Education & Technology

An Encyclopedia

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Editors

Education and Technology

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An Encyclopedia

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Introduction

It has never been easy to define educational technology or the scope of the profession. Educational technology has roots in the broadly defined disciplines of education, psychology, and communication, as well as more specialized areas of interest such as organizational development, business and management, and computer sciences. As a result, individuals with different professional training experiences often find that they share similar goals and methods, though they may use different words to describe what they do. Educational technology may also refer to specific technological devices and machines. When used in this way, educational technology describes a particular method: the use of a technology or a technique toward achieving an educational outcome. Without an educational focus, the technology in question is only a device. And as if this weren't confusing enough, in some cases the technology may provide educational value only because it is the most convenient and efficient delivery medium, or because only one of its characteristics serves a specific teaching or learning goal.

Although there may be no singular definition for educational technology, any definition is likely to include reference to the use of technology for instruction, training, learning, or teaching. In practice, definitions serve to focus the interest of associations of individuals by emphasizing a particular scope of interest. From 1990 to 1994, Barbara Seels and Rita Richey (1994) led members of the Association for Educational Communications and Technology (AECT) in an effort to update one definition of the field. The AECT definition highlights the scope of activities of member individuals who share common interests in the systematic design and development of instruction and instructional resources using education technologies. These activities are: design, development, utilization, management, and evaluation. More recently, Robert A. Reiser (2001) has suggested a redefinition of the field along with a shift in emphasis, from “instructional technology” to “instructional design and technology.” His proposal highlights the numerous ways in which educational technology is regarded as a framework for action. Though not necessarily synonymous, terms such as “instructional technology,” “instructional systems design,” and “instructional media” have all been used to describe topics relevant to educational technology. To understand this dynamic nomenclature is to understand the historical development of educational technology as a discipline-based effort to establish a consistent and comprehensive set of methods for the use of technology as an educational tool. Yet each new technological invention presents a new set of possibilities as well as challenges for integrating practices with past achievements.

In short, educational technology may describe a process, a product, or a profession defined by a shared knowledge base. Selecting terms that accurately demonstrate the history, achievements, and accomplishments of the field is an effort fraught with ongoing debate and discussion. In this encyclopedia, we have elected to focus on an enduring vision of educational technology. This is a vision that defines educational technology by its service to learning. As such, education provides a framework for selecting and using technology, regardless of whether the technology in question is a machine, a technique, or an innovative idea.

A number of excellent books already exist that offer insight into educational technology as a domain of knowledge. David Jonassen has edited the *Handbook of Research for Educational Communications and Technology: A Project of the Association for Educational Communications and Technology* (1996, 2001), a comprehensive overview of educational technology research and scholarship. Paul Saettler’s *The Evolution of American Educational Technology* (1990) provides a historical look at educational technology’s evolution as a profession and its supporting institutions and industries. Tjeerd Plomp and Don P. Ely’s *International Encyclopedia of Educational Technology* (1996) includes more than 100 in-depth articles that together represent educational technology’s global influence as a domain of practice across many academic disciplines. Most recently, Robert A. Reiser and John V. Dempsey have edited *Trends and Issues in Instructional Design and Technology* (2002), an exploration of past and current trends and issues in the field that emphasizes the junction of instructional design, instructional technology, and performance technology. Although these reference books are written for those with a professional or scholarly interest in the field, this encyclopedia is written for a general, nonpractitioner audience.

The broad sphere of influence of educational technology means that this volume should be considered as a complement to the other excellent reference handbooks cited above. In this encyclopedia, we aim to provide an opportunity for those who have had little or no formal introduction to the field of educational technology to learn about its numerous applications and to recognize the relevance of educational technology to many endeavors. We have tried to present concise entries written in layperson's terms that include avenues for further exploration for readers. Where possible we have chosen to highlight the ways that new technologies, enabled by the wide adoption of the personal computer, demonstrate the core principles of educational technology. Though we've tried to ensure a contemporary focus, the history and foundations of the field are critical to understanding its current value and purpose. Therefore, we have included references to established concepts, principles, tools, and individuals that have shaped the field as a professional discipline. For example, we have included such entries as Analysis because the use of educational technologies nearly always requires this professional competency. It is through analysis that we select appropriate technologies and define methods of addressing learning or training needs. We've documented the multiple perspectives found within the field with entries such as Wilbur Schramm, which is a biographical sketch of a pioneer in research on the utilization of television; his work shaped early uses of broadcast technologies as tools for educational and social change. And we have included long-standing approaches to good practice (see Instructional Design and Performance Support). It is on the basis of these foundational concepts and practices that such current applications as Open-ended Learning Environments, Virtual Reality, and Probeware have their significance.

Another challenge that we share with many authors writing on this topic is the never-ending effort to stay current. The multifaceted quality of educational technology means that it is a field on the go. Thus our challenge is compounded not only by the effort to stay current with the pace of technological change but also by the need to stay current with what we know about educational processes—in short, all the activities that we associate with teaching and learning. This became a particularly pressing challenge in the 1990s as the Internet and personal computer became common tools for education and industry; this challenge continues in the first decade of the twenty-first century. Consider, for example, the shifting fortunes of Virtual Universities (see the entry of that same name, as well as the entry Western Governors University), or the impact of changing delivery technologies on the development of educational resources as described in the entry *Who Built America?* Finally, the many entries that reference technologies and strategies that support online communications and collaboration suggest that, even though such topics have been vital to the educational process, we are examining their significance in new ways using new tools.

Take but one example of the pervasiveness of educational technologies: expectations for their use in K-12 schools as evident in the standards developed by professional organizations such as the International Society for Technology in Education (ISTE) and the National Council for Accreditation of Teacher Education (NCATE). These organizations have now established indicators and criteria that define effective uses of technology for instruction, outline adequate levels of access to technology within the schools, consider planning, implementing, and assessing technology usage, and attend to the social, ethical, and human concerns related to technology. Likewise, content-specific associations, such as the National Council for Social Studies and the National Council of Teachers of Mathematics, call for the use of technology to advance content-area learning.

