the students to list the Presidents of the United States in order, that is a lower level cognitive task. Such an expectation of would not require anything beyond a basic, short answer exam as an assessment tool. If the objective of the lesson is to develop an understanding of the consequences of the election of Abraham Lincoln, an objective style assessment may not be adequate to assess the competency. The format of the assessment would prohibit the collection of content linkages.

In the larger debate, a proponent of authentic assessment would object to an exercise as simple as listing the Presidents of the United States in order. Since there is no apparent purpose for this activity, it would not be considered an authentic task. This does not mean that all rote learning is valueless and that all objective style testing should be eliminated. Consider the example of nursing education; there is a great deal of information about human anatomy, terminology, and appropriate safety protocols that simply must be learned before students can progress to more complex and applied problems. For this reason, it is common in many vocational subjects for students to work through a progression of examinations beginning with simple objective style testing and ending with an authentic assessment such as the performance of a procedure or the creation of a project. It is unrealistic to expect a student to perform an authentic task well when they do not have the basic contextual background for the experience.
TYPES OF AUTHENTIC ASSESSMENT METHODS

Once the appropriate learning domain and level of complexity has been established, potential assessment methods should be reviewed. Beyond objective style testing techniques, authentic assessment methods provide an effective way to teach and assess mastery of higher order skills in all domains. Some commonly used authentic assessment methods include object tests, case studies, problem based scenarios, projects, observations, and portfolios.

Object Tests

Object tests are a transitional testing format. They retain some of the structure of traditional objective style testing while allowing students to experience actual objects in relation to an actual problem. It is more artificial than other forms of authentic assessment because the problems are segmented into small tasks and each item is timed. Since in some subjects, completion time is a factor in assessing mastery, this may or may not be a negative requirement depending on the competency.

Object tests require students to identify actual tools, materials, or specimens and to explain relationships between these items and analyze or apply the items in a brief task. For example, a selection of fastener types might be laid out on a workbench, and students might be required to select the appropriate fastener and tool that is appropriate for the specific task. In a science laboratory, a student might be required to examine specimens in order to form a hypothesis about their living environment.

Since the objects used in these exams are often small and difficult for students to see, these exams are usually set up as stations. At each station is an item or collection of specimens to be examined all along with the question relating to these items. Students are provided with a testing booklet that allows them to write their answers next to the appropriate number for each item. Students rotate through the stations to complete the exam and this is a timed rotation. For stations that might take longer than a single rotation period, the rotation sequence is adjusted to allow for a smooth rotation.

There are several advantages of this format. Students have the opportunity to work with real objects on applied problems in a novel format that students seem to enjoy. For the instructor, object tests require the least amount of time of any authentic assessment method to integrate into a traditional class. An effective object test can begin and end within one class session.

Significant teacher preparation is required to develop a meaningful task for each station that supports the objective and can be reasonably completed in the allowed time. Because this is a timed experience, the test is an effective format for measuring higher level psychomotor skills such as mechanism and complex overt responses. Unfortunately, the limited time allotted for each station also limits time for the reflection needed to develop transference skills for the knowledge to other types of tasks. For this reason, object tests would not be considered true authentic assessments by some educators.

Case Studies

Case studies are narratives that describe a situation or an event in detail and ask the student to assess the situation to identify possible consequences. Case studies have been widely used in management science for many years and are particularly effective at assessing affective objectives at the valuing level. Case study analysis is also useful as an assessment of higher order cognitive skills, such as judging and evaluation.

Case studies are often developed from recent real-world situations. When developing a case study assignment, it is important to limit the information to a short description of the case in order to hold student attention. Effective cases are rarely more than a few pages long, and in the example of cases developed for secondary education purposes, they often are limited to a few paragraphs.

Once a case has been written or selected, the case can be used in a variety of ways in the classroom. One method is to use the case as a springboard for a discussion group. The students are then assessed on the quality of their interaction in relation to the issues of the case. The instructor takes notes during the discussion as part of the assessment. More commonly case studies are assigned as writing assignments. Students review the case and are expected to research the related issues and reflect upon these issues and consequences prior to developing a written analysis. A third method is to assign the writing of the case as the assignment. This causes students to analyze the event in detail to
determine which elements are critical for understanding the solution.

Case study analysis is a method that is easily transferred to Internet delivery. By providing a basic case and linking that case to related resources, Web-based case studies allow students not familiar with the technique to develop expertise in sifting through information prior to working with more open ended case study problems. WebQuests can be developed that support a case study assignment for students less skilled at information retrieval.

Case studies are highly relevant experiences and require significant intellectual engagement on the part of the student. For instructors, locating or writing appropriate case studies can be difficult. Case studies are excellent in generating rich discussion and for emphasizing the interconnectivity of ideas and events.

**Problem-Based Scenarios**

Problem-based scenarios are similar to case studies, but are focused on a central problem. This is presented as a narrative with the problem embedded in the narrative. Not all needed information is presented and the problem has several possible solutions. During the analysis of potential solutions, the students learn to recognize that some consequences may be unexpected. Effective problem-based scenarios assess cognitive knowledge at the application, analysis, and evaluation levels and can also be effective assessments of affective objectives at the valuing level depending on the structure of the problem.

The advantages and disadvantages of problem based scenarios are similar to those of case studies. Problem-based scenarios have been adapted for Web-based delivery. Web delivery is an effective format for embedding procedural information within the problem scenario and highlighting consequences. Such programs are well received, but are particularly time consuming to develop.

**Projects**

Projects require the application of specific skills that have been developed during the course of instruction to create an object, an analysis or a portfolio. Final projects are assessed by a predetermined rubric and by performance checklists. The performance checklist assesses techniques used during project development while the final project rubric assesses the quality of the final work. In many fields, the procedure used to reach the final project stage is as important as the final project itself. This is particularly true when there are safety concerns that are addressed by the procedure.

Effective projects are developed from areas of importance to the students. For this reason, advocates of the project method encourage students to select their own project within parameters set by the instructor. The instructor’s guidance assures that the project will meet course standards, and by empowering the students to select their own projects, the purpose of the project is clearly understood. Often the student is expected to present a formal proposal of the project for approval. This provides an opportunity for feedback and allows the instructor to limit the project to one of reasonable scope.

A project plan is then developed that breaks the project down into workable subsections. This provides scaffolding needed by both the student and the instructor to identify appropriate evaluation points. Evaluation points should be set at critical content junctures; those points at which if the student were to be unsuccessful he could not successfully complete the project.

Because the scaffolding will effectively keep the student on task, instructors provide only minimal assistance during the course of the project. Students are referred to resources that help them answer questions independently of the instructor. Only in cases where the student has hit a significant roadblock or there is a potential safety or legal concern would an instructor intervene.

Projects are an effective assessment tool as long as the instructor is careful to align the proposed projects with the expected criteria for the subject. Without this step, students will often create wonderful projects that unfortunately do not help them master the required material of the course. It is also critical that project criteria and assessment tools such as checklist and rubrics are developed prior to the student beginning work on the project. This minimizes any unintended grade bias toward those students who have access to more expensive materials or resources than are available to the group as a whole.

**Observations**

The most authentic form of assessment is to assign a student a task and to observe that student actually
performing the task. Depending on the subject, the task may take a wide variety of formats from changing brake pads on automobiles to performing a solo in a musical production. The task assigned should support a significant competency and it should require significant effort for the student to master. It is common for students to complete intermediate assignments to master or reinforce the expected skill prior to their graded observation. These intermediate assignments allow both the instructor and the student to identify areas for improvement and to clarify any misunderstandings regarding the expected performance standards. The performance is assessed by a rubric or a performance checklist list that was developed prior to the due date of the assignment.

Observations are effective authentic assessment tools when the performance takes place in conditions similar to the conditions in which the activity would take place in the real world. Observations that require students to use substandard materials or tools or forgo the use of certain conditions, such as computer resources, stage equipment, and so forth, weaken the validity of the assessment. In situations where the student has not been allowed to practice the expected skills, observations can be an unfair assessment of student ability. Without an opportunity to improve, the value of authentic assessment is limited.

**Portfolios**

Portfolios are a collection of student work that illustrates the progress of the student from the beginning of instruction to the end. Ideally portfolios showcase the interconnectedness of the content that the student has learned and relate that content to subjects outside the course. Items that are collected for the portfolio are called artifacts and may consist of work samples, recordings of performances, final project reports and related case studies. These items are often developed and organized by the student, who also has an opportunity to revise and improve these items before the final presentation of the portfolio. Since portfolios have become increasingly important in program assessment, some portfolios are collected by the instructor rather than the student. This allows the instructor to compare weak assignments with strong assignments to determine the range of achievement within a given course.

Portfolios are often embedded throughout a course rather than assigned as a final experience at the conclusion of the instruction. Portfolios are assessed with rubrics and item check sheets and the presentation format currently includes electronic presentations as well as paper formats.

**FUTURE ISSUES AND CONSIDERATIONS**

Given the intense interest in assessment in the last two decades, it is reasonable to expect that authentic assessment methods will develop that take full advantage of the resources on the World Wide Web. Scenarios problems have been developed for Web-based delivery using Dreamweaver (Juneau, 2006). Software tools exist that can streamline this task; however, software availability is uneven or costly. Some programs are held as proprietary by the developing institutions. The Challenge suite was an authoring system developed by Terry Stewart at Massey University specifically for the development of problem-based scenario problems for Web delivery. This project was folded into a second project called PBL-Interactive that can purchased at http://www.pblinteractive.org/. Based on the relative youth of the field, software tools developed specifically for the use in authentic assessment have yet to be developed. Basic research into the structures and support systems for effective authentic assessments is still needed to provide the developmental foundation for Web-based support tools.

**CONCLUSION**

Authentic assessment methods are based on different premises than many traditional assessment methods. They are a hybrid of assessment and instructional methods and if correctly designed promise to be the most valid of all assessment techniques. Although the implementation of these methods is currently awkward for many instructors, as the methods gain in popularity, these methods will become more clearly understood. The variety of methods currently in use allows instructors to design assessments that fit the needs of their programs while intellectually engaging their students. As the technical support systems develop to support these methods, it is likely that hybrid assessment programs combining authentic assessment methods with traditional methods will become the educational gold standard.
REFERENCES


KEY TERMS

**Authentic Learning**: Learning focused on the application of the developed skills beyond the classroom environment that allow for inquiry and self determination.

**Critical Content**: Content or skill areas that, if failed, could lead to a lack of successful completion of the course.

**Exhibitions**: A display of student projects or a student performance that serves as a summative experience for the student.

**Performance Assessment**: Any assessment method that requires the student to demonstrate their skill by applying those skills in the solution of the problem or the creation of an object or performance.

**Reflective Exercise**: An assessment that encourages students to reflect on what they have learned and to relate that learning to their own life experience. A journal is a type of reflective exercise.

**Rubric**: A scoring tool that describes the expected levels of performance acceptable for each grade category for each criterion. These are often presented in chart format.

**Scenario Problem**: A narrative exercise that describes a problem that could be encountered in real life. Scenario problems have multiple solutions and require the student to assess the consequences of the possible solutions before deciding on a course of action.

**Traditional Assessments**: Assessments that measure mastery of a subject by sampling the subject content and developing objective style exams such as multiple choice exams to judge mastery.
INTRODUCTION

Perhaps for the first time since the computer made its debut, the teacher is in the position to command the technology-based instructional resources used in the classroom. Gone are the days when teachers must rely solely on the expertise of computer professionals to create computer-assisted instruction. With the advent of the World Wide Web, creating student-centered, age-appropriate material rests in the hands of the classroom teacher. The Virtual Tour is the newest link to literally millions of content specific sites that supply images, sounds, and video media.

Defining the Virtual Tour. A Virtual Tour is a Web-based teaching strategy that presents multisensory, multimedia instruction appropriate for individual student exploration and group learning experiences. Virtual Tours offer the learner a host of “Front Doors,” 14 in all, each uniquely suited to address a particular learning style. “Amplified” sites provide the specific content information. They are either external (found on the Internet) or internal (developed by the classroom teacher).

From the teacher’s perspective. Few strategies provide teachers with such rich opportunities for expanding the walls of their classroom. The Virtual Tour enhances curriculum with authentic learning experiences in the form of exhibits, simulations, games, portfolios, paths, galleries, guided tours, and linked itineraries. Both Cooperative and Discovery lessons are improved by focusing the Virtual Tour on instructional units immersed in interpersonal communication, community awareness, and technology objectives. Students with special needs also benefit greatly from a multitude of learning medias. Needing individualized instruction can be challenging at times, but having a medium that addresses a variety of learning styles proves beneficial for both student and teacher.

Preparing a Virtual Tour. Technology-based instruction is best prepared with the aid of an instructional systems design (ISD) model, and the ADDIE Model is an excellent choice for creating a Virtual Tour. By following the five-step process, teachers analyze, design, develop, implement, and evaluate a technology-rich unit of instruction employing all the strengths of the World Wide Web.

To aid in reader understanding, a prototype Virtual Tour was prepared to serve as our example. The Tour was based on an actual third-grade lesson presented to special education students, during the 2005-2006 school year, on the topic of The Nine Planets, and they loved it. The lesson was modified and adapted to meet a variety of individual learners and their ability levels. Its design followed these steps.

Analysis. The initial stage of any instructional development effort determines the appropriate goals, objectives, and content for the lesson. When preparing a Virtual Tour, teachers must first select a topic best taught using the Web-based format. Some topics lend themselves to technology; others do not, and no amount of images, sounds, or video clips will make them successful. Once the content focus is determined, the psychology for teaching the topic (behavioral, cognitive, or humanistic) must be decided.

Behaviorally, the Virtual Tour is a natural extension of sequential learning with content presented from first to last, simple to complex, general to specific. The Cognitive teacher offers content in progressive steps until a schema, or pattern, emerges to aid the learner in the construction of new knowledge. Humanism offers a personalized approach to learning, selecting information important to the student although, for younger students, they may not be particularly aware of what is or will be important to them. The Virtual Tour supports each of these major psychologies perhaps better than any previous teaching strategy ever devised.

The Virtual Tour makes the perfect integrated thematic unit by combining several academic disciplines. As a result, the analysis phase can be the most time-consuming step in lesson preparation. In their Backward
Virtual Tour: A Web-Based Model of Instruction

Table 1. Learning goals for the nine planets lesson

<table>
<thead>
<tr>
<th>Learning goal</th>
<th>Task description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigate the Internet</td>
<td>Use the mouse to point and click on hyperlinks identified by the teacher and containing content-specific information.</td>
</tr>
<tr>
<td>Locate specific Web sites</td>
<td>Enter a specific URL (Uniform Resource Locator) in the Location Window of Netscape.</td>
</tr>
<tr>
<td>Download images and text</td>
<td>Use the right mouse button to click on an image, view that image to ensure it is desired, then save that image onto a personal copy or storage media. Use the left mouse button to click and drag selected text, copy that text, and paste the text into a word processing document.</td>
</tr>
<tr>
<td>Print images and pages</td>
<td>Use Netscape to print an entire web page, selected portion of a web page, and specific images on a page.</td>
</tr>
<tr>
<td>Prepare a 3-5 minute presentation</td>
<td>Use the rubric for classroom presentations to present the Nine Planets lesson to your classmates.</td>
</tr>
<tr>
<td>Prepare a personal Web Address Book</td>
<td>Add, File, and Edit Bookmarks in Netscape and print a copy of your bookmarks to share with other students.</td>
</tr>
</tbody>
</table>

Design Model, Wiggins and McTighe (1998) suggest that learning goals must be the first decision when creating the new lesson. Table 1 displays the learning goals for The Nine Planets lesson on the left, and the specific activity that is being targeted on the right.

**Design.** Lesson design begins by considering the target learner. Piaget (1970) identifies a characteristic of learning called “operations” and distinguishes between the concrete and abstract learner, bringing to light the importance of making instructional material age-appropriate for the learner. Concrete learning (approximately ages 7-11 years) demands tangible experiences: images, sounds, and video clips, each supported by the Virtual Tour and the Web-based media on which the Tour is grounded. The abstract learner (ages 11 years and older) revels in concepts and ideas; graphics and hyperlinks support multisensory exploration.