The amount of technology available in schools has increased dramatically in only a few years. Unfortunately, a disproportionate amount of money has been spent on professional development for teachers, technical support, and curricular support. This often results in a lack of technology use, the use of technology in additive, nonessential ways, or the use of technology to replace traditional instructional methods. Many of those traditional methods are grounded in solid pedagogy and research but often do not require the use of expensive hardware and software. This volume thus provides an overview (see the entry Technology in K-12 Schools) of the current status of uses of technology that enhance student learning experiences, encourage higher-level thinking skills, and promote interdisciplinary understandings; another entry on strategies (Curriculum Integration) complements this overview.

As a result of the amount of technology now common in schools, teacher professional development has received increased attention at both the state and national levels. In addition to strengthening teachers' content and pedagogical knowledge, current efforts include expectations for preparing teachers to use information technologies effectively in the classroom. In the entry Teachers: Preparation and Training, the authors review the status of teachers' professional development relative to technology integration. This includes preparing teachers to use technology as an administrative tool, as a productivity tool, and as an instructional tool.

Even with sufficient technical resources and increased attention to teachers' professional development, technology integration may be hindered by a lack of vision (see School Reform); another entry (Technology Planning) contains concrete steps for implementing a school's vision. Part of preparing a vision for technology in K-12 schools includes consideration of social factors. Many of these are addressed in this encyclopedia in entries such as Internet Safety, Digital Divide, and Assistive Technology.

Although there is much progress to be made relative to the integration of educational technology in the K-12 environment, many exemplary projects and activities can serve as models for others. These include the entry Electronic Emissary, describing a resource designed to bring together mentors who are experts in various disciplines with K-12 students; and Learning Circles, an initiative to facilitate collaboration among groups of classrooms around the globe.

Colleges and universities have always valued technology as a research tool to support data analysis and as an administrative tool to support instructional management activities such as student registration and facilities scheduling. Furthermore, within various disciplines, technologies have always been a part of curricula focused on professional and applied sciences such as engineering and broadcast journalism. Within the physical sciences, technologies have long served to model and simulate data analysis and natural phenomena. However, such academic uses of technology often were limited because they required expensive initial investments and their maintenance required highly specialized knowledge; allowing novice learners access presented significant risks. With the introduction of the desktop personal computer and the Internet, access to technology tools and resources has become an expected feature of the postsecondary experience. See the entry on Campus Computing Project for ample evidence of technology's increasing importance in post-secondary education.

The integration of technology into postsecondary environments as an educational support tool has presented three primary challenges for colleges and universities. The first is the organizational change required to ensure the sufficient financial, technical, and human support for educational technology. Traditionally, support for educational technologies has been provided by separate service units; for example, slide projectors and videotape players were distributed by the library, statistical computing support came from the survey research center, videotaping was provided by a media productions unit associated with marketing and publications, and so on. Support was typically device-centered, that is, defined according to the type of media or technology delivery system. As networked computing environments became the norm, the technologies used within these separate units have converged. The management and utilization of educational technology within the postsecondary environment is now less device-centered and more service-centered as the desktop computer has become the predominant gateway to digital content. The ubiquitous nature of networked computers means that less emphasis is placed on managing a particular device and more on providing services to design, create, deliver, and use digital content in an appropriate format. Thus the entries on Learning

Objects and Virtual Library underscore how technology resources and services crisscross the postsecondary environment and present challenges for the effective design of learning experiences and the usage of specific technology tools.

The second challenge that those who teach at colleges and universities face—similar to those who teach in the K-12 level—is defining the role of technology as an educational tool. This is essentially a question of good instructional and curriculum design and often teaching or instructional support units exist within colleges and universities to assist university faculty in developing effective teaching skills. Unlike K-12 teachers, who often learn their profession as students seeking a degree in the field of education, postsecondary faculty typically have little formal exposure to educational theory. Rather, they study to become specialists in a particular discipline. Consequently, they must learn not only to skillfully use technologies but also to use them in ways that enhance and support learning. Teaching and instructional support units are often charged with the responsibility of assisting faculty in gaining the basic teaching skills important to the effective use of technology as a presentation tool and to author and design content for teaching and learning applications. The entries on Computer-Mediated Communication and Web-Based Instruction describe effective principles for designing and delivering content via digital technologies.

Lastly, with the wild popularity of the World Wide Web beginning in 1995, universities and colleges saw technologies as playing a significant role in extending education beyond the physical classroom. The entry on Distance Education offers a detailed consideration of how educational technology has been used to deliver postsecondary learning opportunities in new formats and to new audiences. Numerous entries also address the processes and tools associated with online communication and collaboration. Yet the expectations for using technology for education at a distance have raised many issues for colleges and universities as access to the Internet and levels of technology literacy among potential distance learners are problematic. In addition, the costs of providing quality content to serve distance learner populations while supporting the effective use of technology in the classroom campus can be steep. Effective teaching at a distance often requires a set of skills other than those used to teach in a classroom, where face-to-face student-teacher interaction is the norm.

Educational technologies have also gained a prominent foothold in corporate industry. Employee training and professional development have always been a key concern within corporate environments since they are so crucial to economic productivity. Whether employed for nonformal continuing education or to support ongoing credentialing and skills training, the use of educational technologies within the corporate and industry contexts is most commonly identified with Just-in-Time Training; the entry on Collaborative Technologies also provides an excellent overview of digital tools used to meet not only the communication needs of end-users within corporate environments but also project management and team-building needs within and across organizations. Finally, the value of using technologies to support formal and nonformal communication that enhances the workplace and serves professional and personal growth is aptly described in the entry on Communities of Practice.

We devised an organizational scheme for including entries in this volume, looking at seven overall categories: (1) Foundations; (2) Implementation (e.g., strategies, methods, processes); (3) Issues; (4) Leaders; (5) Professional Associations; (6) Projects; and (7) Research and Theory. These categories, while useful for organizing the study of educational technology, should not be considered exclusive. In fact, there is considerable overlap among them (see Contents by Category). How a term is categorized is a matter of emphasis. Each of the categories is described below.

Foundations are principles that have sustained educational technology as a professional practice over time. These are the building blocks of the field, and any student of educational technology should aim to grasp the significance of these essential terms. Such terms focus on the theories and concepts drawn from a wide range of disciplines and help to provide an orientation toward educational technology as a discipline.