Once the age and learning styles of the prospective students are in place, specific learning objectives can be formulated. For this task, many teachers prefer the format attributed to Mager (1962). Its simplicity of design makes the behavioral learning objective a natural for this instructional format. Mager suggests three components for a properly constructed objective:

- **Condition**, provides the instruments for the learning situation
- **Behavior**, are both observable and measurable activities that surround the lesson and present evidence that learning has occurred.
- **Criteria**, specifically details how well the behavior must be performed to satisfactorily accomplish the lesson goals.

The behavioral learning objectives for the Nine Planets Virtual Tour are shown in Table 2.

**Development.** With the analysis and design firmly in mind, the next step in the ADDIE Model is the advancement of the lesson material. And, for the Virtual Tour, that means the selection of a front door. There are 14 actual front doors that offer a facade for the Tour and its many amplified sites. Each is strong in a particular operation, either Concrete or Abstract. Each is also tagged with a psychology for learning: Behavioral, Cognitive, or Humanistic. And, since we are dealing with technology, each front door has also been labeled Easy, Challenging, or Difficult with respect to the intricacy of the tools required to effectively place the Tour online.

**Implementation.** Selecting a front door commensurate with your lesson objectives and personal technical skills is not difficult. With 14 available, the selection is based first and foremost on your analysis of the lesson goals, followed by the learning styles of the student, and then finally by the technical expertise of the designer. For this article, we have selected the six “Easy” front doors to explore in detail. Let’s examine each of them now.

- **Next exhibit:** One of the most readily mastered formats for the Virtual Tour, the Next Exhibit opens with an introductory screen explaining the purpose of the lesson and some simple directions. Textual material is held to a minimum; images control movement throughout the lesson. The learner travels sequentially forward to the next exhibit, returns to the previous exhibit, or ends the tour at any point by returning to the front door. The Evaluation Tag “ABE” indicates that the Next Exhibit is most appropriate for teach-
Virtual Tour: A Web-Based Model of Instruction

Table 2. Behavioral learning objectives for the dinosaur lesson

<table>
<thead>
<tr>
<th>Objective I</th>
<th>Using a personal computer and Web address list, students will navigate the Internet locating two specific Planets and/or Solar System Web sites and, locate, download, and print at least two images of a planet that caught your interest or that you learned something new about.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective II</td>
<td>After locating a given Web site, a student will review the information and answer the questions in the Workbook: &quot;What is the difference between an Omnivore and a Carnivore? When did the Dinosaurs Live? And, What Where the Most Common Dinosaurs in North America?&quot;</td>
</tr>
<tr>
<td>Objective III</td>
<td>Given a Web address, students will click on a dinosaur’s name to go to a simple black-and-white print-out and color, cut out, and mount their favorite Dinosaur for instructional use. Students will be expected to provide a 3-5 minute presentation on their Dinosaur.</td>
</tr>
</tbody>
</table>

- **Topical path:** Also appropriate for Abstract content is the Topical Path, which focuses on the delivery of content material appropriate for Discovery Learning objectives. Learners are provided an opportunity to use their prior knowledge (a precept of the Cognitive approach) by selecting teacher-identified amplified sites containing additional instructional materials.

- **Event sequence:** A lesson on The Nine Planets might be composed of many mini-lessons; one for each of the specific planets, the solar system, as well as the different changes in weather and seasonal patterns. The Event Sequence front door focuses on the planets in our solar system- their locations, the time it takes them to rotate around the sun, the seasonal changes that may occur- as well as their dependency on one other. Highly Abstract, this door is principally Humanistic in its presentation and relies primarily on text-based links to its amplified sites.

- **Chronology text:** This front door uses the timeline approach to create text-based links to new information. Each time increment is expressed in days, weeks, years, decades, or centuries, and is a link to more detailed material oftentimes created by the teacher. Remaining consistent with the demands of the Concrete learner, images augment the instruction with multisensory features. Chronology is a natural learning style for the Behavioral lesson as it follows the time increments to present the information. And, again, Planets are a likely topic for this front door format.

- **Gallery:** One of the most popular of front doors, the Gallery promotes cognitive learning via images organized to follow the specific learning objectives of the lesson. Amplified sites augment the instruction, and sidebars (links provided on the left or right of the screen) offer navigation beyond the lesson, should the student wish additional materials. The Gallery’s reliance on graphics promotes Concrete learning and fosters the building block approach that Cognitive learners relish.

- **Itinerary:** The final “Easy” front door is patterned after a person’s daily diary. It presents learning as a series of related activities, appointments, and personal memories. Most Itinerary Virtual Tours simulate the activities of a subject during a “typical” 24-hours period, while others chronicle events over a much longer period of time.

One of the many advantages of the Virtual Tour is the flexibility that Web-based lessons offer the teacher. While other forms of educational technology demand considerable computer storage resources, a Tour is usually hosted on a single floppy diskette. Most of the resources of the Virtual Tour are external sites. Only the front door itself, along with any internal sites and related images, needs to be captured to a local storage medium. Students can take the single floppy to any Internet-ready computer in the school lab, classroom or even at home, and immediately connect to the materials that the teacher has prescreened for content and applicability. Or, the diskette can be given to the technology coordinator and uploaded to the school’s Web server for universal access and better teacher control. Regardless, the use of the Virtual Tour is becoming a popular venue for the presentation of Web-based material. But
Virtual Tour: A Web-Based Model of Instruction

Table 3. Evaluating the front door lesson

<table>
<thead>
<tr>
<th>Front Door</th>
<th>Rating (1-10)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Next Exhibit</td>
<td>2</td>
<td>Assessment almost non-existent; requires external review via objective tests such as matching, true-false, completion.</td>
</tr>
<tr>
<td>Topical Path</td>
<td>2</td>
<td>Similar to the Next Exhibit, this Front Door requires external assessment via class discussion or essay tests.</td>
</tr>
<tr>
<td>Event Sequence</td>
<td>4</td>
<td>Most effective evaluation for this Front Door includes authentic assessments such as portfolios and thinking journals.</td>
</tr>
<tr>
<td>Chronology Text</td>
<td>5</td>
<td>Use a hard-copy, text-based quiz with this Front Door to assess your student's understanding of the material.</td>
</tr>
<tr>
<td>Gallery</td>
<td>6</td>
<td>With so many user choices for this format, students are best assessed using typical discovery learning techniques such as group work, reports, and presentations.</td>
</tr>
<tr>
<td>Itinerary</td>
<td>5</td>
<td>Subjective evaluations are most appropriate here. Assess your student's knowledge with reports.</td>
</tr>
</tbody>
</table>

Table 4. Front doors and representative Internet sites

<table>
<thead>
<tr>
<th>Front Door</th>
<th>Evaluation Tag</th>
<th>Site Name</th>
<th>Site URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided Tour</td>
<td>ABC</td>
<td>US White House</td>
<td><a href="http://www.whitehouse.gov">www.whitehouse.gov</a></td>
</tr>
<tr>
<td>Table</td>
<td>ACC</td>
<td>A. Phillip Randolph Museum</td>
<td><a href="http://aphiliprandolphmuseum.com/">http://aphiliprandolphmuseum.com/</a></td>
</tr>
<tr>
<td>Map/Globe</td>
<td>ACD</td>
<td>Gordon’s Ongoing Journey</td>
<td><a href="http://www.philnolimits.com/">http://www.philnolimits.com/</a></td>
</tr>
<tr>
<td>Room Exhibit</td>
<td>AHD</td>
<td>The Mariner’s Museum</td>
<td><a href="http://www.mariner.org/exhibitions/">http://www.mariner.org/exhibitions/</a></td>
</tr>
<tr>
<td>Timeline Map</td>
<td>CBD</td>
<td>The History of Invention</td>
<td><a href="http://www.cbc.ca/kids/general/the-lab/history-of-invention/default.html">http://www.cbc.ca/kids/general/the-lab/history-of-invention/default.html</a></td>
</tr>
<tr>
<td>Picture Button</td>
<td>CCC</td>
<td>New Mexico Museum of History</td>
<td><a href="http://www.nmnaturalhistory.org/">http://www.nmnaturalhistory.org/</a></td>
</tr>
<tr>
<td>Vehicle</td>
<td>CHD</td>
<td>The U-505 Submarine Tour</td>
<td><a href="http://www.msichicago.org/exhibit/U505/index.html">http://www.msichicago.org/exhibit/U505/index.html</a></td>
</tr>
</tbody>
</table>

until now, no one has identified the various front door formats and their pedagogical importance.

Evaluation. The final stage of the ADDIE Model is often overlooked by educators, particularly when technology is used. Table 3 offers a final look at each of the six Easy front doors examined in this article and offers a few words regarding their evaluative strengths and weaknesses.

CONCLUSION

Keep in mind that there are eight additional Front Doors available for presenting abstract and concrete ideas; behavioral, cognitive, and humanistic content; and technically challenging or difficult construction. If you would like to visit representative sites of these remaining formats, Table 4 provides URLs of some of the best sites discovered so far.

Using the Virtual Tour format and these Front Doors, teachers can design their own online resources for the classroom. They no longer rely on the computer professional to create technology-based instruction. The Virtual Tour is the answer to locating, organizing, and incorporating millions of content specific sites into student-oriented online lessons.

REFERENCES


Virtual Tour: A Web-Based Model of Instruction

KEY WORDS

Amplified Sites: Web pages that provide the specific content information. They are either external (found on the Internet) or internal (developed by the classroom teacher).

Concrete Learners: Individuals that learn best with hands-on methods and show the most success when doing it themselves, being involved with their learning process, and “doing” rather than “watching.”

Front Doors: One of 14 teacher-developed formats uniquely suited to serve as the opening page of a virtual tour, and addressing an instructor’s preferred teaching strategy and a student’s particular learning style.

Individualized Instruction: Instruction focused on the individual learner and their needs, making sure that they master the skills being taught in the way that the individual student learns best. This can be done by using a variety of medias to produce a lesson that “fits” many different ability levels at the same time.

Multimedia: Refers to integrated collections of computer-based media including (but not limited to) text, graphics, sound, animation, photo images, and video.

Virtual Tour: A Virtual Tour is a Web-based teaching strategy that presents multisensory, multimedia instruction appropriate for individual student exploration and group learning experiences.
Vygotsky and the Zone of Proximal Development

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INTRODUCTION

Thinkers throughout history have surmised that humans exist most fully in communion with others. Learners mimic or model, read or reflect, and listen or lecture within a social context; therefore educational experiences, traditional or technology based, ought not to discount the interplay between shared experience, individual’s attitudes, and relational understandings. The theories of learning that emphasize this kind of interpersonal interaction, the necessity of collaboration and collegiality, a reliance on social reference points, and intentional modeling have had various nomenclatures (Rogoff & Lave, 1984). Vygotsky’s (1978) seminal work is commonly referred to as “social cognition” or “social constructivism.”

According to Vygotsky’s theories (1978), social interaction both precedes and initiates cognitive development, especially during the process of language acquisition. Vygotsky understood language to be an example of a mediated activity of cognition. His contention was that cognitive development proceeds in a series of relatively predictable transformations, beginning at the social interpsychological (between people) level and gradually progressing toward internal learning capabilities (interpsychological). In order to be effective, learning must occur within a social context; “...human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them” (Vygotsky, 1978, p. 88).

Vygotsky explicates social cognition with a description of finger-pointing. An infant first points his/her finger as a meaningless gesture; however, after others within the community react to the finger point, it is endowed with meaning and becomes a learned and repeatable form of social interaction.

Vygotsky’s ideas suggest that learning is rooted in a social environment in which context and interpersonal interaction play fundamental roles in learners’ cognitive development. It is by observing and modeling others and in an engagement with authentic tasks that learners are able to attain their full cognitive potential.

THE ZONE OF PROXIMAL DEVELOPMENT (ZPD)

Classroom teachers often define educational performance levels as independent-functioning level (including tasks that students are capable of completing completely on their own without supervision or guidance), instructional level (involving tasks that require instructional scaffolding, guided practice, or teacher assistance to complete), or frustration level (entailing those activities that are too difficult for learners to do, even with more expert guidance). In general, lessons are designed so as to afford the majority of learners opportunities at their instructional levels; in this way, teachers intentionally structure learning experiences that push students beyond that which they can do independently, and guide them towards utilizing existing independent knowledge as a foundation upon which to build new understandings.

Vygotsky described the “zone of proximal development” (ZPD) as the distance between what a learner can do independently and what he or she is capable of accomplishing with more expert assistance. Learners do not develop skills and proficiencies by performing only those tasks that they can do on their own; rather, it is by imitating and modeling more-skilled learners that students progress to a new stage of cognitive development. “The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively” (Vygotsky, 1978, p. 87). Therefore, learning must occur in a social setting so that students may select those role models that facilitate proximal development. Thus, the social context of the learner defines the zone of proximal development as that optimal teaching space where an expert (the teacher) structures the environment to promote cogni-
Vygotsky and the Zone of Proximal Development

Vygotsky and the Zone of Proximal Development. Using scaffolded interaction with the instructor (or another expert) and their context, learners use what they know to figure out what they don’t know (Conway, 1997, p.2). In practical teaching terms, the ZPD refers to what is generally called a student’s “instructional level.”

**Authentic activity.** In terms of formal education, Vygotsky maintained that activities involving language (such as speaking, reading, and writing) must have a necessary and authentic purpose. Activities and assignments from which students learn best are those based on something that they need to do rather than those that are purely teacher-generated tasks. Vygotsky theorized that learning has human social processes as its foundation, and also entails an intensely personal process. For this reason, new knowledge should be applied to a task that mimics the social reality of the learner, and parallels a “real world” application of the activity. In order to facilitate new understandings, educational opportunities must be structured so that they have an authentic purpose, mimic real-world application, are as socially-based and collaborative as possible, and allow the learner to operate within his/her zone of proximal development.

**Implications for instructional technology.** The University of Houston (2007) defines instructional technology as a multifaceted discipline that integrates concepts from cognitive, computer, and instructional science with educational psychologies, pedagogies, and curriculum development in order to systematically create and deliver instruction. “Instructional Technology is thus a consumer of concepts, theories, and research... and it also contributes its own concepts, theories, and research” (University of Houston, 2007, ¶ 1).

From this perspective, Vygotsky’s ideas have ramifications for instructional design, student attitude and achievement, learner motivation, and choice. If development occurs most significantly within the zone of proximal development, then the ways in which teachers structure instruction must seek to facilitate such interactions.

Teacher modeling assumes greater importance than teacher direction. Learners will look to imitate teachers’ attitudes, motivations, and strategies as they seek cognition of a concept beyond their independent functioning. Collaborative and/or collegial tasks where skilled peers assist more novice learners also facilitate understanding, as learners seek to create meaning within an authentic social setting and in the completion of relevant tasks. Whatever the age of the learner, instructional design must be relevant, authentic, and challenging enough so that interactions occur within the zone of proximal development (Ormrod, 2004). Learning situations ought to be structured neither as didactic drill and practice sessions nor as media-enhanced independent research activities. Rather, technology should be intentionally integrated into guided learning opportunities that offer technology-assisted situations in which students supported in the construction of relevant understanding within an authentic context.

The use of technology enables students to transform socially acquired knowledge into personally meaningful understanding. Various technology applications support social constructivism by enhancing students’ reasoning and critical thinking skills, providing opportunities for problem solving, affording a means of information retrieval and dissemination, enhancing collaborative learning within the zone of proximal development, and developing reflective learning practices. Instructional implementation of technology tools (e-books, Web logs, digital storytelling, podcasting, e-mail, multimedia productions, Internet research and analysis, etc.) provides educators “...the opportunity to create a learning zone that unifies thinking and problem solving, adult guidance (teacher/guest experts) and peer collaboration.... this learning zone...allows a student to impact their digital identity as knowledge collectors and creators” (PPS, 2003, ¶2).

**REFERENCES**


KEY TERMS

Vygotsky and the zone of proximal development: Commonly referred to as “social cognition” or “social constructivism,” Vygotsky’s theories of learning emphasize interpersonal interaction, the necessity of collaboration and collegiality, a reliance on social reference points, and intentional modeling. These ideas include descriptions of the “zone of proximal development” (ZPD), the distance between what a learner can do independently and what he or she is capable of accomplishing with more expert assistance.


A Web log, more commonly known as a blog, is a publication on the Internet. Blogs have been credited with allowing people to develop online communities with a group of friends, classmates and professors, or the wider world because of how easy they are to create and how accessible they are to anyone on the Internet. They are easy to create because they do not require the blogger, the person creating the blog, to know hypertext markup language (HTML). In addition, content in a blog may be text, graphics, hyperlinks, photos, audio, and/or video. Many blogs look like personal journal entries because they are updated on a daily or weekly basis. They typically have the following features:

- **Title**: Main title, or headline, of the post
- **Body**: Main content of the post
- **Comments**: Comments added by readers
- **Permalink**: The URL of the full, individual article
- **Post Date**: Date and time the post was published
- **Blogrol**: Hyperlinks to other blogs that the blog author reads or is affiliated with

In addition to these typical blog features, the blog may also contain the following optional features:

- **Categories (or tags)**: Subjects that the entry discusses
- **Trackback**: Links to other sites that refer to the entry

An example of a typical blog may be seen in Figure 1.

**WEB LOGS**

**HISTORY OF BLOGS**

Jorn Barger is often given credit for first using the term Web log in 1997 in his Web site title *Robot Wisdom*

Figure 1. A blog homepage

(Paquet, 2003). Then in 1998, Jesse James Garrett, who had published a Web log and was editor of Infosift, began compiling a list of Web sites similar to his own. This list was then sent by Garrett to Cam-World’s Cameron Barrett, who published it on his Web site in late 1998. This 1998 list include only 23 known Web logs. Then in early 1999, Peter Merholz is reported to have said that a Web site on which an author posted journal entries in chronological order with the most recent appearing at the top of the page should be called a “wee blog.” This eventually become shortened to “blog” with the site’s author being called a “blogger” (Merhol, & Peterme, 1999). These early Web logs were simply manually updated components of common Web sites. Rebecca Blood (2002) describes these early Web logs as link-driven Web sites that had “a mixture of commentary, and personal thoughts and essays.” These early Web logs were created by people who already knew how to make a Web site. These early bloggers were people who had either taught themselves to code HTML for fun or had jobs creating commercial Web sites.

In July of 1999, Pyra Labs introduced Blogger. Blogger was the first developer-hosted blogging application that offered free creation and hosting of Web logs. Later that same year, UserLand Software announced its development of Manila, a server-based content management software. Late in 1999, software developer Dave Winer introduced Velocinews. All of these products allowed individuals to publish material to the Web using a simple browser-based interface where the user creates a Web log by choosing a template, filling in the forms, and then clicking a button to have the Web log published on the Internet. This meant that individuals wanting to publish on the Internet no longer had to have a rudimentary knowledge of a basic markup language (HTML), have a Web site account, and be able to use file transfer protocol (FTP) software to copy the created Web page from the user’s local hard drive to the actual Web site account.

Between 2001 and 2004, an increasing number of people were becoming interested enough in blogging that how-to manuals began to appear, primarily focusing on the steps to creating a blog. In addition more people were reading blogs and forming blogging communities. Most of the blogs that were on the Internet at this time were of a political nature: Andrew Sullivan’s AndrewSullivan.com, Ron Gunzburger’s Politics1.com, Taegan Goddard’s Political Wire and Jerome Armstrong’s MyDD. Also, several established schools of journalism began researching blogging and studying the differences between journalism and blogging. In 2004, Merriam-Webster’s Dictionary declared “blog” as the word of the year.

The New York Times estimated in August (2006) that there were now over a half a million Web logs, with the number growing.

**HOW ARE BLOGS CREATED**

A blog is created using a standard Web browser and a blogging application. The blogging application may be a user-hosted or developer-hosted system. User-hosted means that the software for creating the blog is installed on either a server administered by the user or on the users own computer. With a user-hosted system the blogger must be directly connected to the server housing the software in order to create a blog entry. User-hosted systems are more appropriate for institutional use, since access can be controlled. Examples of user-hosted blogging applications are Wordpress, Greymatter, and Movable Type. In developer-hosted blogging the software application for creating the blog is located on a server owned by someone else who administers the hardware required to run the blog. Many developer-hosted systems allow the blogger to create and edit a blog without having to be on the Internet. With a Web interface the blogger using a developer-hosted system may create a blog entry anywhere in the world. Developer-hosted systems are provided by some Web hosting companies (e.g., Tripod, Edublogs, and SchoolBlogs.com), Internet service providers (America Online), online publications (Salon.com) and internet portals (Yahoo! 360° or Google).

Whether user-hosted or developer-hosted, the blogging application presents the blogger with a simple template containing form fields into which the blogger enters text for the title, body, and category of the blog entry. For those situations in which the blog will also contain graphic, image, audio, and/or video files the blogger simply clicks a button. Each button opens a dialog box for accepting a specific kind of information. This system of buttons and dialog boxes allows the blog software to write HTML code. Finally, with a developer-hosted blogging application the blogger clicks a publish button to finish the process and upload the entry to the Web homepage for general viewing.
However, with a user-hosted blogging application it is necessary to “upload” created Web pages to a server, similar to the way Web pages are transferred via FTP software to an Internet server where they can be accessed. Most user- and developer-hosted blogging applications provide multiple design templates so that bloggers can customize the look and feel of their blog Web site.

The blogging application also allows bloggers to update their blog home page daily. Blog entries on the home page are presented in chronological order with the most recent being at the top of the page. These blog entries may be archived after a certain period of time. In addition to providing for the creation of blogs; blogging applications also allow for the management of blog home pages. Management features usually include easy filtering of content for various presentations: by date, category, author, or other attributes, as well as allowing the administrator to grant permission for others to access and/or become authors of a blog home page.

Other features common to Web logs are blogrolls, commenting or feedback, really simple syndication (RSS), and aggregation. A blogroll is a list of other Web logs that are linked to a Web log entry or article. Blogrolls allow bloggers to provide visitors to their blog with connections to other blogs that have similar content. Blogrolls are also a way of measuring the validity of the information presented in the blog. A particular blog’s validity may be assessed by counting the number of references to that blog found in other blogs (Mills, 2006).

One of the features of blogs that define them as interactive tools, but are likely to make many teachers initially cringe, is their ability to permit Web visitors to leave comments on posted entries. Comments are usually time-stamped and identified by the author’s name and perhaps a link to their Web site or blog. On some blogs, comments are threaded so that readers can comment on other comments, but on most blogs comments are simply displayed chronologically. Many bloggers consider comments to be a critical feature of their blog. The comments on a blog are referred to as the blog’s community. Blog management systems usually allow the blogger and/or Web page manager to determine several features related to comments. For example, the blogger and/or Web page manager may determine who will be granted permission to post comments, whether comments will be posted by name or anonymously, and whether the writer of the comment may edit and/or delete the comments created.
Really simple syndication (RSS) enables Web sites that share a common interest to expand their content by publishing news headlines from other Web sites and blogs. In fact, a large news site can be entirely made up of syndication feeds. RSS was developed by UserLand in 1997. In order to receive an RSS feed, the user needs a special program that reads the XML (extensible markup language) code RSS feeds are written in. These special programs are a standard feature in the current version of most Internet browsers and e-mail programs. Free plug-ins are also available for older versions of many Internet browsers. RSS works by automatically searching those blog sites bookmarked by the user. The user is then notified of any blog entries that have been posted since the last time the user visited the blog site. New blog entries are presented to the user in a manner similar to that of a news headline ticker common in many television news networks. The notification is usually the title of the blog entry, a short description, and a link to the article for the new blog entry. This notification is referred to as the headline. The user may then choose to read a new blog posting by clicking on the headline. For a master list of syndication feeds, visit www.syndic8.com. RSS feeds can be obtained with or without a news aggregator (or news reader). A news aggregator enables the users to collect the basic text of one or many RSS publications into a single file that can be downloaded and displayed either in a browser or on the desktop via e-mail. A number of free news aggregators are available online, including AmphetaDesk, NetNewsWire, and Radio Userland. Some Internet service providers will also let subscribers add RSS feeds to their Web pages without the need for an aggregator.

BLOGS AS AN INSTRUCTIONAL TOOL

Ruth Colvin-Clark and Richard E. Mayer (2003) state that blogging is a simple technology that can be used to construct learning environments. In addition, blogging provides for the following three important factors that should be a part of e-learning activity:

1. Provides for information acquisition,
2. Provides for frequent responses from learners with immediate feedback from the instructor, and
3. Guided discovery in which the instructor provides support to students as they engage in solving real-life challenges.

Will Richardson (2006) in *Blogs, Wikis, Podcasts, and Other Powerful Webtools for Classrooms* states that learning specialists have identified the following as potential benefits for students publishing on the Internet:

- Promotion of critical and analytical thinking
- Promotion of creative, intuitive, and associational thinking
- Promotion of analogical thinking
- Potential for increased access and exposure to quality information
- Combination of solitary and social interaction

Scott Leslie (2005) categorizes the integration of blogs into the instruction as occurring along the two dimensions. These two dimensions are shown in Figure 2 along with how the use of blogs fits within these two dimensions. As shown in Figure 4 the first of these two dimensions is who the author/audience of the blog is (the instructor or the student). The second dimension is the communicative use of the blog, either as a form of expressive communication (*writing*) or as a form of receptive information (*reading/aggregating them*). As can be seen in Figure 2, the educational possibilities for using blogs in the classroom run the gamut from course management to student portfolios to collaboration, or any combination thereof.

As an expressive writing tool for students, blogs change the motivational value of writing. For example, while some students are motivated to write for an audience of one (the teacher) many students are not. By using a Web log to publish student work the teacher can fundamentally change the writing process for many or all students, because it redefines the audience and their purpose for writing. This is because when students who publish their writing to the Internet have increased their audience beyond that of the teacher or even their peers. On the Internet the audience becomes their parents, community members, and even people they have never met living in other states or other countries who will be reading and commenting on their authored works published to a blog. Charles Lowe and Terra Williams (2004) found that having their students post writing assignments on the Web forced students to think more carefully about articulation.

As an expressive writing tool for the instructor, the blog provides a way to communicate assignment requirements to students. The teacher can post grad-
Web Logs

ing rubrics for assignments as well as post examples for students to use as guides that they may use when creating their own assignment submission. In addition, the teacher can have a blog which they use to communicate with the parents of the children in their class. This parent-teacher blog could be a way for the teacher to keep parents informed about what is happening in the classroom.

For the teacher who is already using student Web logs as a way for students to turn in assignments, RSS aggregator could be used to collect student work. In this way, the teacher could scan through all student submissions in one place, make sure it is all appropriate, and then click through to a particular post in order to make a comment related to the work of a specific student. In addition, that teacher could provide individual student Web log feeds to parents so that they may keep up on how their child is doing in the class.

Students could use Web logs as a search tool. For example, a student could create an RSS feed that would bring any news published in a blog about a subject they are researching to the student’s aggregator as soon as it was published. This could be accomplished by the student adding their search terms to the following URL in place of the words “your+terms+here” (http://www.justinpfister.com/gnewsfeed.php?q=your+terms+here). It is also important if you plan to teach students this strategy that you also teach them how to evaluate the validity of information contained in a blog. This is because the vast majority of Web logs are not edited for content by someone other than the author, and invariably there will be some questionable posts that will land in their aggregator (Richardson, 2005).

REFERENCES


KEY TERMS

Blog (or Web log): A user-generated Web site where entries are made in journal style and displayed in a reverse chronological order.

Blogger: The author of a blog.

Blogging Application: A user-hosted or developer-hosted system used to create or host blogs.

Blogging Community: Individuals who make comments related to a particular blog.

Blogroll: Hyperlinks to other blogs that the blog author reads or with whom the author is affiliated.

Developer-hosted Blogging Software application: The software application for creating the blog is located
on a server owned by someone else who administers the hardware required to run the blog.

**News Aggregator:** Client software that uses Web feed to retrieve syndicated Web content such as blogs, podcasts, vlogs, and mainstream mass media Websites.

**Permalink:** The URL of the full, individual article or blog.

**Post Date:** Date and time a blog entry was published to the Internet.

**Really Simple Syndication (RSS):** A family of Web feed formats used to publish frequently updated digital content, such as blogs, news feeds, or podcasts.

**Trackback:** Hyperlinks on other sites that refer to a blog entry.

**User-hosted Blogging Software Application:** The software for creating the blog is installed on either a server administered by the user or on the users own computer.
INTRODUCTION

Traditionally, a bibliography is regarded as a list of printed resources (books, articles, reports, etc.) on a given subject or topic for further study or reference purpose (Alred, Brusaw, & Oliu, 2006; Lamb, 2006). According to the Micropaedia (1990), the bibliography refers to “study and description of books.” It is either the listing of books according to some system (enumerative or descriptive bibliography) or the study of books as tangible objects (analytical or critical bibliography). The term webliography is commonly used when discussing online resources. Although there is no clear agreement among educators regarding the origin of this term, many tend to believe that the term webliography was coined by the libraries at Louisiana State University to describe their list of favorite Web sites. It is referred to as “Web bibliography.” Accordingly, a webliography is a list of resources that can be accessed on the World Wide Web, relating to a particular topic or can be referred to in a scholarly work.

A variety of studies suggest that understanding and developing webliographies, which relate to locate, evaluate, organize, and use effectively the needed online resources, are essential for information literacy and technology integration.

BACKGROUND

The rapid technological change and proliferating information resources are lineaments of our contemporary society. Probably the most exciting and significant innovation in education in recent years is the widespread computer-based technology integrating in teaching and learning. Particularly, the World Wide Web is radically redefining how people obtain information and the way people teach and learn. Apparently, more and more educators and students have access to abundant information, and the amount of that information is growing at a staggering speed. However, “the uncertain quality and expanding quantity of information pose large challenges for society. The sheer abundance of information will not in itself create a more informed citizenry without a complementary cluster of abilities necessary to use information effectively” (Association of College & Research libraries, 2000, p. 2). When resources come to individuals as unfiltered, fragmented, and overloaded information, it increases individuals’ information anxiety. Individuals may feel confused and stressed to the overwhelming amount and variety of information available online. As a result, they are unable to access or understand the information they need, and neglect the authenticity, validity, and reliability of information. The question of how to help individuals locate large numbers of diverse and timely resources is, therefore, a major concern of those practicing in education and preparing future practitioners.

Educators have long been concerned with increasing information literacy. The term information literacy was first introduced by Paul Zurkowski in 1974, which had been described as “people trained in the application of information resources to their work can be called information literates. They have learned techniques and skills for utilizing the wide range of information tools as well as primary sources in molding information-solutions to their problems” (Behrens, 1994). Within the last decade, professional organizations have focused and promoted principles and standards of information literacy. In 1989, the American Library Association (ALA) Presidential Committee on Information Literacy called attention to information literacy at a time when many other learning deficiencies were being expressed by educators, business leaders, and parents, and issued a Final Report (1989) for meeting information literacy needs. In 1990, the National Forum on Information Literacy (NFIL) was formed as a response to the recommendations of the ALA Presidential Committee Final Report. In 1998, NFIL published A Progress Report on Information Literacy: An Update on the American Library Association Presidential Committee on Information Literacy: Final Report. In 1998, the American Association of School Libraries (AASL) and the Association of Educational Communications
and Technology (AECT) issued *Information Literacy Standards for Student Learning*. These standards detail competencies for students in K-12. In 2000, the Association of College and Research Libraries, a division of the ALA published *Information Competency Standards for Higher Education*. Today, more and more educators believe that “to be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information” (Association of College & Research Libraries, 1989). Particularly, as the Final Report noted, information literate individuals should be able to:

- Knowing when they have a need for information.
- Identifying information needed to address a given problem or issue.
- Finding needed information and evaluating the information.
- Organizing the information.
- Using the information effectively to address the problem or issue at hand.

Furthermore, The National Educational Technology Standards for Students (International Society for Technology in Education, 2000) and Teacher (International Society for Technology in Education, 2002) have attested the trend of being information literate. These standards emphasize technology integration, which personally and professionally use technology to locate, evaluate, and collect information from a variety of sources.