Implementation includes terms that describe the use of technologies to support general educational outcomes. Such terms represent broad applications of technology, typically implemented on principles described within the Foundations category. These entries note examples of the ways that educational technologies may be used, and they are often applicable to a broad cross-section of educational contexts. Thus we have included a sample of entries that describe implementations characterized by specific educational goals, objectives, learners, or learning conditions. We also include terms that define particular technologies existing apart from any educational purpose but that can be defined by their implementation within an educational context (see, e.g., Interactive Television).

Issues relate to the policies and procedures relevant to educational technology. Many terms (see, e.g., Copyright) have always had an impact on the use of educational technologies. Others, such as Acceptable Use Policies and Web Accessibility reflect emerging concerns brought about by new technologies. Many of these terms relate to the way in which teachers, students, and institutions must manage and organize technologies as resources. Others provide insight into the social and cultural changes that result when new technologies are introduced.

Leaders includes biographical sketches of luminaries in the field, individuals who have contributed in numerous ways and whose work can serve as references for further study. Selecting leaders is always a difficult task—particularly in a field as broad and dynamic as educational technology. Therefore, the reader should not assume that the entries provided in this category are exhaustive. Rather, we've aimed to sample the contributions that make educational technology an exciting field by selecting scholars and practitioners whom we view as models of the quality of work worth aspiring toward.

Professional Associations are as varied as the disciplines influenced by educational technology. Those selected for inclusion here represent a wide cross-section of the associations in existence today and should not be considered exhaustive. Rather, we seek to highlight the important roles that professional organizations play in advancing the practice of educational technology principles.

Projects includes terms that are intended to draw attention to best practices and exemplify uses of educational technologies. Like those terms in the Implementation category, the projects described here draw on established strategies and methods specific to the foundations of educational technologies. These terms present work that is widely recognized as a model practice, that have spurred a series of research studies to establish standards for ensuring project success, or that have functioned to demonstrate important proof-of-concept applications of strategies or technologies. The entries selected, however, should in no way be considered inclusive of all the noteworthy projects in the field.

Research and Theory includes terms that summarize important intellectual developments that help to define the significance of educational technology as a field of inquiry. Here we include topics that attempt to explain, predict, or describe learning processes tethered to educational technologies. We also include research that serves as a standard of excellence for the scholarly inquiry that takes place within the field.

Given the range of technologies now available to the general public, we thought it useful to also include a glossary of terms to define many of the technologies now commonly found in the educational technologist's toolbox. These definitions provide a basic description of many technologies and how they function. A broader description of the context for the use of many of these terms can then be located within the alphabetized section of the book. In this way, we seek to give readers a solid grounding in the specific technologies referenced by the contributors who highlight educational technology as a set of shared practices.

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A

Acceptable Use Policies (AUP)

One of the most powerful trends in education today is the integration of technology throughout the K-12 curriculum. As our schools begin traveling the information superhighway, it is crucial that certain guardrails are put into place to ensure the safest route to effective integration. As schools use the Internet and technology on an everyday basis, it becomes critical that a clear set of guidelines is established to promote a positive and efficient use of these resources. According to the Center for Democracy and Technology, 92 percent of U.S. schools utilize an acceptable use policy as their guidepost on the Internet.

Simply stated, an AUP is a legal document that identifies the parameters of the acceptable use of technology as indicated by a school. Its purpose is to establish a standard of behavior that is expected by those individuals who use the technology (computer-based services, information networks, Internet access, etc.) made available through the school system. These technical resources are intended to serve as educational supplements, as tools for instruction, and as tools for personal productivity. The AUP is a policy statement that focuses on maintaining the intended purpose of such resources in an effort to sustain their use within the educational setting.

A variety of individuals should be involved in the development of a school system’s AUP. A legal expert skilled in both school law and state policy development should be a primary participant in the development of an AUP. Others include school administrators, school technology officials, teachers, parents, and community leaders.

Most schools require that these policies be signed by administrators, teachers, students, and parents in an effort to promote awareness on all levels. Although each AUP is unique, most include a similar set of content. Examples of content include: a description of who is authorized to use the resources; a working definition of what type of use is acceptable; and a set of repercussions for the misuse of such resources.

Enforcement and accountability are the key ingredients in maintaining a usable AUP. Without these two features, the AUP simply becomes another form filed away with little to no actual meaning. With the combined efforts of all parties involved, an effective AUP can help to protect the use of technology in the realm of education.

Certain limitations may lead to ineffectiveness. Due to the legal nature of the document, the vocabulary and sentence construction may not easily convey the meaning of the policy to most students and many adults. Due to this lack of clarification, parents and students often sign the policies without deciphering its true purpose. This haphazard approach leads to a student population that simply does not understand the true nature of the policy or the behavior that is expected of them. One solution is to draft a separate memo to accompany the AUP in an effort to more clearly identify the meaning of the school district’s definition of “acceptable use.” Additionally, it would also be beneficial to rework the AUP into an age-appropriate set of guidelines that would serve to identify student behavior expectations. These guidelines could then be discussed in the classroom and posted as reminders in visible locations.

Even with the most detailed AUP, it is a good idea for teachers to expand upon the school’s AUP and establish an additional set of rules (to complement the AUP) specific for their individual class and written in an age-appropriate language. By discussing these rules as a group, the teacher will have an opportunity to reemphasize that students will be held accountable for their actions, to clarify the expectations, and to underscore that it is a privilege for the students to be able to use such resources. It also highlights the fact that the rules will be enforced on a regular basis.

Judith Oates Lewandowski

See also

Copyright; Educational Fair Use; Internet Safety; Netiquette; Technology Planning

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Critiquing Acceptable Use Policies (www.io.com/~kinnaman/aupessay.html). A critique of acceptable use policies with many interesting links.

Crystal, Jerry. 2000. “Empowering Your Acceptable Use Policy.” *Technology and Learning* 21(4): 27.

Indiana Department of Education Model AUP (doe.state.in.us/olr/aup/aupmod.html). This is the officially sanctioned state model for policies to be incorporated by the state.

K-12 Acceptable Use Policies (www.erehwon.com/k12aup). This site offers an assortment of reference materials, including example AUPs, student account agreements, and examples of letters to parents. Great resource for the online teacher.