In an attempt to increase information literacy on Web-based resources, many educators have been either creating their own webliographies for further study/reference, or requiring students to develop webliographies as a part of learning process.

**STEPS OF DEVELOPING A WEBLIOGRAPHY**

Typically, educators and students develop their webliographies through a series of four steps: searching, evaluating, organizing, and updating Web resources.

**Searching Web resources.** As Jonassen (2000) indicated, “getting lost in hyperspace has been a consistent problem for learners using hypertext. When users follow a number of links through a variety of information sources, they get lost (lose awareness of where they are in hyperspace) and forget how they got there” (p. 177). In order to avoid aimless surfing the Web, it is important that educators and students need to focus on specific purposes, formulate and carry out their plans. Dodge (1999) suggested two sequences prior to searching the Web: 1) think about the topic. Jot all the relevant information down on scrap paper to articulate clearly a topic such as target people, terms, organizations, places, objects, and so forth. 2) create a 3M list of search terms. Specify the topic by writing words that must, might, or must not appear in the Web pages.

There are a variety of Web search engines. To use these search engines effectively, educators and students should understand how different types of search engines take actions. “Each search engine operates differently in terms of how a search term can be entered, whether Boolean logic or other advanced search capabilities are supported, and the different truncation symbols that may be used” (Jonassen, 2000, p. 181). For example, Dodge (2005) developed four NETS for better searching by using Google’s advanced search as following (see Figure 1). The N in NETS stands for starting “narrow,” put all the words that would always appear on the perfect page in the *with all of the words* field (must words); put words that may eliminate distracting pages in the *without the words* field (must not words); and put words with synonyms that might appear on the relevant page in the *with any of the words* field. The E in NETS stands for finding “exact phrases,” type a distinctive phrase into the *exact phrase* field to help find some predictable pages. The T in NETS stands for “trimming” back the URL to relocate relevant and missed pages. The S in NETS stands for looking for “similar” pages, use Google’s similarity search to surface a number of sites that are likely to be relevant and interesting.

**Evaluating Web resources.** Locating the relevant information is one thing, deciding whether those resources are useful is another thing. Evaluating Web resources may be time consuming, but it is essential for developing an appropriate and valuable webliography. There are many ways to evaluate Web resources, of which the most frequently quoted and adopted one is Kapoun’s (1998) five criteria, as shown in Table 1.

Meanwhile, some educators are infusing the idea of “triangulation” into their teaching, which requires
students to find and compare three (more or less) sources that address the same thing so that they can engage critical, creative, and complex thinking skills through the evaluation process (Jonassen, 2000).

Organizing Web resources. Currently, there is no standard and specific format for developing a webliography. Some existing webliographies simply include a number of Web links that appear as “patchworks.” The way that these “patchworks” are presented, and how they are organized, is problematic and questionable. Not only does it not help developers to articulate their intentions, but also it does not show necessary information to other users. One of the main purposes of the webliography in education is that it allows educators and students to select and list Internet sources relevant to the topic or theme that can be used for the future references or projects. To fulfill this purpose, many educators suggest that a webliography should be the annotated bibliography. Like a typical annotated bibliography, a well-developed webliography should include completed bibliographic information about a source, followed by a brief annotation of what the source contains. Bibliographic information includes author, title, URL address, publisher, and date of each item/source. The list of sources is usually arranged alphabetically or chronically followed American Psychological Association (APA) or Modern Language Association (MLA) citation style. Annotation part includes a brief description to summarize the central theme and scope of the source, and a concise evaluation to comment on the authority or background of the author, the intended audience, relevance and usefulness, and strength and weakness of the source, and so forth.

Updating Web resources. Web resources are extremely abundant and dynamic. What is true today is often outdated tomorrow. Therefore, it is crucial for educators and students to periodically update their webliographies in order to delete outdated or unavailable sources and to add new relevant sources. The updating process serves two purposes: first, it provides an opportunity for educators and students to reinforce the ability to locate, evaluate, and use effectively the needed information; second, it keeps a webliography alive that can be used for the future references or projects.

CONCLUSION: THE WAY FORWARD

Understanding and developing a webliography can greatly improve individual’s information literacy. As Engle, Blumenthal, and Cosgrave (2007) noted, the process of creating an annotated bibliography alone requested the application of a variety of intellectual skills: concise exposition, succinct analysis, and in-
formed library research. In spite of significant benefits, the various potentials of weblogs on teaching and learning are yet to be determined and fulfilled. There are some limitations of existing conventional weblogs. On one hand, developing and posting such a weblog on the Internet still requires educators and students to have the skills and knowledge of tools such as Web-editing software and FTP clients, which can be daunting to them; on the other hand, the published weblog can only be read by other viewers, and who are incapable of leaving reviews and feedback; thus, they are limited for Web-based interaction, communication, and collaboration. It appears that reforming a new type of weblog that simplifies the technology part of publishing content yet allows developers and viewers to share resources and ideas for reflection and collaboration is much needed.

Weblogs, for instance, are considered to be the means that could reduce the technical barriers to effective Web publishing significantly (Martindale & Wiley, 2005). Martindale and Wiley (2005) summarized some distinctive features of a Weblog such as automatic formatting of content in the form of “headlines,” followed by “entries,” or “stories”; time and date stamp of entries; archiving of past entries; a search function to search through all entries; a “blogroll”—a list of other blogs read by the author(s) of the current blog; a section associated with each entry where readers can post comments on the entry; simple syndication of the site content via RSS (Really Simple Syndication); and so forth. These features make Weblogs very effective and attractive to users in two-fold: a Weblog developer can edit or update a new entry without much knowledge of programming, formatting, and FTP; meanwhile, a Weblog is constantly comprised of reflections and conversations from developer and viewers; it stimulates interaction (Downes, 2004; Martindale & Wiley, 2005; Richardson, 2006). Eide and Eide (2005) investigated Weblogs on brain structure and function, and found that Weblogs could:

- Promote critical and analytical thinking.
- Be a powerful promoter of creative, intuitive, and associational thinking.
- Promote analogical thinking.
- Be a powerful medium for increasing access and exposure to quality information.

Table 1. Five criteria for evaluating Web pages (Source: Kapoun, J. (1998). Used with permission.)

<table>
<thead>
<tr>
<th>Evaluation of Web documents</th>
<th>How to interpret the basics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Accuracy of Web Documents</td>
<td>Accuracy</td>
</tr>
<tr>
<td>- Who wrote the page and can you contact him or her?</td>
<td>• Make sure author provides e-mail or a contact address/hone number.</td>
</tr>
<tr>
<td>- What is the purpose of the document and why was it produced?</td>
<td>• Know the distinction between author and Webmaster.</td>
</tr>
<tr>
<td>- Is this person qualified to write this document?</td>
<td></td>
</tr>
<tr>
<td>2. Authority of Web Documents</td>
<td>Authority</td>
</tr>
<tr>
<td>- Who published the document and is it separate from the “Webmaster”?</td>
<td>• What credentials are listed for the author(s)?</td>
</tr>
<tr>
<td>- Check the domain of the document, what institution publishes this document?</td>
<td>• Where is the document published? Check URL domain</td>
</tr>
<tr>
<td>- Does the publisher list his or her qualifications?</td>
<td></td>
</tr>
<tr>
<td>3. Objectivity of Web Documents</td>
<td>Objectivity</td>
</tr>
<tr>
<td>- What goals/objectives does this page meet?</td>
<td>• Determine if page is a mask for advertising; if so information might be biased.</td>
</tr>
<tr>
<td>- How detailed is the information?</td>
<td>• View any Web page as you would an infomercial on television. Ask yourself why was this written and for whom?</td>
</tr>
<tr>
<td>- What opinions (if any) are expressed by the authors?</td>
<td></td>
</tr>
<tr>
<td>4. Currency of Web Documents</td>
<td>Currency</td>
</tr>
<tr>
<td>- When was it produced?</td>
<td>• How many dead links are on the page?</td>
</tr>
<tr>
<td>- When was it updated?</td>
<td>• Are the links current or updated regularly?</td>
</tr>
<tr>
<td>- How up-to-date are the links (if any)?</td>
<td>• Is the information on the page outdated?</td>
</tr>
<tr>
<td>5. Coverage of the Web Documents</td>
<td>Coverage</td>
</tr>
<tr>
<td>- Are the links (if any) evaluated and do they complement the documents theme?</td>
<td>• If page requires special software to view the information, how much are you missing if you don’t have the software?</td>
</tr>
<tr>
<td>- Is it all images or a balance of text and images?</td>
<td>• Is it free, or is there a fee, to obtain the information?</td>
</tr>
<tr>
<td>- Is the information presented cited correctly?</td>
<td>• Is there an option for text only, or frames, or a suggested browser for better viewing?</td>
</tr>
</tbody>
</table>
Webliography: Conception and Development

- Combine the best of solitary reflection and social interaction.

Weblogs, therefore, have shown a great deal of potential impact on the webliography development, and have supported students' self-reflection, interaction, and collaboration on their learning.

REFERENCES


KEY TERMS

*Annotated Bibliography:* It refers to an alphabetical list of sources (books, journals, Web sites, periodicals, etc.). In addition to bibliographic data, an annotated bibliography usually includes a concise summary and evaluation of each source.
**Information Anxiety:** It refers to the stress caused by the inability to access or understand the needed information. It is caused by information overload, lack of clear organization to information, insufficient information, excessively difficult presentation of information, and so forth. (Retrieved March 25, 2007, from http://www.usabilityfirst.com/glossary/term_787.txt)

**Information Literacy:** It refers to a constellation of skills revolving around information research and use. According to the Final Report of the American Library Association Presidential Committee on Information Literacy (1989), the information literate person is, “able to recognize when information is needed and have the ability to locate, evaluate, and use it effectively.” (Retrieved March 25, 2007, from http://www.ala.org/ala/acrl/acrlpubs/whitepapers/presidential.htm)

**Information Pollution/Overload:** It refers to the state of having too much information to make a decision or remain informed about a topic. According to Jakob Nielsen, “Excessive word count and worthless details are making it harder for people to extract useful information. The more you say, the more people tune out your message.” (Retrieved March 25, 2007, from http://www.useit.com/alertbox/20030811.html)

**K-12:** It refers primary education and secondary education in North America, from Kindergarten level to the 12th grade.

**Search Engine:** It refers to an information retrieval system to retrieve a list of items that match specific criteria (key word or phrase). Usually it refers to a Web search engine that searches for information on the public Web.

**Technology Integration:** It refers to describe effective uses of technology by teachers and students for teaching and learning in content areas.

**Weblog/Blog:** It refers to a Web site where entries that an author created are made in journal style and displayed in a reverse chronological order. It allows an author to publish instantly to the Internet from any Internet connection.
WebQuest: Learning Through Discovery

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INTRODUCTION

The Internet has a vast array of information resources that educators and students can access when studying a particular topic. There are millions of different types of Web sites available on the Internet that could prove useful in the learning process. However, this wealth of Web resources can create problems determining which sites are valid, credible, and up-to-date. In addition, students become overburdened in locating applicable Web resources when completing coursework due to the quantity of Web sites (Faichney, 2002). WebQuests have increased in educational popularity by helping students perform inquiry-based and/or cooperative learning that is planned and organized. The need for students to cipher through numerous Web sites to determine applicability and authenticity is unnecessary because the research has already been performed and validated by the teacher in WebQuests. This article explains the role that WebQuests play in structuring curriculum content and giving students an authentic investigatory experience. The principles and components of WebQuests are described first to provide a foundation for their applications in instruction. Applications and methods of integration are also addressed to offer educators ideas on integrating WebQuests into the curriculum.

BACKGROUND

WebQuests have become popular tools for integrating Internet resources into existing curriculum content and have expanded rapidly in popularity. They are presently the most common tool used for the integration of technology into the classroom environment (Lamb & Teclechaimanot, 2005). In the past 10 years, WebQuests have evolved from a basic knowledge acquisition tool into exercises that enhance critical thinking skills through the integration of knowledge, analysis, and application strategies structured around a particular issue or social problem. WebQuests are usually presented as hyperlinked documents that link relevant resources to the specified problem. Developing WebQuests can provide students with an effective tool for locating and evaluating online information.

Defining WebQuests

This instructional method was originally developed by Dodge (1997) and March (2004) at San Diego State University in 1995. March defined WebQuests in 2003 as a “scaffolded learning structure that uses links to essential resources on the World Wide Web and an authentic task to motivate students’ investigation of a central, open-ended question” (¶ 10). A WebQuest is an inquiry-based learning activity that requires students to interact with resources located on the Internet, develop collaborative learning skills, and engage in higher level learning (Sandars, 2005; Zheng, Stucky, McAlack, Menchana, & Stoddart, 2005). WebQuests are built upon the constructivist paradigm using cooperative learning frameworks such as scaffolding as important design criteria. Cooperative learning is the instructional use of small groups to maximize individual and group learning and is tailored to activities that are well-defined and contain logical problems (Mills, 2006). Scaffolding provides structure to the learning experience by clearly defining the purpose and boundaries of student exploration in examining a case study or problem (McKenzie, 1999).

Structured technology projects such as WebQuests fall into this category. Through a structured process such as scaffolding, WebQuests affect student achievement by transforming what they read into a new understandable and relative form (March, 2003; Zheng et al., 2005). Finally, depending upon the instructional goal, WebQuests can be either long-term or short-term (Johnson & Zufall, 2004). Long-term WebQuests can involve a week or month’s time during which the learner is required to extend and refine the information through
analysis and demonstration. Short-term WebQuests can take between one and three class sessions and involve learners in knowledge acquisition and in integration of new information.

**Instructional Principles**

In terms of educational applications, March (1998) and Christie (2002) have identified several educational principles that support the use of WebQuests in instruction. March (1998) explains that the instructional features of WebQuests work to increase student motivation by engaging in real-world learning activities, developing critical thinking skills to transform information into useful knowledge, and supporting teamwork and cooperation by requiring student participation. Christie (2002) expands upon these three principles by adding additional components such as the (a) encouragement of reasoning skills involved in a problem-solving process, (b) requirement of students to interpret, analyze, evaluate, and draw inferences, (c) promotion of social skills that also helps increase one’s appreciation of diversity, (d) facilitation of students to reflect, analyze, and evaluate their own thinking, and (e) fostering of interdisciplinary learning. WebQuests provide a method for integrating Web-based learning activities into the curriculum that foster appropriate instructional principles.

**Design of WebQuests**

According to Bernie Dodge (1997), there are six essential elements in an effective WebQuest: introduction, task, process, resources, evaluation, and conclusion. All of these elements have a specific purpose that contributes to a successful WebQuest.

1. The introduction explains the issues and establishes the problem setting.
2. The selected task must be intellectually engaging and within the ability of the students to achieve.
3. A set of references or sources that have been preselected for the students to review are given. These sources usually include sources on the World Wide Web, but may also include other hard copy sources and interviews.
4. An explanation of the process or the procedural steps detailing what the students need to complete that addresses the task.
5. A structuring or scaffolding device that provides guidance and resources to the students on how to organize the new information.
6. A summary or conclusion to review what is learned in the experience and highlights how this new knowledge can be applied to other applications or subjects.

Although Dodge initially did not require that the WebQuest include such elements as group activities, role-plays, or interdisciplinary instruction, his original conception included these attributes (Dodge, 1997). Others have expanded the application of the WebQuest into these areas. WebQuests have been promoted as a tool for the development of discovery learning activities in group settings (Castonia, 2002) and literature role playing (Teclehaimanot & Lamb, 2004), and as a tool to integrate subject area content with technology (Smith-D’Arezzo, 2002).

The current model used in some WebQuests differs from Dodge’s original template by the inclusion of a credits and references page or a page that provides information for teachers. In addition, the current template combines the processes and resources into a single component that is usually organized as a Web page with several sections or a set of linked Web sites (Mills, 2006). Nonetheless, whichever model has been used, WebQuests have been promoted as a technique to improve critical thinking skills (Felix 2003; Kanuka, 2005; Vidoni & Maddux, 2002). WebQuests are well received by students, as well as teachers, who believe that this method is more intellectually engaging to the student (Castonia, 2002; Lara & Repáraz, 2005). As a result, this instructional method has spread into nearly every academic subject area including mathematics, science, physical education, history, and career education (March, 2006a).

**Essential Elements of Effective WebQuests**

The core of WebQuest design can be described as five distinctive elements: problem introduction, task alignment with objectives, clearly defined activities, cognitive progression, and the selection of appropriate resources. The introduction presents an authentic scenario problem that is easily approachable for the intended audience. The required tasks to be completed and the processes applied in the WebQuest are based
upon competencies required in the course. The activity clearly guides the student from basic understanding to higher order skills though the use of clear and bounded directions. Success at these tasks is expected at appropriate cognitive levels. Quality resources are provided that offer information that could not be easily duplicated without Internet access.

A commonly used acronym developed by Dodge (2001) called FOCUS summarized these elements as:

- Find great sites.
- Orchestrate your learners and resources.
- Challenge your learners to think.
- Use the medium.
- Scaffold high expectations. (¶ 4)

**WEBQUESTS IN EDUCATION**

**Instructional Uses of WebQuests**

The primary reason for implementing WebQuests as instructional tools is to make learning of material interesting for the students (Network for Instructional TV, 2001). First, the power of the Internet is placed upon the hands of students in which they discover information for themselves. Instead of just telling students the information, students can explore, interpret, and evaluate the information gathered to draw their own conclusions. As with many research projects, students often feel that they are basically collecting and regurgitating information on paper. WebQuests, on the other hand, allow students to examine and use their imagination and problem-solving skills (Starr, 2002).

WebQuests also allow students to work at their own pace, either individually or in teams (Network for Instructional TV, 2001). This permits flexibility in learning as students use metacognitive strategies to self-monitor and plan their learning experiences. These strategies pertain to the student’s capability of setting goals for learning, estimating the success with which goals are being met, and selecting alternative strategies to meet the goals. Because WebQuests are adaptable, students can determine what, when, and how to complete their learning experience.

Although students can explore the topic in-depth, they are still limited to the content that teachers have selected (Network for Instructional TV, 2001). This condition is ideal for classroom situations in which students have varying ability levels. In addition, because teachers have already reviewed the Web sites for content, student safety on the Internet is not a major concern. This is important because nearly one fourth of students using the Internet have reported feeling uneasy while using the Internet and there is little evidence that adults are effective at monitoring safe Internet practices by adolescents (Stahl & Fritz, 2002). Vetting sites is a workable and reasonable solution for creating a safe virtual learning environment.

By their design, WebQuests offer a dynamic approach toward Internet research and help increase student’s comfort level (Network for Instructional TV, 2001). Although most students may be knowledgeable in surfing the Internet and in using online resources, some may need additional practice. Allowing students to explore resources through a bounded experience that helps develop discriminate research and technology skills. Thus, WebQuests have many benefits in the instructional and learning environments.

**Tools**

A multitude of tools exist on the World Wide Web to aid teachers in the creation of effective WebQuests. These include design templates (San Diego City Schools, 2001), interactive design tools interactive design tools such as *Web and Flow* (March & Reed, 1999) and *Fila-mentality* (March, Reed, & Woods, 2006), evaluation rubrics (Bellofatto, Boh, Casey, Krill, & Dodge, 2001), and tutorials (Network for Instructional TV, 2001).

WebQuest templates have been developed based on both paper and Web-based formats. Formats have been further divided to the types of tasks that the student is expected to perform such as design, decision, analysis, predictive, and creative tasks (WebQuest Design Patterns, n.d.). Web-based templates and design tools such as *QuestGarden* guide the nonprogrammer through creating a WebQuest intended to be delivered on the World Wide Web (Dodge, 2006; March et al., 2006; Schellenberg, 2004). Other templates and tools intended for use with Dreamweaver or XHTML and CSS are available for the more advanced Web designer (Schellenberg, 2004).

Evaluation rubrics further refine the effectiveness of WebQuests by providing base criteria in the design of WebQuest elements. These are defined by Dodge that includes aesthetics and mechanics, cognitive and
motivational effectiveness of the introduction, task alignment with the curriculum and intended cognitive level, clarity of the scaffolding, quality of resources, and defined evaluation criteria. (Bellofatto, Boh et al., 2001; Dodge 2001). March (2006b) offered a broader perspective and included an assessment criteria based on the use of role play, the development of transformational thinking, and transference to real world applications.

Others add additional emphasis to the importance of complexity in character development for role plays and creativity in problem solving (Spartanburg School District 3, n.d.). Although WebQuests are still evolving, the major criteria of a defined problem or scenario researched through given quality resources with the intention to develop higher level cognitive skills appears to be a universally accepted standard for WebQuest design.

Online tutorials for WebQuest design are widely available ranging from basic presentation materials such as PowerPoint presentations to self-paced tutorials (Brooks & Byles, 2005; Network for Instructional TV, 2001). More advanced developmental tools guide writers through the creation of their own WebQuests using templates based on XHTML and CSS (Schellenberg, 2004), and through the use of online authoring tools such as QuestGarden (Dodge, 2006). These tools provide frameworks allowing the user to focus on content refinement that should significantly speed up developmental time (Dodge, 2005).

This availability of resource material for the WebQuest designer has resulted in a number of extensive libraries of existing WebQuests posted by school districts (Saskatoon East School Division, 2004), as well as individual educators (Pearl-Hodgins, 2005). Due to these existing extensive resources, it is reasonable to expect that WebQuests will continue to increase in popularity in the coming decade.

Effectiveness

Research into the effectiveness of WebQuests is limited. In a study comparing WebQuests with traditional laboratory presentation methods in biology, no statistically significant difference in student achievement was found between the two methods (Burke, Guffey, Colter, & Riehl, 2003). Strickland and Nazzal (2005) found WebQuests to be less effective at presenting history content compared to other types of group activities such as poster projects. In comparison to other instructional strategies such as debate, nominal groups, brainstorming, invited guests, and case studies, Kanuka (2005) found WebQuests to be particularly effective at developing higher order thinking skills. The difference could be attributed to WebQuests being more effective at developing higher order thinking skills such as analysis and evaluation and less effective as an introductory lesson intended to develop the understanding of basic subject area content.

Evaluation

A successful WebQuest places content in context by permitting students to learn about a topic within larger framework (Network for Instructional TV, 2001). Furthermore, a good WebQuest explores a topic as part of an interdisciplinary unit so that students can see the relationships between concepts rather than as separate facts or discipline-specific areas. WebQuests that are effective also contain a good hook to get students involved and motivated to take on the task. Ensuring that WebQuests are age and ability appropriate can help the student complete the activity effectively. Maintaining student interest by incorporating visuals and audio can make the teaching tool productive. Including multimedia such as pictures, maps, animations, videos, and sounds can not only assist students in understanding concepts, but preserve the attention of students to the task. A built-in evaluation system is also required to help students remain on track and know what is to be expected.

Tom March (2000) suggests evaluating WebQuests using the principles of the 3 R’s: real, rich, and relevant. Right from the Introduction and Task, the objective of the WebQuest should be realistic and pertains to topics and issues faced by people in the real world. Ensuring that the task undertaken by students is realistic helps authenticate their experiences. In addition, student projects from WebQuests need to be viewed by others to be real. Completing a project without any feedback from others does not help motivate students to write. Student work should be validated by arranging their projects to receive feedback from real-world individuals whether they are students, teachers, experts, and so forth. The second principle is to introduce students to interesting thematic relationships and contrasts that create a rich environment. By adding richness within the scope of the topic, students will know what to expect and envision the holistic picture. Finally, the WebQuest
must be relevant to the students or otherwise they will lose interest in the task. Because of the interdisciplinary nature of WebQuests, using activities, information, tasks, and so forth, that is important to students will help students bridge the old information with the new. If the task or topic is not relevant, then the connection will not be made.

There are different ways to assess WebQuests. However, the easiest form is to use a rubric that divides the components of the WebQuests into different areas. These rubrics also serve as a good checklist for the WebQuest creator. These rubrics can be obtained online and were created by Tom March (http://www.ozline.com/webquests/rubric.html) and Bernie Dodge (http://edweb.sdsu.edu/webquest/webquestrubric.html). The rubrics may vary a little in terms of areas of assessment, but they do have commonalities. Common areas addressed are task, relevancy, navigation/flow, resources used, transformative thinking/cognitive effectiveness, and richness of the process. These rubrics can help the WebQuest creator evaluate whether the WebQuest is effective and whether any modifications need to be completed to meet the conditions set forth in the rubrics.

FUTURE ISSUES AND CONSIDERATIONS

March (2004) proposes that WebQuest design should require students to reach new conclusions or applied knowledge in a new problem in order for this method to be truly effective. Because this is an admittedly difficult task, it is speculated that many WebQuest designs may be less sophisticated exercises that come closer to Internet questionnaires rather than being true WebQuests. Like many technology-based instructional methods, WebQuests presuppose that the teacher is comfortable with technology and is motivated to spend the time to fully develop the resource. Because teachers who developed their own Web pages have been found by Perkins and McKnight (2003) to be more likely to create and use WebQuests, a higher level of comfort with the online environment seems to be a characteristic of teachers who are interested in developing these materials. WebQuest development is a time-consuming task and it may be that as the advancement of authoring tools reduces the required developmental time that these exercises could advance in the complexity of their design and in their effectiveness. The need for training in this technique is already being recognized by the inclusion of WebQuest author training in some teacher preservice programs (Bellofatto, Casey, & Krill, 2000; Joyce & Stohr-Hunt, 2003).

CONCLUSION

WebQuests are an effective way of using the vast resources on the Internet to help students gain practical knowledge through the use of the computer. As technology advances, teachers and students can take advantage of the many opportunities available on the Internet. Furthermore, WebQuests are effective for developing critical thinking skills because they use an inquiry-based model. WebQuests also embody the constructivist principles of cooperative learning and scaffolding that promote learning due to their realism and relevancy. Based upon the nature of WebQuests, the most effective use of this method would be in subject areas that allow for intellectual exploration and speculation, rather than content areas that require strict right or wrong answers. Like any instructional method, teachers need training or independent study and the willingness to commit the time to create quality instructional products. WebQuests require time to develop, assess, and produce the content, task, process, resources, evaluation instruments, and to offer an informative and useful conclusion. WebQuests can be a fun and interactive way for students to learn material on a given topic by forming relationships and developing their own inferences. In fact, students can take ownership of the knowledge for they are the ones who completed the tasks through self-discovery and examination. This ownership becomes the reward for students—a product they can call their own.

REFERENCES


Webquest


KEY TERMS

**Constructivism**: A philosophical theory that defines reality based experiences and individual interpretations of those experiences to construct reality. In education, constructivism is the concept that requires reflection and connection to a larger reality to be effectively adopted by the learner.

**Cooperative Learning**: This instructional method uses small groups to solve a common problem or examine a common topic. The intent is to encourage effective group work habits that emphasize the importance of each individual member’s contribution.

**Inquiry-Based Learning**: Instruction based on a progression of inquiries or questions that lead the student to examine the topic of investigation in-depth with the ultimate goal of developing possible solutions. Students begin with an essential question that frames a problem, proceed to definitional questions, and then research and assess related resources. This information is then applied to the development of possible solutions which are evaluated in the final phase of the experience.

**Process**: A progressive set of stages that create change through a series of events or actions. The process includes suggestions that learners can take to complete a given task.

**Scaffolding**: An organization of knowledge from abstract to applied and simple to complex so that the learner will progress in understanding from low levels of understanding towards more complex levels of understanding. Scaffolding provides more structured learning at the beginning of the process and reduces that structure as the student advances, thereby transferring the responsibility for learning from the teacher to the structure.

**Task**: A specific action that is observable and measurable and is a subset of a larger process or action. Successful task completion is the foundation of mastery for more complex skills that combine the application of multiple task based skills.

**WebQuest**: A scaffolded learning experience that is anchored on a central problem and researched through given quality resources. The intention is to develop higher level cognitive skills.
Wide Area Networks

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INTRODUCTION

When network services must be distributed over large geographic areas, it is essential to have an understanding of the telecommunication systems on which such distribution depends. One of the most significant differences between wide area networks (WANs) and local area networks (LANs) is the general dependency on third-party carriers to provide these transmission services. Whenever data is being sent across a WAN it must be routed between locations.

PHYSICAL WIDE AREA NETWORKING TRANSMISSION

WAN transmission technologies and services fall into two overall categories. This categorization is based largely on WAN services as they are organized by and purchased from carriers. Local loop transmission provides bandwidth to customer locations. Local loop transmission services generally provide access to the carrier network. Broadband transmission typically refers to transmission services offering greater than 1.544Mbps transmission rates.

The 1.544Mbps standard is part of a hierarchy of standards known as the Digital Service Hierarchy or DS standards. Table 1 shows the digital services hierarchy for both North America and Europe (CCITT). The digital service standards are independent of the standards for transmission, which provide the bandwidth on the circuit. Technically speaking, a DS-1 is not the same as T-1 but the two terms are often used interchangeably. To be exact, a T-1 transmission service modulates a DS-1 signal on two twisted pair of wires.

Table 1. Digital service hierarchies

<table>
<thead>
<tr>
<th>US Digital Service Hierarchy</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Service Level</td>
<td>Number of Voice Channels</td>
<td>Transmission Rate</td>
<td>Corresponding Transmission Service</td>
</tr>
<tr>
<td>DS-0</td>
<td>1</td>
<td>64 Kbps</td>
<td>DC-0</td>
</tr>
<tr>
<td>DS-1</td>
<td>24</td>
<td>1.544 Mbps</td>
<td>T-1</td>
</tr>
<tr>
<td>DS-1C</td>
<td>48</td>
<td>3.152 Mbps</td>
<td>T1-C</td>
</tr>
<tr>
<td>DS-2</td>
<td>96</td>
<td>6.312 Mbps</td>
<td>T-2</td>
</tr>
<tr>
<td>DS-3</td>
<td>672</td>
<td>44.736 Mbps</td>
<td>T-3</td>
</tr>
<tr>
<td>DS-4</td>
<td>4,032</td>
<td>274.176 Mbps</td>
<td>T-4</td>
</tr>
<tr>
<td>CCITT Digital Hierarchy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Service Level</td>
<td>Number of Voice Channels</td>
<td>Transmission Rate</td>
<td>Corresponding Transmission Service</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>2.048 Mbps</td>
<td>E-1</td>
</tr>
<tr>
<td>2</td>
<td>120</td>
<td>8.448 Mbps</td>
<td>E-2</td>
</tr>
<tr>
<td>3</td>
<td>480</td>
<td>34.368 Mbps</td>
<td>E-3</td>
</tr>
<tr>
<td>4</td>
<td>1,920</td>
<td>139.264 Mbps</td>
<td>E-4</td>
</tr>
<tr>
<td>5</td>
<td>7,680</td>
<td>565.148 Mbps</td>
<td>E-5</td>
</tr>
</tbody>
</table>
**T-1 Transmission**

Standards were required to define the size and structure of digital communications links. The standard for digital transmission circuits in North America is known as a T-1 with a bandwidth of 1.544Mbps. The E-1 standard for digital transmission utilized in other parts of the world provides a bandwidth of 2.048Mbps.

The T-1 transmission standard is divided into twenty-four 64kbps channels, each of which is known as a DS-0. Each channel consists of a group of eight bits known as a time slot. Each time slot represents one voice sample or a byte of data to be transmitted through the T-1 switching architecture using time division multiplexing (TDM) techniques.

T-1 circuits are examples of leased or private communication lines. As a dedicated service, the T-1 differs from circuit-switched lines in several ways: Leased lines do not provide dial tone; the circuit should remain up and operational at all times.

In some cases, multiple 64kbps channels within a T-1 transport circuit are provided to a customer that does not require the full T-1 bandwidth. A Fractional T-1 or FT-1 only provides a subset of the 24 available DS-0s within a T-1. While the full T-1 circuit must be physically delivered to the customer premises, the customer only pays for the number of 64kbps channels enabled. The ability of FT-1 to provide the bandwidth necessary for customer applications, in 64kbps increments, has made it very attractive service offering.