Sample AUP in Spanish (www.rice.edu/armadillo/aupspanish.html). Bilingual forms are necessary for use in some communities. The emphasis should be placed on informing as many parents as possible.

Active Learning

Active learning constitutes learning that helps students to think critically, analyze, synthesize, and evaluate information, work efficiently and effectively in groups, and solve problems within a variety of different disciplines. Active learning is an attempt to counter traditional instructional models that primarily consist of knowledge transmission and development of inert knowledge (Whitehead 1929). Inert knowledge refers to knowledge learned out of context that is not readily transferable to novel situations. For example, students may learn the formula for determining distance but be unable to apply this information within the context of an interdisciplinary scenario.

Assumptions of Active Learning

S. E. Berryman (1991) outlines several assumptions of traditional educational practice that have been with us since the industrial age:

1. Knowledge transfer occurs when students learn decontextualized concepts;
2. Learners are information receivers or knowledge sponges and teachers are information providers;
3. Learning is a behavioristic endeavor;
4. Learners are blank slates waiting to be written upon; and
5. Knowledge is best attained independent of context.

R. S. Grabinger (1996, 666) counters these “erroneous assumptions” with the following assumptions on which active learning is based:

1. Knowledge transfer is difficult and is best accomplished with content and context learning;

2. Learners are active participants in the learning process;
3. Learning involves cognitive functioning and is constantly growing and evolving;
4.

Learners’experiences and prior knowledge must be considered in all learning situations; and

5. Skills and knowledge are best acquired and assessed in authentic and holistic forms.

Rich Environments for Active Learning

In order to operationalize these assumptions, Grabinger (1996) proposes the use of instructional systems: real environments for active learning (REALs). These environments have six main characteristics or attributes:

1. *Constructivist underpinnings* guide the development of REALs and build on the notion that learning is an evolutionary process by which students modify their personal representations of knowledge as new knowledge is explored. This process involves social interaction and collaboration.
2. *Authenticity* also guides the development of REALs. Learning tasks should be as realistic as possible in terms of context and task. Authenticity is important because it encourages student ownership in learning. Through authenticity, problems hold more relevance, develop deeper meaning and understanding (thus increasing the likelihood of transfer to other situations), and encourage collaboration, cooperation, and negotiation.
3. *Student-centeredness* is essential in REALs because it encourages intentional, responsible learners and lifelong learning skills such as reflection and metacognition or thinking about and analyzing what one is learning and how well learning is progressing.
4. *Collaboration* is a key feature in REALs because students are able to shape their personal knowledge by learning from others, are willing to take more learning risks in a group setting, are able to learn about individual accountability within a group setting, and are exposed to skills and issues that they will face in an increasingly collaborative workforce.
5. *Generative learning* refers to learning where students generate knowledge through active participation in the learning process. Students may generate knowledge as they attempt to make sense of multiple perspectives or as they compare and contrast their knowledge representation with those of their peers.
6. *Authentic assessment* of the environment and of student learning is required in REALs. Teacher observation, student interviews, focus groups, product analysis, portfolios, journals, and

peer evaluations are among the techniques that could be used during authentic assessment.

Instructional Strategies Associated with Active Learning

Numerous instructional strategies may be considered when implementing the principles of active learning, including: anchored instruction, collaborative learning, problem-based learning, cognitive apprenticeships, and case-based instruction. A brief definition of each follows. While each strategy is presented separately, they are rarely used independently, as there is considerable overlap among them.

1. *Anchored instruction* is grounded in a realistic event or problem that is meaningful and motivating to students, is complex, requires the consideration of multiple perspectives and solutions and the use of multiple processes, and facilitates collaboration, cooperation, and negotiation.
2. *Collaborative learning* is built on the need for students to collaborate with each other to share perspectives, solutions, and plans related to a complex task or scenario. Collaborative learning requires individual accountability within a group situation and parallels expectations in the modern workforce.
3. *Problem-based learning* is grounded in the process students go through to solve a realistic problem and requires self-directed learners, acquisition of content knowledge, and use of metacognitive strategies (Savery and Duffy 1994).
4. *Cognitive apprenticeships* are modeled after traditional apprenticeships. Whereas traditional apprenticeships involved learning a visible activity or skills, cognitive apprenticeships involve using mentors to model processes that are typically invisible, such as problem-solving, comprehension, and computation.
5. *Case-based instruction* involves the use of stories or teaching “cases” to facilitate contextual knowledge and understanding.

Applications of Active Learning

Educational technology provides an excellent medium to facilitate active learning. Technology provides a nonlinear, multimedia context in which to develop teaching cases and anchored scenarios. It also enables easy revisions to these contexts. Likewise, educational technology may facilitate the collaborative process and enable students to communicate with geographically disparate peers and experts. The following three projects exemplify or facilitate the principles of active learning and are detailed in separate entries in this encyclopedia.

The Adventures of Jasper Woodbury

The Adventures of Jasper Woodbury is a series of video-based instructional materials with accompanying printed teacher manuals designed to facilitate higher-level thinking skills via motivating and authentic problem-solving and reasoning, interdisciplinary mathematics instruction, and collaboration. The Jasper Woodbury series is distinct from other video-based instructional efforts because students are presented with complex, believable scenarios and a challenge that must be solved by integrating mathematic concepts and skills with the story details. The series was developed by an interdisciplinary staff at the Learning Technology Center at Peabody College, Vanderbilt University; its goals include improving instructional tools for teachers through the use of technology. The series integrates learning theory such as anchored instruction, generative learning, and constructivism with classroom practice.

Electronic Learning Circles

Learning Circles groups six to ten classes of students attending different schools in diverse locations with the goal of publishing their collective work organized around an interdisciplinary, curriculum-based theme. Each school takes the responsibility to create a project, direct the student responses from the others schools, monitor the progress of their partners in completing the task, and then integrate the responses into a final report or anthology.

Electronic Emissary

The Electronic Emissary is an example of how technology can facilitate active learning. It is a web-based service and resource center that helps preschool and K-12 teachers and students with Internet access locate mentors who are experts in various disciplines, for purposes of setting up curriculum-based, extended electronic exchanges among teachers, students, and experts.