In order to access a T-1 service, customers may use a variety of T-1 access technologies. The fundamental T-1 access technology is the CSU/DSU (channel service unit/data service unit). This device interfaces directly to the carrier’s termination of the T-1 service and the customer’s equipment.

**SONET and SDH**

SONET (synchronous optical network) is an optical transmission service similar to the T-1 transmission service. The primary difference between T-1 and SONET transmission services is the higher transmission capacity of SONET due to its fiber optic media. SONET is defined by ANSI (American National Standards Institute) in the T1.105 and T1.106 standards.

Just as the digital service hierarchy defined levels of service for traditional digital services, optical transmission has its own hierarchy of service levels. In the United States, SONET is used; however, international countries use the synchronous digital hierarchy (SDH). Whereas the SONET hierarchy makes use of synchronous transport signals (STS), the SDH hierarchy makes use of synchronous transport modules (STM). As shown in Table 2, these two service hierarchies utilize the same data rates, but at different service levels. Fortunately, service levels of the same transmission rate allow for interoperability between North American and international network systems.

SONET is flexible in its definition of the use of its payload area. It can map DS-0 (64Kbps) channels into the payload area or it can map an entire T-1. These flexibly defined channels are known as virtual tributaries or VTs.

The architecture of a SONET network is based on a layered hierarchy of transport elements and associated technology. Understanding the differences between these various SONET transport elements is vital to understanding how to build a SONET network.

Accessing SONET services requires the local carrier to bring the fiber-based ring directly to a location and to assign dedicated bandwidth to each SONET customer. Add-drop multiplexers, sometimes referred to as broadband bandwidth managers or cross-connect switches, are the customary type of hardware used to

<table>
<thead>
<tr>
<th>SONET Level</th>
<th>SDH Level</th>
<th>Transmission Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS-1</td>
<td>STM-0</td>
<td>51.84 Mbps</td>
</tr>
<tr>
<td>STS-3</td>
<td>STM-1</td>
<td>155.52 Mbps</td>
</tr>
<tr>
<td>STS-12</td>
<td>STM-4</td>
<td>622.08 Mbps</td>
</tr>
<tr>
<td>STS-48</td>
<td>STM-16</td>
<td>2.488 Gbps</td>
</tr>
<tr>
<td>STS-192</td>
<td>STM-64</td>
<td>9.953 Gbps</td>
</tr>
<tr>
<td>STS-768</td>
<td>STM-256</td>
<td>39.81 Gbps</td>
</tr>
</tbody>
</table>
access SONET services. In some cases, ATM switches are equipped with SONET interfaces for direct SONET access.

SONET network capacity can be increased substantially using wavelength division multiplexing. By transmitting more than one wavelength (color) of light simultaneously on a given single-mode fiber, multiple optical signals can be transmitted simultaneously. Individual DWDM wavelengths are referred to as lambdas.

LOGICAL WIDE AREA NETWORK CONNECTIVITY

Once the underlying transmission technologies are in place, a means of providing logical connections across the WAN must be developed. Switching allows temporary connections to be established, maintained and terminated between sources and destinations. There are two primary switching techniques employed: circuit switching and packet switching.

A circuit switched network provides dedicated bandwidth on circuits created between two devices for their sole use. In a packet switched network, packetized data is transported across circuits between packet switches along with the data of other users of the same packet switched network.

Remember that packets are specially structured groups of data that include control and address information in addition to the data itself. These packets must be assembled (control and address information added to data) somewhere before entry into the packet switched network and must be subsequently disassembled before delivery of the data to the message destination. This packet assembly and disassembly is done by a device known as a PAD or packet assembler/disassembler. PADS may be standalone devices or may be integrated into specially built modems or multiplexers.

Another way in which packet switching differs from circuit switching is that as demand for transmission of data increases on a packet switched network, additional users are not denied access to the packet switched network. Overall performance of the network may suffer, errors and retransmission may occur, or packets of data may be lost, but all users experience the same degradation of service. This is because, in the case of a packet switched network, data travels over any available path within the network rather than waiting for a switched dedicated path as in the case of the circuit switched network.

In order for any packet switch to process any packet of data bound for anywhere, it is essential that packet address information be included on each packet. Each packet switch then reads and processes each packet by making routing and forwarding decisions based upon the packet’s destination address and current network conditions. These self-sufficient packets containing full source and destination address information plus a message segment are known as datagrams.

A switching methodology in which each datagram is handled and routed to its ultimate destination on an individual basis is known as a connectionless packet network. It is called connectionless because packets do not follow one another down a particular path through the network. Datagrams may be sent along multiple possible paths to the destination address, therefore there is no guarantee of their safe arrival. This lack of inherent error-detection or flow-control abilities is the basis for connectionless packet networks also being known as unreliable packet networks.

In contrast to the connectionless packet networks, connection-oriented or reliable packet networks establish virtual circuits enabling message packets to follow one another, in sequence, down the same connection or physical circuit. Unlike a connectionless service, a connection-oriented service, because of the establishment of the virtual circuit, can offer checksum error-detection with ACK/NAK re-transmission control and flow-control.

Connection-oriented packet switching networks actually define two types of virtual circuits: switched virtual circuits (SVC) and permanent virtual circuits (PVC). The switched virtual circuit connection is terminated when the complete message has been sent and a special clear request packet causes all switched virtual circuit table entries related to this connection to be erased. The virtual circuit table of the permanent virtual circuit is not erased, making the PVC the equivalent of a “virtual” circuit-switched leased line.

LOGICAL WAN CONNECTIVITY TECHNOLOGIES

There are three main WAN connectivity technologies currently in use: frame relay, asynchronous transfer mode (ATM) and multi-protocol label switching (MPLS).
Frame Relay

Frame relay utilizes a network of frame switches to route data from one point in the network to another. Unlike a leased line, frame relay sessions share bandwidth between sites. Data is placed onto the frame relay network by a frame relay assembler/disassembler or FRAD. The frames which a frame relay network forwards are variable in length with the maximum frame transporting nearly 8000 characters at once.

Frame relay networks most often employ permanent virtual circuits (PVC) to forward frames from source to destination through the frame relay cloud. Switched virtual circuit (SVC) standards have been defined but are not readily available from all carriers. An SVC is analogous to a dial-up call; in order to transport data over an SVC-based frame relay network, tributary client-systems must communicate call set-up information to the frame relay network before sending information to or receiving information from a remote frame-relay device.

A key advantage of frame relay over circuit-switched technologies, such as leased lines, is the ability to have multiple virtual circuits supported from a single access line. This allows for the creation of a logical mesh through a frame relay core to geographically distributed locations. Another feature that is appealing for LAN interconnection is that frame relay is merely a delivery service.

ATM

ATM was the first widely accepted standard for cell-relay transmission services. The key physical difference between cell relay and frame relay is that, unlike the variable length frames associated with frame relay, ATM cells are a fixed length of 53 octets.

Since ATM switches utilize very short, fixed-length cells, they can process information much faster than frame relay switches. Fixed-length cells allow for virtual circuits (VCs) to be forwarded in hardware as opposed software. In addition, the fixed-length cells are enhanced with connection-oriented services. The predictability and consistency of transmission that is associated with ATM make this technology a good choice for transporting real-time services (voice and video) as well as data. Access to the ATM core is typically provided by T-carrier services (T-1 or T-3); however, SONET is used as the physical-layer protocol within the network core. As a result, the transmission rates associated with core ATM networks are only limited by the SONET standards and concatenated OC-192c ATM services are common in large service-provider networks.

ATM is presently defined by two different cell formats. The first is called the user-to-network interface (UNI), which carries information between a client device and the core ATM network. The second cell format is known as the network-to-network interface (NNI). Cells with the NNI format are used to carry information between core ATM switches. The UNI cell format allows for more bits in the ATM cell header to be utilized for virtual channel identification (VCI) since these identifiers are more prolific at the ATM network edge for distribution of information to tributary systems.

User inputs of data, video, or voice must be processed into fixed length ATM cells before they can be forwarded and delivered by ATM switches. This processing is done on the ATM adaptation layer (AAL). Depending on the type of input (voice, video, or data) a different type of adaptation process may be used and different types of delivery requirements or priorities can be assigned within the ATM network. After emerging from the ATM Adaptation Layer, all cells of a given AAL are in the identical format.

MPLS

A second cell relay protocol is multi-protocol label switching (MPLS). Multi-protocol label switching technologies have evolved with the strengths and weaknesses of ATM in mind. One of the biggest weaknesses attributed to ATM was the “cell tax.” This term refers to the fact that ATM cells generally impose 10% overhead to the transmission stream. Additional bandwidth is also reserved for signaling between ATM network devices. This signaling information contains routing updates with network topology changes. Additional control information is necessary to establish and terminate switched virtual circuits (SVC).

MPLS is implemented in a three-level architecture. The first layer of the architecture is the network edge. Devices contained in this layer are typically non-MPLS devices. Examples of such devices may include ethernet switches, IP routers, or voice gateways. These non-MPLS devices are connected to label edge routers (LER), which form the access layer of the MPLS.
network. The responsibilities of the LER include encapsulation of traffic from the network edge within MPLS frames. In addition, the LER establishes, maintains, and terminates label switched paths through the network core for non-MPLS edge devices. The third level of the MPLS network architecture is formed by label switch routers (LSR).

The core MPLS network accepts requests for label switched paths from the MPLS access layer. These requests are processed with Layer 3 IP addresses to determine the best path through the MPLS core. Once the preferred path is determined, the next-hop LSR is contacted to determine if it has the resources necessary to meet the QoS requirements of the transmission. This negotiation process is repeated hop-by-hop through the MPLS core until the egress LSR is reached. At this point, the egress LSR communicates an accept message back through the MPLS core to the originating LSR and the connection-oriented LSP is established. With the accept message from egress LSR to the originating LSR, and the establishment of the LSP, a next-hop label forwarding entry (NHLFE) is created within each LSR along the LSP. The NHLFE table in each LSR is utilized for established LSP connections. This precludes the need to process subsequent MPLS frames with the same label identifier at layer 3. The ability to switch MPLS frames in hardware enables shaping and policing of traffic through established connections, which ensures that QoS contracts are met for each customer.

**ROUTING**

Routing is the process of moving data across network segments toward its final destination. Routers receive frames of data, de-encapsulate the network layer packet, examine its header, determine the next hop, package the packet into a new data frame and transmit the new frame.

The routing process is analogous to the method used by the post office to deliver a letter. Someone places a sheet of paper (data) in an envelope (packet), addresses it, places it in their mailbox and raises the flag (transmits the packet). The postman picks up the letter and places it in a mail bag (data frame) and takes it to the post office (default gateway). At the post office, the letter is taken out of the mail bag (data frame), and the zip code (network segment address) is used by the post office to determine where to send the letter (routing). After the next hop is determined, the letter is placed into a new mail bag (data frame) for transmission to the destination post office (router on the destination network segment). This process continues until the letter reaches the post office that services the destination zip code (router to the destination segment). At the destination post office, the letter is removed from the mail bag placed into the mail bag of a mail carrier that services the destination street address. The mail carrier then places the mail in the mailbox of the destination street address for final delivery to the recipient.

The first logical step in the routing process is for the source workstation to fill in the source address field in the network layer header with its own network layer address and the destination address field in the network layer header with the network layer address of the ultimate destination workstation. Since the destination workstation is not on the local LAN, the packet must be forwarded to the local gateway, or router, which will have sufficient information to forward this packet properly.

The source workstation looks in its network layer configuration information in order to determine the network layer address of its default gateway. The default gateway is the only way out for packets off of the local LAN. In order to deliver this packet to the router for further processing, the packet must be wrapped in a data link layer frame such as Ethernet, Token Ring, or FDDI. Addresses which are included in the data link layer header are known as physical addresses. Although the source workstation has the network address of the default router in its network configuration file, it does not know the physical address of that router. The source workstation determines the physical address of the router through address resolution using the ARP protocol.

Once the source workstation determines the physical address, it encapsulates the network layer packet in a data link layer frame. The physical address associated with its own NIC is placed in the source address field of data link layer frame and the physical address of the default gateway is placed in the destination address of the data link layer frame.

The default gateway or local router receives the data link layer frame explicitly addressed to it and examines the ultimate destination address held in the packet. The router then consults its routing tables to see if it has an entry for a known path to the ultimate destination workstation. That known path may be via another
router or, the ultimate destination workstation may be part of a different LAN connected to this same router through a different NIC. In either case, the packet and its layer 3 addresses are not modified but are instead re-encapsulated in a fresh data link layer frame with the physical layer destination address of either the ultimate destination workstation, or of the next router along the path to that workstation. The source address field on the fresh data link layer frame is filled in with the physical address of the default router which has just completed processing the packet.

Hosts and routers decide where to send packets by looking the destination address up in their routing table. A routing table consists of a series of destination networks, the address of the local router that provides service to the destination network, and a cost associated with the route. The cost is used to determine the best route in the event that there are multiple routes to the destination available. In addition to these required items routing tables are protocol specific with different layer three protocols adding different fields to the routing table.

Regardless of protocol there should always be a special entry in the routing table for the default router or gateway of last resort. This is the router where a packet should be sent if there is not a route listed in the local routing table for the destination network. You can think of the default router as the “out of town” slot at your local post office: it gets the packets that leave the scope of the local router. You have no idea of how it’s going to get to the destination, but trust that the default router will find a path for it.

Routing Protocols

In the previous example it was assumed that each router intuitively knew where to send a packet to get it to its destination. However, when a router is initially started, it only knows about the interfaces connected to it or static routes that have been configured by an administrator. In order for a network to dynamically build comprehensive routing tables that automatically add new routes and remove old ones, a routing protocol must be used. Routing protocols provide routers a means of automatically exchanging routing table information to ensure that each router knows where to route packets for a given destination.

There are two major categories of interior routing protocols: distance vector and link state. Distance vector protocols broadcast their entire routing table periodically. In this manner, changes to the network routing tables slowly make their way through the network. A router using a distance vector algorithm knows nothing about the make up of the network beyond the next hop to the destination, merely that sending a packet of data to the next hop should allow it to eventually make it to the destination.

Link state protocols transmit a more complete picture of the network between routers. Through the use of link state advertisements (LSA), each router learns the structure of the entire network. In this manner, the link state algorithm can make better routing decisions. Link state routing reacts quicker to changes in the routing structure than distance vector routing while using less bandwidth maintaining routing tables.

Routes to specific network can be entered into a routing in two different ways. Static routes can be manually entered by a network administrator into a router’s routing table. By definition, static routes do not change as network conditions change and are therefore not able to adapt to network failures. As networks grow, configuring and maintaining static routes on multiple routers can become a real challenge.
Dynamic routing is achieved when routers are allowed to build their own routing tables based on route advertisements received from other routers. This may be simpler to configure, but runs the risk of having one misbehaving router create a potentially cascading negative impact on other routers. This is a greater concern when those other routers are controlled by other unknown organizations as explained further in the section on hierarchical networking and autonomous systems.

There are two basic, non-proprietary IP interior gateway protocols: RIP and OSPF. The most basic routing protocol used in the TCP/IP protocol suite is RIP or the routing information protocol. There are two versions of RIP: RIPv1 and RIPv2 with the key difference being that RIPv2 supports passing extended network prefixes required for the use of VLSM and CIDR.

RIP broadcasts its routing tables to all directly connected routers every thirty seconds. Those directly connected routers then propagate the new routing table information to the routers directly connected to them. However, the delay which occurs while all of the routers are propagating their routing tables, known as slow convergence, could allow certain routers to think that failed links to certain networks are still viable.

OSPF or open shortest path first is an IP link state routing protocol developed to overcome some of RIP’s shortcomings such as the 15 hop limit, full routing table broadcasts every thirty seconds, and slow network convergence. Each OSPF enabled router in an autonomous system maintains an identical database consisting of link states, router states, usable interfaces, and known-reachable neighbors. This information is used by each router to construct a tree-like image of the network where each router is at the root of its tree and the branches of the tree represent shortest paths to destinations.

For large internal networks the address space can be broken into sub-sections, or OSPF Areas to reduce the amount of traffic required to converge the network. All OSPF networks have at least one area, known as Area 0 or the backbone area, configured. Depending on the size of the network, in order to keep the topological databases of manageable size, and to reduce the amount of OSPF information that needs to be transmitted between routers, additional areas can be defined. All areas would communicate with each other through Area 0, the backbone area.

The most commonly used exterior gateway protocol currently is BGP4 (border gateway protocol version 4). BGP4 is an exterior gateway protocol that performs routing between multiple autonomous systems or domains and exchanges routing and reachability information with other BGP systems. To the outside world, the AS is seen as a single entity. Each AS runs its own interior gateway protocol independent of any other AS. Simply stated, any network can talk to any other network via the Internet because, regardless of what routing protocols those networks may speak internally, they all speak the same language (BGP) externally.

REFERENCES


KEY TERMS

**Asynchronous Transfer Mode (ATM):** A cell relay, circuit switching network and data link layer protocol which encodes data traffic into small fixed-sized cells. ATM provides data link layer services that run over SONET (Synchronous Optical Networking) Layer 1 links and differs from other technologies based on packet-switched networks (such as the Internet protocol or Ethernet), in which variable sized cells are transmitted.
packets (sometimes known as frames) are used. ATM is a connection-oriented technology, in which a logical connection is established between the two endpoints before the actual data exchange begins.

**Border Gateway Protocol (BGP):** The core routing protocol of the Internet. It works by maintaining a table of IP networks or ‘prefixes’ which designate network reachability among autonomous systems (AS). BGP does not use traditional metrics, but makes routing decisions based on path, network policies and/or rule sets. BGP was created to replace the previous routing protocol to allow fully decentralized routing in order to allow the removal of the Internet backbone network and allowed the Internet to become a truly decentralized system.

**Frame Relay (also found written as “frame-relay”):** Consists of an efficient data transmission technique used to send digital information quickly and cheaply in a relay of frames to one or many destinations from one or many end-points. Network providers commonly implement frame relay for voice and data as an encapsulation technique, used between local area networks (LANs) over a wide area network (WAN).

**MultiProtocol Label Switching (MPLS):** A data-carrying mechanism which emulates some properties of a circuit-switched network over a packet-switched network. MPLS operates at an OSI Model layer that is generally considered to lie between traditional definitions of Layer 2 (data link layer) and Layer 3 (network layer), and thus is often referred to as a “Layer 2.5” protocol. It was designed to provide a unified data-carrying service for both circuit-based clients and packet-switching clients which provide a datagram service model. It can be used to carry many different kinds of traffic.

**Open Shortest Path First (OSPF):** Protocol is a link-state, hierarchical interior gateway protocol (IGP) for network routing. An algorithm is used to calculate the shortest path tree. It uses path cost as its routing metric. Path cost is determined generally by the speed (aka bandwidth) of the interface addressing the given route.

**Routing Information Protocol (RIP):** One of the most commonly used interior gateway protocol (IGP) routing protocols on internal networks (and to a lesser extent, networks connected to the Internet), which helps routers dynamically adapt to changes of network connections by communicating information about which networks each router can reach and how far away those networks are.

**Synchronous Optical Networking:** A method for communicating digital information using lasers or light-emitting diodes (LEDs) over optical fiber. The method was developed for transporting large amounts of telephone and data traffic and to allow for interoperability between equipment from different vendors.

**T1:** Refers to Digital Signal 1, originally over a “T1” interoffice “trunk” or “Transmission Level 1” telecommunications line in North America and Japan.
Wireless

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INTRODUCTION

Many people in higher education have been computing for years, including faculty, staff, and students. Everyone has expectations of what they want and need on campus and that includes access anywhere and anytime to e-mail, data, and other electronic materials and documents accessible by computer only. As Cossey (2005) writes, “wireless technology has the potential to be a valuable enabler.” Wireless technology allows users to go mobile or without wires and to communicate with others and send data using mobile phones, personal digital assistants (PDAs), laptops, or handheld games. Typically, this wireless communication involves using radio waves or infrared waves to transport signals instead of cables.

Technically, wireless technology is a set of standards defined by a, b, g, and n modifications. Wi-Fi is the more common term used for wireless local area networks (LANs) (Bitter & Legacy, 2005). The International Electrical and Electronics Engineers (IEEE) Association created the 802.11 wireless LAN standards. The 802.11b/g/n wireless standards function at the 2.4 GHz band, as do microwaves, some cordless phones, and baby monitors, while the 802.11a wireless standard functions at the 5.0 GHz band. At the 5 GHz band, the 802.11a standard has much less interference but must be in line of sight with the access point to be effective.

Wireless technology is not only designated for computers and networks but for peripherals like game controllers, mice, keyboards, mobile phones, laptops, digital cameras, and speakers. Peripherals usually work at much closer areas and have much slower speeds. Bluetooth is used in many situations, at usually shorter distances, typically 10 meters or less, and as a rule less secure. Bluetooth is designated by the industry as a personal area network (PAN). Bluetooth uses a short-range radio standard protocol signal to communicate with other Bluetooth enabled devices and does not have to be in line of sight. Ultra-wideband technology is another low-power radio signal device and has very fast speeds but little of the hassle of Wi-Fi. It is being heralded as a compliment to Wi-Fi. Instead of using cables to connect speakers, stereo, computer, and high definition television equipment, one can now connect those components wirelessly and minimize the clutter that surrounds all of it (Fleishman, 2007).

THE WIRELESS TECHNOLOGY MOVEMENT IN EDUCATION

Reducing the hard-wiring has aesthetic implications on campus by reducing untidiness and disarray. Wireless campuses also allow teachers the ability to move more freely, whereas before they had to have all computers connected, they now only have to have one dropped line connection (Roblyer, 2005). As long as the wireless access point is in range of the main router or access point, computers or mobile labs should not have any problems logging on the LAN or onto the Internet. Many schools have hot spots that are easy to access during breaks or at lunch.

In England at the Dulwich Picture Gallery, students are given palm hand-held computers equipped with wireless technology. These computers are installed with a software program titled Street Access that allows them to preview all of the gallery’s paintings. The students may view all of the paintings at their own pace and study each gallery or theme in any manner they choose. When students become more accustomed to the gallery, they retrieve the palm, update the answers to questions, and save to a local server. All of the work completed is accessible from any computer. More activities and questions can be given based on the lesson plans to motivate deeper thinking concerning the arts (“Art for all,” 2004).

According to a report given at EDUCAUSE by Kenneth C. Green (2006), director of the Campus Computing Project, greater than 50% of college classrooms have wireless access. One of the reasons, Green states, is that more students are buying laptops and need Internet access around campus. Faculty are also moving work around campus and need to access internal and external
networks and having wireless access helps them easier and much quicker access than searching for available hard wired hookups or connections.

**ADVANTAGES OF USING WIRELESS TECHNOLOGY**

Over the past few years, more and more K-12 schools have instituted wireless networks because of cost savings, better security, and ease of setup. Instant wireless “hotspots” can be created almost anywhere with a wireless access point, laptops, and an outlet, therefore creating a mobile computer lab (Roblyer, 2005). Teachers can take students anywhere inside or outside of a building as long as there is somewhere they can access an electrical source and connect to a fixed access point. There are also savings in older buildings with asbestos where hard wiring is a more costly effort. The cost of hard-wiring in many older buildings can be cost prohibitive, and in some cases setting up wireless LANS can save districts money. If a wired network is already in place, it can also be cost effective in expansion plans where wireless networks might be used to expand the infrastructure to the existing network (Walrey, 2004).

There are more than a few advantages of using wireless networks instead of wired networks in computer labs at schools. For instance, Brunswick, a college-preparatory school in Connecticut, has a laptop program because the administration feels that the “21st century learner” needs to be unbound and not restricted to a wired computer lab (Rajala, 2003). Desktop setups can sometimes be heavy and cumbersome, which at times is counterproductive to learning. Desktop computers do not allow the learner to meander, investigate, and expand boundaries.

Rajala (2003) further reasons that wireless technology adds portability with lightweight laptops or even pocket-sized PDAs. There are many wireless base stations around schools, airports, and coffee shops. This allows for anytime, anywhere Internet access where students can upload and download information and check e-mail.

According to the National Centre for Technology in Education (NCTE) (Kim, Holmes, & Mims, 2005), mobile phones have and can be used for learning intentions. Mobile phones allow students to study and complete class work anytime and anywhere. The NCTE has stated that educators could use mobile phones in the educational setting to improve literacy, assist and collaborate project-based learning activities, access Internet resources, and implement writing exercises using SMS text services (Kim, Holmes, & Mims, 2005).

**CONCERNS**

One of the chief problems with any wireless network is security. Green (2006) found for a third straight year that hacking network systems and stealing information data are among administrators’ and information systems engineers’ greatest concerns at colleges and universities. There are several types of risks when setting up public wireless systems. A user who is not permitted to access the network can attempt to connect by setting up a laptop or PDA that is unauthorized or by setting up an unauthorized access point. It is suggested by Internet Security Systems that all organizations create measures to correctly inspect for illicit or rogue access points and computers on their networks (Internet Security Systems, 2001).

According to Internet Security Systems (2001), to intercept data an attacker needs to be within 300 feet of an access point;

Wireless, however, creates a whole new vulnerability because someone does not have to walk into a building to attempt to access your system. They can walk up or drive into a parking lot, open their laptops and start searching for access points. (Burton, 2005)

A hacker may capture sensitive data including usernames, passwords, addresses, phone numbers, social security numbers, and school identification numbers. An unscrupulous hacker could sell this information to a third party. A hacker may also send a flood of requests to an access point thus causing a “denial of service” attack to those computer users that need access to the network.

There are also several types of encryption methods that users can choose to incorporate when using a wireless network. The first is wireless equivalent privacy (WEP). WEP has a 40-bit key and a 128-bit key, but both can be cracked quickly with the correct software. The Wi-Fi Alliance created Wi-Fi protected access (WPA and WPA2) that incorporates much better encryption methods than WEP. WPA2 is fully supported in Windows Vista and current versions of Mac OS X.
Many institutions are implementing wireless solutions to give students, staff, and faculty the opportunity to move around campus freely. One institution that added a wireless LAN was Elgin Community College (ECC). At ECC one of their major problems was funding. The actual deployment and installation of the access points across two campuses took not only large capital resources but time to find the right mix to adequately handle the campus population (“Wireless enriches community education,” 2007). The good news is that wireless technology continues to drop as costs keep sliding downwards while equipment speed is improving and is becoming more robust (Cossey, 2005).

“Furthermore,” Michael Chahino, director of network operations at ECC added, “we needed to protect the system from worms and other viruses found on students’ and visitors’ PCs. We couldn’t let day-to-day internal operations be compromised due to a flaw in network security” (“Wireless enriches community education,” 2007).

Instructional technologist consultant Kellie Doubeck believes that wireless technology can be misused if school districts do not focus on the purpose at hand and get too caught up in the “new technology trends.” Doubeck indicated that often goals and implementation plans are ignored by the administration because they become engulfed by the innovative tools they purchase and do not use sound instructional strategies in planning for the future (Briggs, 2006).

CONCLUSION

Wireless technology in education is becoming commonplace quickly. Beckman (2005) indicates that 80% of colleges and universities have installed wireless networks campus wide. Over the past decade there has been a steep increase in the number of schools that have implemented wireless technology due to the convenience and savings that were reported in business and industry. Anytime and anywhere access to important documents as well as class time or studies is becoming the norm rather than the exception and technology access is becoming one of the central criteria students look for when applying for colleges today. Tech support today has to be current with security on both wired and wireless products that are constantly changing. The forecast for the future, according to EDUCAUSE, is for wireless networking in higher education to keep expanding and improving as students and faculty populations become more and more mobile (Barnett-Ellis & Charnigo, 2005).

REFERENCES


**KEY TERMS**

**802.11**: A specification developed by the IEEE for wireless LAN technology to determine the interface between wireless clients and/or a client and a base station.

*802.11a*: up to 54 Mbps in the 5 GHz band

*802.11b*: up to 11 Mbps in the 2.4 GHz band

*802.11g*: up to 54 Mbps in the 2.4 GHz band

*802.11n*: up to 108 Mbps in the 2.4 GHz band and up to twice the range of both the b and g protocols.

*These speeds are all theoretical and based on best-case scenarios. Typically these products run at much slower speeds, usually half these rates or less.*

**Bluetooth**: A short-ranged radio technology that allows devices (computers, mobile phones, headsets, PDAs, remotes, etc.) to communicate over the 2.4 GHz band.

**EDUCAUSE**: A nonprofit organization whose charge is to progress higher education by advancing the intellectual use of information technology.

**IEEE**: The International Electrical and Electronics Engineers are a nonprofit group that produces standards for Ethernet and wireless networking, telecommunications, nanotechnology, and other power and energy areas throughout the globe.

**WEP**: Wired Equivalency Privacy is a security protocol for wireless LANS defined by the IEEE 802.11 standards. WEP is offered in both 40-bit and 128-bit security but both can be cracked fairly easily.

**WPA**: Wi-Fi Protected Access is a security protocol that is an improvement upon WEP. WPA uses improved data encryption and user authentication standards.
Wireless Computer Labs

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INTRODUCTION

In February 2000, three seemingly unrelated events came together to present a unique challenge at one mid-Atlantic university—a challenge that is being experienced more and more by colleges and universities across the country.

First, the faculty approved a new undergraduate teacher preparation curriculum that would include instructional technology in both the first two semesters of the freshman year and three semesters in their junior and senior years—12 new sections of technology-based training. Second, a graduate degree in instructional technology was growing beyond even its most optimistic predictions. In less than four semesters, enrollment increased from 24 to 140 students. Third, funds, staffing support, and classroom space had not been programmed for yet another much-needed computer facility and renovations to available space were cost-prohibitive.

To meet the demands for more technology resources, a new multimedia classroom was proposed. Estimated to cost over $200,000, the proposal was rejected by senior administrators due to budgetary considerations. It was clear that to resolve this dilemma, the program director needed to think “outside the box”.

Enter the wireless lab. With 29 multimedia-ready classroom and student computer labs already on campus, weaknesses in pedagogy had been recognized for years. Increasingly, labs contain outdated hardware and software. The inflexibility of scheduling, location, and access to desktop capabilities made computer labs unattractive to many faculty members. And the cost! For the price of a single multimedia-ready classroom, a department can purchase 3-4 portable wireless labs, incorporating the power of technology with the more traditional classroom. Wireless carts can be rolled into classrooms, making scheduling conflicts a thing of the past. CDROM, printers, and overhead projectors can be appended to the cart with little hassle. And, perhaps most important, with the deployment of a wireless access point, only one network connection is required to make all 24 computers Internet-ready.

The wireless lab was identified as the most promising technology to address these issues. It enables an entire class to be online at the same time—simultaneously surfing different web sites, accessing e-mail, creating documents, and swapping files through a single Internet connection. It seems the perfect cost-effective solution for schools with limited budgets and facilities at capacity or those who simply want a more flexible networking solution. The specific advantages of a wireless lab are best represented by examining how it was integrated into six university courses and programs.

The university’s Introduction to Educational Technology course is similar to many such first-year familiarization courses. It provides an introduction to the various classroom technologies. Students use the wireless lab to master the complete set of basic skills and competencies required before entering the masters program. Using the laptops, students are introduced to word processing, spreadsheets, graphics presentation, and the Internet. The lab offers students more opportunities for both abstract and concrete, practical hands-on experiences. Using wireless labs frees the multimedia facility for more classroom-centered teaching (and technology-intensive applications) while offering the complete suite of software, hardware, and network concepts demanded of the graduate program in technology. One anecdotal comment lifted from a student’s evaluation claimed, “When then instructor rolled in that wireless lab, learning really took off.”

A companion course, Assessment of Instructional Technology, evaluates “best practices” for using instructional technology in the classroom and was previously taught without technology due to space and access considerations. The wireless lab allows students to simulate online quizzes, download test banks, and demonstrate educational software. The flexibility provided by the wireless lab made all the difference in student understanding of the material while providing them the ability to work at their own pace.
Two other non-technical courses, Social Studies Methods and Elementary School Administration, advanced the practical applications of the wireless lab. Two faculty members needed online access at the same time, so another innovation was initiated in the school. The wireless lab was divided into two to serve both classes simultaneously. Faculty simply rolled the cart into the third floor hallway, distributed 14 machines to one class and 10 machines to the other—and both classes were up and running within minutes.