Kara Dawson

See also

Anchored Instruction; Cognitive Apprenticeship; Electronic Emissary; Jasper Woodbury; Learning Circles; Problem-Based Learning

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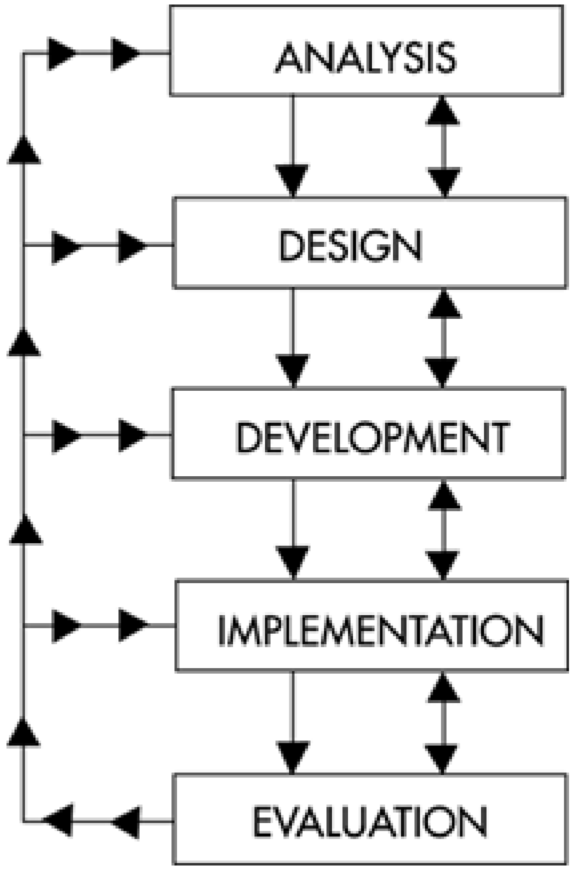

Figure 1:

An ISD Model Featuring the ADDIE Processes

Source: Deborah J. Grafinger (1988), Basics of Instructional Systems Development, INFO-LINE Issue 8803 (Alexandria, VA: American Society for Training and Development).

Savery, John R., and Thomas M. Duffy. 1994. “Problem Based Learning: An Instructional Model and Its Constructivist Framework.” *Educational Technology* (August).

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ADDIE Model

The ADDIE model describes a systematic approach to instructional development. The term is virtually synonymous with instructional systems development (ISD) and evolved informally through oral tradition. It is not a specific, fully elaborated model in its own right but rather an umbrella term that represents a family of models that share a common underlying structure. The acronym ADDIE refers to the major processes that comprise the generic ISD process: Analysis, Design, Development, Implementation, and Evaluation. When used in ISD models, these processes are considered to be sequential but also iterative, as depicted in Figure 1.

The basic engine of ISD models is the systems approach: viewing human organizations and activities as systems in which inputs, outputs, processes (throughputs), and feedback and control elements are the salient features. Advocates claim that the process of designing instruction can be carried out more efficiently and effectively if the steps are followed in a logical order so that the output of each step provides the input for the next. For example, the output of the Analysis phase is a set of performance deficiencies (such as errors being made by workers), which can be broken down to determine what ought to be taught. This output is converted into statements of performance objectives. In the Design phase the content and objectives are examined to decide on appropriate sequencing, media, and methods—specifications that comprise the blueprint for the instruction. The blueprint created in the Design phase is converted into instructional materials and procedures in the Development phase. The materials and procedures are used by actual learners in the Implementation phase. In the Evaluation phase the learners and the instructional system are probed to decide whether revisions are necessary, in which case the process would be repeated with the next version of instruction.

The iterative aspect of the model is represented by the line and arrows running vertically down the left side of the model and the two-headed arrows between each component, as depicted in Figure 1. Each major phase of the process is accompanied by some sort of formative evaluation to test the adequacy of the decisions made during that phase. After Analysis, for example, are the descriptions of the audience and the learning needs accurate? After Design, are the objectives and methods judged appropriate by experts? After Development, does the prototype work in a small-scale tryout (or how can it be improved)? After Implementation, did the entire intervention achieve its goal (or what remains to be done)? This summative evaluation is what is symbolized by the final Evaluation phase. At each of these phases, the results of the evaluative activity could lead the developers to revisit earlier steps (thus the two-headed arrows).

The origin of the label itself is obscure, but the underlying concepts of ISD can be traced to the model developed for the United States armed forces in the mid-1970s. As Robert Branson (1978) recounts, the Center for Educational Technology at Florida State University worked with a branch of the U.S. Army to develop a model, which evolved into the Interservice Procedures for Instructional Systems Development (IPISD), intended for the Army, Navy, Air Force, and Marine Corps. Branson (1978) provides a graphic overview of the IPISD, which shows five top-level headings: Analyze, Design, Develop, Implement, and Control. This model is referenced in virtually all subsequent historical reviews of instructional development, but notably it is not referred to by the ADDIC acronym, thus it is clearly not the source of the ADDIE acronym either.

The underlying concepts of the IPISD model can be found in an earlier handbook by Leslie Briggs (1970), who also was affiliated with Florida

State University. Briggs’s model (1970) incorporates ideas similar to the IPISD model, but without the ADDIC headings.

Although Sivasailam Thiagarajan (1976) is sometimes cited as the originator of the ADDIE label, this is not satisfactory because he only refers to “the basic systems approach A-D-E model” and not “ADDIE,” nor does he provide a visual or verbal model as such.

In fact, the term “ADDIE” does not appear at all in the many textbooks on instructional design, the dictionaries or encyclopedias of education, or the several histories of instructional design written in the 1980s and 1990s. The name itself seems to have been disseminated by word-of-mouth, beginning perhaps in the 1980s. The ADDIE processes appear in a figure in a how-to monograph distributed by the American Society for Training and Development on “basics of instructional systems development” (Grafinger 1988), as shown in Figure 1, but nowhere in the monograph is the acronym ADDIE itself given (it is consistently referred to as the “ISD model” in Grafinger [1988]). Similarly, Allison Rossett (1987) includes a figure showing an ISD model in which the superordinate boxes are labeled with the five ADDIE names, but the caption reads “What happens during ISD.” ADDIE also appears quite frequently on the World Wide Web in various manifestations. One of the better-known web sources is “Big Dog’s ISD Page” (Clark 1995). As with Deborah Grafinger and Rossett, Donald Clark provides a visual model incorporating the ADDIE terms but refers to it as the “ISD model.”