Even more flexibility was demonstrated in the Behavioral Disorders course for special education teachers. Providing a current overview of the field of education for persons with serious emotional disturbances, research is paramount as students explore diagnosis, assessment, treatment, intervention, and prevention strategies. The course validated on-demand technology in the classroom. The wireless lab was used several times during the semester when the class explored factors contributing to behavioral classroom disorders. The instructor was not always able to plan exactly when the research phase of each topic would begin; as a result, scheduling was haphazard and conflicts were common. Using the wireless lab as an on-demand technology resource created the flexibility to re-locate the cart to any classroom equipped with a single network connection. Theory and “book learning” were the previous means of exploring these topics. With the introduction of the wireless lab, students were able to conduct both individual and group discovery learning exercises. Initial feedback from students was extremely positive, some even claiming that the portable computers helped them understand the practical side of special education.

A special program for preparing school district superintendents found the wireless lab a perfect tool for introducing senior administrators to laptop, wireless technology. The lab was brought into their seminar room and, together, the participants explored the Internet locating information pertinent to school board issues, budget and funding school districts, in-service training programs for their teachers, computer purchases, student safety issues, and so forth. Practicing administrators found a resource suitable for small group learning situations, from 3-5 student seminar rooms with an overhead projection system and printing capability suitable for classroom discussion. The wireless lab was equally effective in this small seminar room environment. The portable laptops permitted the instructor to break down the class into focus groups, with each group using the computers to access information particular to their assigned topic. Participant comments included: “The wireless lab was absolutely wonderful. Convenience and practicality are just two words to describe this innovation. I would love to have this in our schools.” (Assistant Superintendent of Schools, Pittsburgh). Here’s another, “…very innovative approach in linking us to technology to work together as a team on a grant proposal as we were circled about each at one table. I found that the lab provided us convenience (never leaving our classroom), accessibility to the Internet, better communication in working as a team, and personal instruction” (Director, Special Education).

**ISSUES**

Of course, with any technology, serious debates are needed to ensure the appropriate application of the technology for teaching and learning, so, too with wireless labs. Here are some particularly poignant concerns for consider.

**Keeping Laptops Safe**

Most student desks do not provide adequate space for a laptop which can lead to accidents. Security can also be an issue with laptop computers; their size makes them easy targets to slip one out of the classroom undetected. In fact, a recent theft from one middle school computer lab reduced the number of laptops from 51 to 32 in one weekend incident. Most schools will lock down their carts when not in use and store them in a secure location. Often theft is reduced by the demand for laptops to recharge after each extended use, making them tied to a power source that is often dedicated only to the cart and contained within a secure area. Laptops are most vulnerable at the end of a class period when instructors as well as students are moving quickly to their next class. After school opportunities for theft are also numerous. A balance must be maintained with the flexibility of laptops, the convenience of wireless carts, and the vulnerability of both to pilfering. It takes a diligent teacher to keep laptops from being broken, vandalized, or stolen outright.
Wireless Computer Labs

Maintenance Issues

The most time-consuming maintenance task associated with computer labs of any kind is updating software and removing viruses. Although, theoretically, wireless laptops can be updated in their cart, often the wireless network bandwidth has not been sufficient to allow the simultaneous updates. Although the technology is advancing geometrically, most schools must connect their laptops to a local area network in an existing computer lab to appreciate the much higher data transfer speed (100MB) needed to complete these tasks in a reasonable time frame. Another solution to this problem is to reconfigure the laptops to use Ethernet for updates, or individually update each laptop, both of which are time-intensive processes.

Response Issues

As mentioned earlier, the technology is moving rapidly; however, for most educational environments, wireless protocols continue to present problems, especially in technology-intensive courses. For instance, 30 laptops accessing the access point simultaneously inevitably results in dropped connections or extremely slow transfer rates. Slow response rates are also a particular problem at the end of class when students clamor to save their work to the server or when the instructor leads students through a step-by-step example. Since the wireless lab is being used in the classroom, an educational technician is not usually available resulting in frustrated teachers and irate students. A nearby technician ready to troubleshoot (or at least recognize and explain) these issues encourages wider use of mobile labs.

Flexibility and Savings

Although continuously improving, wireless still lags behind hard-wired connections in terms of speed. However, its tremendous flexibility proves attractive to many school systems. Wireless networking removes barriers to school-wide network access and provides more flexibility when designing new school systems and their desired learning environments with respect to effective technology-oriented learning space layouts. Teachers with access to wireless technology use them much more frequently. When teachers can simply roll a cart into a room, plug it into an electrical outlet, connect it to a data drop, and pass out computers to each student, the wireless carts become an integral part of the daily curriculum. The speed of wireless is typically adequate for classroom activities (even in higher education) because the communication between the access point and the laptop is minimal. Using wireless laptops, teachers, students, and administrators are connected to anywhere and anyone on campus. In the classroom, students can experiment with new knowledge, collaborate with their peers and instructors, and provide feedback quickly. In libraries, they conduct their own research and in physical education courses, they track their fitness progress. Carts that contain multiple laptops also come in handy for faculty in-service and administrative meetings.

Another benefit of wireless is its ease and speed of installation. Because it is so easy to incorporate wireless within an existing hard-wired infrastructure, many schools use it as a backup or an extension of their wired local or wide-area network. If fibers are cut, for example, a quick switch to the wireless network maintains uninterrupted connectivity. Handheld devices, which many schools are just beginning to use, also integrate easily into a wireless network. From a technical perspective, wireless provides an environment where solutions are otherwise not feasible.

Wireless is also an excellent choice for schools with small classrooms that lack space for stationary computers or schools that were built in the era of brick and mortar where drilling for hard-wire connectivity is cost-prohibited. Wireless carts can be secured on adjacent locations when not in use, leaving room for other teaching activities. Further, when schools outgrow their facilities and revert to temporary classrooms and administrative offices, wireless is the quickest (and least expensive) way to provide connectivity. Most institutions have integrated wireless connections into their long-term strategic plans. While wireless is not necessarily less expensive than wired connectivity, it is becoming more competitive as schools, companies, and even cities are opting for this more flexible networking environment. Most find that they can quickly recoup any initial investment expenses because of the efficiency of the hardware. Instead of hard-wired computers sitting idle in unoccupied classrooms, a cart of laptops is apt to be in constant use as it travels throughout the educational building.
Designing Through the Technology

The designs of educational facilities are changing in response to the increased sophistication of teaching, learning, and administration. Some applications require larger classrooms to accommodate technology. For example, projectors that display data from the teacher’s console take up more room than monitors. On the other hand, wireless laptops take up much less room than fixed machines. Power requirements have increased dramatically and air conditioners have increased in size because of the tremendous heat generated by the technology, but not so for wireless laptops. A new computer lab once required planning for electricity as well as connectivity; with laptops, a dedicated circuit to handle recharging of a cart-full of computers is all that is necessary.

Current and future technology needs demand careful planning for renovations and new buildings. Technology can enhance learning and related academic and administrative work only if it is accessible. Architectural structures designed initially with aesthetics in mind may serve a dual purpose as ports that accept wireless signals. The location of data drops is another important consideration. Placed too close to a cabinet or in some out-of-the-way place and connectivity is impeded. In wiring a whole new building, current thinking is that antennas should not be installed in classrooms but in hallways so they can cover the rooms on both sides of the building. For both hard-wired and wireless applications, schools must work closely with architects and engineers in the design of wiring schemes for buildings. All new or updated buildings should consider wireless networks or, at the very minimum, a combination of hard-wired and wireless infrastructure. Such environments promotes learning areas that extend outside the traditional classroom into the cafeteria, hallways, student and faculty lounge areas, video presentation rooms, and technology learning centers.

Planning for Technology

Architects and engineers design buildings and then consider technology—at least that is how buildings were planned. With the emphasis and weight placed on today’s instructional technology, buildings are now designed around specific educational needs. Engineers integrate conduits for networking and communications cabling. Architects are asked to consider classroom size and width of hallways with technology in mind. And, proper design of wireless systems ensures available connectivity to cable networks and antennas. The continuing rapid changes in technology make planning ahead a true challenge. Many institutions plan 5 to 10 years into the future. With technology, that is oftentimes impossible. Again, the use of wireless technology contributes to successful long-range planning and simplifies upgrades and renovations along the way. Whether hard-wired or wireless, institutions can translate student learning needs into functional designs by involving users (e.g., students, faculty, administrators, and others) during their engineering, architecture and technology planning, strategic planning efforts, and facility upgrade requirements.

ADVANTAGES/STRENGTHS

In the journal, *From Now On*, author Jamie McKenzie summarizes why wireless networks utilizing mobile computers have become the media of choice preferable to the desktop machines in classrooms and computer labs and, by so doing, offers readers a list of the key strengths of wireless technology (McKenzie, 2001):

- **Ease of Movement**: Stand-alone laptops are readily moved to any location within a building without considerations that make desktop machines seem so inflexible. Wiring, electricity, lighting, special furniture, and so forth are non-factors when using laptops in a wireless environment. On the downside, battery life remains a strong consideration for classes conducted in several-hour blocks of time. Also, connectivity to other technology resources (backups, printers, etc.) also restricts laptop usage.

- **Strategic Deployment**: Wireless devices are deployed on rolling carts (in the case of laptops) or in a pocket (in the case of handheld devices). They go where they are needed most, creating unique learning opportunities that traditional methods of placing hard-wired computers throughout a school do not provide and are just now being realized by instructors.

- **Flexibility**: Wireless laptops are easily re-configurable to changing conditions, teaching styles,
Wireless Computer Labs

and learner experiences as well as team, group, or individual preferences. Wireless laptops place no additional demands on furniture or space.

- **Cleanliness**: Consider how computer labs looked in the past. Cables and electrical cords introduced numerous tripping hazards, monitors, desktops, keyboards, mice, printers, and speakers all presented clutter and confusion. The elimination of cables, wires, and peripherals not only removes many of these hazards but opens the room to better utilization of space for instruction.

- **Low Profile**: Unlike desktops, students are not prone to hide behind large monitors. The low profile of wireless laptops allows better two-way communications and feedback between instructors and students.

- **Convenience**: Wireless laptops are easily stowed in specially-made carts that make them more likely to be used. A disadvantage for some instructors is the unwieldy size and weight of a fully-loaded cart. However, pre-positioning of a wireless lab reduces lost classroom time for setup and simplified technology demands on the part of instructors and students. For most applications of wireless, the time has come where the technology itself is becoming secondary to the undertaking of learning.

- **Simplicity**: The simplicity, comfort, and reliability of wireless laptops promote a focus on learning rather than the technology. Simple as that.

**CONCLUSION**

Wireless access has become the environment of choice for educators, corporate trainers, tech-savvy entrepreneur, and the ordinary business traveler. In addition to laptop computers, cell phones, personal digital assistants (PDAs), two-way pagers, and other compact gadgets all use the same wireless technology that makes hard-wired computer labs a technology on its way out.

Wireless-enabled laptops make it possible for students to use their time more efficiently, access databases and information from the Internet, and work collaboratively. Using conferencing software and portable laptops, learners are able not only to electronically store documents and data and retrieve them instantaneously, but also to successfully engage in document sharing and collaborative writing from various locations on and off a campus environment. With the implementation of more flexible learning approaches, they succeed in selectively incorporating critical input from peers and instructors, then revise documents based on their own interpretation of facts and theory.

Continuous improvements in wireless technologies will only serve to advance new pedagogical practices that take advantage of the full range of educational psychologies. Such learning practices incorporate higher-order skills like problem-solving, reasoning, and reflection. The integration of mobile learning environments and wireless computing also has implications for many other educational venues such as business schools, science programs, corporate training, medical nursing schools (including nursing), and law schools.

In summary, the advantages of wireless computing include education are its breadth of scope, prolific portability, and broad applicability for both individualized and collaborative learning projects. Access extends to home, office, classroom, leisure, airports—virtually everywhere and all the time, providing the means to integrate computers into every aspect of teaching, learning, and research.

Certainly, wireless labs have proven themselves highly adaptable to both the personal teaching styles of classroom instructors and the learning strategies of traditional and adult students. There are few inherent weaknesses in laptop capability compared to similarly-equipped desktop computers. Plus, they have added advantages and flexibility only laptop computers provide. They seem to support all aspects of teaching and learning, including abstract values and concrete ideas; behavioral, cognitive, and humanistic psychologies of teaching and learning; and, all levels of human development from elementary through post-graduate doctoral students.

For considerably less than a multimedia classroom, the wireless lab provides an appropriate venue for teaching at the college/university level. With the power and flexibility of today’s laptops and the requisite pedagogy on which to base teaching with technology appearing more often in the research, schools should at least consider the wireless lab for their next technology enhancement.
REFERENCES


KEY TERMS

IEEE 802.11 Wireless Standard: 802.11 is the IEEE (Institute of Electrical and Electronics Engineers) standard for wireless networking—sending Ethernet data packets through the air. The standard allows for wireless integration with wired Ethernet networks using devices called access points or base stations. IEEE 802.11 wireless standard supports all standard Ethernet network protocols including TCP/IP, AppleTalk, NetBEUI, and IPX. Access Points: An access point or base station is a radio receiver and transmitter that connect to a wired Ethernet network. Through these devices, wireless nodes such as desktop computers, notebooks, and laptop computers equipped with wireless network cards, have access to wired local area network services such as e-mail, the Web, printers, and more. Operating range, management capabilities, wireless network security, and number of users supported are determined by the capabilities of the access point.

Broadband: Faster than modems but slower than Ethernet, several different forms of broadband access are available from local Internet service providers, phone companies, and cable providers. The most common forms of broadband are DSL, ISDN, and cable modems. DSL and ISDN use special adapters to send data over your telephone line without tying it up. Cable modems send data over your cable TV connection. DSL and ISDN availability is limited based on geographic location and telephone line quality. Cable modem availability varies with each cable company.

Data Transmission Modes and Throughput: There are two modes, encapsulation and translation, for transmitting data over a wireless network. Encapsulation mode encloses the 802.3 Ethernet packets inside 802.11 frames for transmission through the air, whereas translation mode converts 802.3 Ethernet packets into 802.11 packets for transmission. Recently translation has emerged as the de facto standard, but support for encapsulation as well ensures maximum flexibility in networks where both addressing modes may be used.

Ethernet: The standard individual connection for many offices, classrooms, labs, and residence hall rooms as well as corporate office and training environments and complexes. Ethernet operates at speeds up to 10 megabits per second, is available 24 hours a day, and does not require a phone line. Fast Ethernet connections that operate at 100 megabits per second are available but usually reserved for server applications.

Local Area Network: The term local area network is usually defined by its size; it is small and generally contained within a single room, a single building, or perhaps a small cluster of buildings.

Operating Range: Factors that affect the operating range of any wireless device include the strength of the access point, the number of walls inside a building, the construction materials used within a building (concrete vs. steel vs. wood), and the data transmission speed. Most access point manufacturers offer enhanced antennas for increased range. Manufacturers recommend that access points be deployed 150ft (50m) apart to ensure full coverage and maximum data throughput rates for roaming computer users.
**Soft Access Point:** As an alternative to deploying an access point for wireless connectivity to a wired Ethernet network, a computer that is physically connected to an Ethernet network, outfitted with a wireless network card, and running a software routing solution, can act as the gateway between the wired network and the wireless network.

**Wireless:** Wireless networks currently operate at speeds up to 11 megabits per second in both indoor and outdoor locations. A great convenience for mobile computer users, wireless does have some drawbacks. Because it uses radio waves to transmit data, wireless networking is inherently insecure. Also, the bandwidth within each coverage area is shared between all users on that “cell”.

**Wireless Management and Security:** Certain wireless client solutions provide utilities to monitor the strength of the signal and data throughput speeds and provide computing users real-time network statistics. Additional wireless network management capabilities are incorporated into the access point and depend on the manufacturer and model.
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