One of the few explicit narrative references to the ADDIE model in the academic literature of the field is found in one work (Molenda, Pershing, and Reigeluth 1996) and is used as a major organizing principle in another (Gustafson and Branch 2002). Neither work provides any citation for the references to ADDIE. Thus it is only in the recent literature that the term is beginning to take on a more fully elaborated meaning. However, authors appear to be creating their own interpretations, as there does not appear to be an original, authoritative version of the ADDIE model.

Michael Molenda

See also

Analysis; Evaluation; Instructional Design

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Adult Learners

Adult learners are people over the age of eighteen in an instructional situation, whether formal or informal. Lifelong learning is now a common expectation of society, but in the field of educational technology most adult learners undertake their studies in employee education and training programs. This stems from the fact that since the 1980s the preponderance of instructional design practice has occurred within the private sector, primarily in business and industrial settings. This coincides with the steady growth of employee training as an integral part of most organizations. This growth reflects the emphasis on producing a more knowledgeable workforce and, increasingly, on improving employee on-the-job performance and solving organizational problems.

For many, the term "adult learner" is too comprehensive. Unlike children, adults span a wide range of ages and developmental phases. There is little agreement upon what these phases are. Some view adult learners in terms of age groupings with characteristic physical changes, others in terms of a person's social and psychological history, and others in terms of typical life events. Nonetheless, it is common to assume that life changes have implications for adult learning in terms of learning style, the motivation to learn, and the capacity to learn. At the least, many scholars recommend distinguishing younger adult learners from older adult learners.

Theories of adult learning encompass a range of topics, many of which are unlike those addressed in generic learning theory. Most adult-oriented theories speak to issues such as how adults learn, what they learn, and why they learn. Such learning theory has implications for a variety of instructional design factors, including how to encourage participation in learning activities, adult motivation and persistence, how to promote using information learned in one's job, and how to modify adult attitudes.

The interest in adults as learners stems from questions surrounding the extent to which they differ from children in learning situations. Popular views of adult learners present them as being more self-directed, autonomous, and problem-oriented. However, others cite many examples of adults who are not mature and self-directed learners. Most scholars in the field recognize many similarities between the learning patterns of adults and children while acknowledging those characteristics that are unique to adults.

The characteristics of adults that seem to most influence learning pertain to demographic and experiential backgrounds, capacity and competence, and attitudes. One of the most important demographic questions is whether age influences one's ability to learn. Most feel that age per se is not a good indication of who is likely to be the best learner. Although at some point age can suggest the likelihood of declining physical abilities, for most people it is a less powerful predictor of learning success than are the experiences one has had. In employee training situations, experiences that are more likely to be associated with effective learning relate to the nature and extent of a person's previous education and training as well as her work, professional, and cultural and language backgrounds.

In employee training especially, it seems that one's experiences can, to a great extent, counterbalance the debilitating effects of age on one's capacity to learn. Although a person may become less adept in general learning with age, people often continue to grow as learners when the instruction pertains to areas of special interest or areas with which they have considerable experience.

Adult attitudes are often important predictors of successful learning. Of particular importance to success in the classroom are feelings of self-confidence, perceptions of the instruction's relevance, and one's personal priorities. These attitudes are often difficult to change and are typically ingrained in well-established work habits. In colloquial language, this is called being "set in your ways," a characteristic of many older adults.

In employee training, learners' attitudes toward their jobs, the company, their supervisors, and even their coworkers can influence the learning process. These attitudes influence not only how much learning occurs but also whether the information learned will be used on the job. Attitudes are an element effecting motivation in the classroom and in the workplace.

Special emphasis is warranted in relation to adult attitudes toward the new technologies used in employee training. Many training programs, especially in larger organizations, are turning to the use of advanced, technology-based instructional delivery systems. A prime example of this is the preponderance of web-based training. Even though there are many advantages of such training methods, there can be problems. Many adult learners and instructors alike have had little experience with computers as a learning tool. Some persons not only don't like learning with computers, they also feel a sense of computer anxiety. These feelings can constrain the learning process.

Any learning situation is characterized to some extent by the nature of the learners, and employee training is no exception. In what ways do instructional designers build upon the distinctive nature of adult learners and the training environment? Today, predesign analysis includes a consideration of the learner and the work context, in addition to the training content. Of particular importance in this analysis is that adults come to employee training programs with a certain amount of related knowledge, skills, and attitudes gathered from previous experiences they've had, both on the job and off. Instructional strategies and motivation tactics must be attuned to these characteristics. Since participation in training programs is usually not voluntary and often detracts from pressing job responsibilities, instruction needs to be efficient, relevant, and engaging to be considered worthwhile. Instruction should build upon real-life situations that will be encountered and provide sufficient hands-on practice for people to feel comfortable with using their new skills. New technologies should not be used in training without providing sufficient practice and orientation to their use. Instructors of adult learners should often take the role of a facilitator rather than a lecturer. Furthermore, there should be an immediate opportunity for trainees to use the knowledge and skills learned back on the job. If the ultimate goal is to change the employee's work habits, training programs must also include tactics for continuing on-the-job support such as refresher experiences or using job aids and tools. Often supervisors are also trained in an effort to ensure daily support.

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See also

Analysis; ARCS: A Model of Motivational Design; Instructional Design; Just-in-Time Training; Performance Support; Web-Based Instruction

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Alternative Assessment

Alternative assessment refers to nontraditional assessment methods. Such assessment methods are often applied to complex knowledge and performances and engage students in higher-level thinking and authentic performances while simultaneously permitting reliable scoring and manageable record-keeping. Most frequently, alternative assessment is used as a complement to rather than a replacement for traditional objective tests. Objective tests are an efficient way to assess students' knowledge of rote facts, whereas alternative assessment strategies move beyond such testing and meet the learning styles of more students. Alternative assessment is closely linked to curriculum planning and instructional methods. Thus the push for constructivist learning environments, authentic learning experiences, collaboration, and facilitation of higher-order thinking skills has fueled interest in alternative assessment.

Alternative assessment strategies often involve the use of rubrics. The term "rubric" has multiple meanings, but in the world of education it refers to formal guidelines used to assess student work. Typically, rubrics are presented in a matrix format with performance levels in the top row, performance indicators along the left column, and evaluation criteria in the cells. Teachers often involve students in the creation of rubrics so that they have a vested interest in the learning experience. A properly designed rubric provides enough guidance for students to know what is expected of them but enough generality to encourage creativity and higher-level thinking.

Educational technology has many characteristics that can enhance alternative assessment strategies, including multiple ways of representing knowledge, support of diverse communication strategies, facilitation of collaborative work, and multiple data collection strategies. Four common alternative assessment strategies that can be enhanced by educational technology are (1) performance-based assessment; (2) project assessment; (3) portfolio assessment; and (4) journal assessment.

Performance-Based Assessment

In performance-based assessment, teachers observe students performing a particular task such as using science laboratory equipment or giving an oral presentation. Educational technology can enhance this type of alternative assessment by providing means of record-keeping through spreadsheets and video technology. Video technology also enables students to review their work and for teachers to share this work with parents. Educational technology can also enhance this type of assessment through the use of simulations. Students may manipulate a variety of variables related to maintaining an ecosystem, managing a city, or negotiating with other countries. Such simulations enable students to demonstrate competency through performances that may otherwise be impossible for fiscal, managerial, or safety reasons.

Project Assessment

In project-based assessment, students are given a project to complete related to integrated curriculum goals. Ideal projects simulate real-life situations, are rich in design and long-term, encourage the development of multiple responses, facilitate collaboration and individual accountability, and encourage creativity, knowledge integration, and planning skills. Examples of projects include development of a school-wide election campaign, creation of a product designed to perform a particular task, or composing a persuasive presentation about a controversial issue. Educational technology can enhance this type of assessment by providing a variety of formats for final products or presentations (i.e., text, graphics, multimedia, video, etc.) by enabling communication with subject-matter experts and by allowing research opportunities beyond those available in the school library.

Portfolio Assessment

Portfolio assessment involves students purposefully selecting works that show effort and achievement in specified areas. Portfolios can be used to assess progress over time. For example, some schools ask each student to keep an ongoing writing portfolio throughout their elementary years. Portfolios can also be used to encourage student reflection and provide summative evaluation information. For example, some teacher education programs require graduating students to complete a portfolio documenting the teaching standards they have met throughout the program. Electronic portfolios are one of the most popular ways that educational technology is used to facilitate authentic assessment and an entry is devoted to them in this encyclopedia.

Journal Assessment

This type of assessment involves students' expressions and reflections and is frequently ongoing. Journal assessment can be highly structured, with strict guidelines and directions, or open-ended, with minimal direction. Students are frequently asked to keep writing journals where they document ideas they have for stories or poems, or math journals where they explain how they came to solve particular problems. Students may also be asked to keep journals about personal experiences related to class topics. For example, when studying habitat destruction, students may be asked to document instances they notice throughout their communities; or when studying nutrition, students may be asked to document their eating and exercise habits for a specified period. Educational technology can be used to allow students to share journals with others beyond the four walls of the classroom. For example, when studying Japan and its culture, American students may be able to “journal” with Japanese students via e-mail. Likewise, journals need not be in written form. Educational technology allows for a variety of formats, thus meeting the needs of more students and encouraging multiple approaches in the same assignment.

Kara Dawson

See also

Electronic Portfolios; Evaluation

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Analysis

Analysis represents the planning phase critical to the effective use of educational technology. It is what educational technology professionals undertake when determining what action should be taken. Whether called “analysis,” “assessment,” “needs analysis,” or “performance analysis,” the focus is on making decisions regarding the design and use of technologies toward achieving educational outcomes by examining and considering many viewpoints and data elements rather than by habit, intuition, or fiat. Through analysis, it is possible to cultivate an analytical point of view rather than a view that favors technology or formal classroom instructional strategies. Similar to the diagnostic activities carried out by doctors, architects, and consultants, analysis is a data-driven process that helps educational technologists identify key problems to design effective solutions. During analysis, many sources, questions, instruments, work products, and approaches are used to plan a solution.

Analysis frequently occurs “up front,” or “first,” especially when influenced by conventional linear models of instructional systems development. However, analysis can be both responsive *and* proactive, immediate *and* perpetual. Examples of when and how an analyst might act include:

- When a client asks, for example, for an online learning program to handle time-management challenges, the educational technologist endeavors to examine the situation before buying or building a program.

- The educational technologist is aware that time is a critical resource in an engineering company and that there’s been some concern about its efficient uses in the past. For eight months, she’s been gathering data associated with that topic, including supervisory comments, engineering opinion and references from the literature, and best practices. Now, when the topic comes up with her vice president, she is ready to speak with authority on the subject.

- The educational technologist adds several questions to the annual assessment survey and spends hours poring over the data. She also plays an active role on the organizational intranet, reading listservs, and asking questions. This extant data provides key directions for planning.

American philosopher John Dewey deserves credit as a parent of analysis. He turned away from the European and manufacturing traditions and urged interest in the needs of the learner. While modern practice now perceives soliciting learner perspectives as commonplace, it was revolutionary at the time for educators to be interested in anything other than the job or subject matter.

Ralph Tyler, generally recognized as the originator of behavioral objectives, emphasized a questioning process as a means of determining objectives. Two decades later, Robert Mager made Tyler's work accessible by crystallizing tools and approaches associated with analysis as well as finding and writing instructional objectives. Objectives assist in planning only if they are the "right" objectives, which in this case is linked to a robust definition of where the organization or individual wants to go, what the current state is, and what it will take to narrow that gap. Thus analysis assures fresh, varied, and data-driven roots for objectives.

Several scholars (Mager 1984, 1970; Kaufman and English 1979; and Rossett 1999) urge an expanding view of analysis predicated on a holistic vision of how organizations and people operate. Roger B. Kaufman presses the profession to consider how gaps and interventions affect the group, the organization, and society, not just the individual performer. Analysis activities must occur throughout the organization, resulting in more robust and data-driven human resources development, product development, organizational development, human resources management, and environmental engineering.

Other researchers (Gilbert 1978; Mager and Pipe 1984; Harless 1975; Robinson and Robinson 1995; Rossett 1999; and Hale 1999) would probably agree that:

- Analysis has two overarching purposes: (1) to make good decisions about technology-based and non–technology-based approaches based on data from many sources; and (2) to influence the organization in systematic and systemic directions.
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- Analysis is critical to figuring out what to put in any particular lesson or class; larger questions about systems and readiness are addressed in analysis, increasing the likelihood that the class or lesson will make a difference.
- Analysis is for the purpose of divining a tailored array of interventions that can be used to enhance performance, including, but not limited to, instruction. Examples of interventions are e-learning modules, job aids, personnel selection strategies, electronic knowledge bases, compensation and incentive programs, reengineered processes, and job redesign.
- Analysis ensures that many fingerprints are on the effort.
- Analysis requires that the analyst then collaborate with appropriate colleagues and market the aligned approach to the organization.
- Analysis increases the need for a fresh and data-driven look necessary to enabling global and culturally diverse contexts.

Two questions dominate analysis. The first is about the “what.” What is the essence of good performance? What are the problems? Where are we attempting to go (e.g., what constitutes good auditing, good sales, or good sportsmanship)? The “what” questions are answered by reviewing the literature, best practices, and observing and querying experts and model performers. The second question that dominates analysis is the “why,” which defines the means for the educational technologist.

Analyzing Causes and Identifying Solutions

Several scholars (Mager and Pipe 1984; Harless 1975; Gilbert 1978; and Rossett 1987, 1999) offer templates for ascertaining why—ferreting out the causes and then using them to derive solutions. Tom Gilbert (1978), for example, elegantly distinguished between two kinds of deficient performers: those who cannot do what is expected of them, and those who can but do not for some other reason. The analyst then must ascertain why they do not, then propose what to do about it. The incumbents themselves and their supervisors are key sources here, not surprisingly. Typical questions are: Why are sales down this quarter? Do they know how to sell *x*? Do they believe in that new product and feel they can represent it positively? Table 1 provides one statement of the relationship between kinds of causes and kinds of solutions.

Four common causes of suboptimal achievement are:

- *Employees lack skill or knowledge or information:* Even if they tried, they could not do it. They do not possess the knowledge

Table 1: Common Relationships between
Causes and Solution Identified through Analysis

Driver	Description	Solutions
Lack of skill, clarity about expectations, knowledge, or information	People don’t because they don’t know how, or they’ve forgotten, or there’s just too much to know.	• Education/training • Information support (job aids) • Documentation • Coaching and mentoring • Clarity re standards • Communications initiatives
Weak or absent motivation	People don’t because they don’t care, or see the benefits, or they don’t believe they can.	• Education/training • Information support (job aids) • Documentation • Coaching, mentoring • Participatory goal-setting • Communications initiatives
Ineffective environment, tools, or processes	People don’t because processes or jobs are poorly designed, or necessary tools are unavailable.	• Reengineered work processes • New or improved tools or technologies or work spaces • Job design or redesign • Job enrichment • Participatory decisionmaking
Ineffective or absent incentives	People don’t because doing it isn’t recognized, doing it is a hassle, or not doing it is ignored.	• Improved appraisal/recognition programs • Management development • New policies

Source: Created by the author.

- necessary to add the memory to the computer that explains the reasons for the new operating system.
- *The environment is in the way:* Individuals do not have access to the equipment, tools, forms, or work space necessary to perform. Software, for example, has not been installed.
- *There are no, few, or improper incentives:* What are the consequences of doing the job badly or not doing it at all? Are supervisors paying attention to desired outcomes? Does the compensation program recognize excellence and extraordinary effort? If managers are expected to implement a program, will their performance appraisals reflect that priority? What happens if they provide only halting support?
-

- *Employees are unmotivated:* Here we direct attention to the internal state of the individuals. What is going on within employees as they contemplate a new product or system?

Tools for Gathering Information and Perspectives

Whether conducted in person or on the phone, interviews are used to gather information about optimal and actual performance, feelings, causes, and solutions. When the information is technical, detailed, or emotionally charged, an interview is appropriate. The interview, especially when conducted in person, is also an effective device for creating relationships, another key purpose of analysis. Another advantage of the interview is that the analyst is able to generate follow-up questions. For example, when an employee says, “I’m not going to say negative things in a performance appraisal,” the analyst can follow with, “Why not? What keeps you from doing that?”

Observations are used to determine what is going on in the workplace. They are a powerful tool for capturing information about current skills and knowledge, as well as for examining the context surrounding the individual. Historically associated with task analysis, many have used interviews to observe model deck-swabbing or motherboard repair in order to generate the details of excellent performance.

According to one study (Zemke and Kramlinger 1982), there are two levels of observation. The first level provides a general “take” on the situation—providing, say, an “establishing shot” of what is going on during the initial stages of an audit. The second level of observation captures the details of the interactions.

Observations often focus subsequent inquiries, and the analysts will often choose to conduct interviews or distribute surveys after conducting observations at the work site. Surveys solicit the thoughts and concerns of many people at lower cost than observations or interviews. The survey can capture mundane information, such as which classes have been taken in the past, and emotionally loaded information, such as the employees’ confidence surrounding it or views about the causes of the problem. Because the survey can be anonymous, the analyst can be hopeful that people will report honestly.

Successful surveys are clear about their purposes, and even the most experienced survey-writer benefits from piloting. This involves distributing the survey to colleagues and selected members of the target population prior to widespread mail or electronic distribution.

Structured focus-group meetings provide an effective means for obtaining and dispensing information and for generating relationships among people and across units. It is essential to carefully construct an agenda based on the purpose of the analysis and to anticipate differences in opinion. The analyst must know ahead of time whether the experts drawn from across the globe to talk about maintenance of turbine engines in desert climates disagree. If they do, it is better to work with them alone initially, to put them in smaller work groups, and ask upper management to designate the expert who is "first among equals." Participants should be thoroughly briefed before they appear for a focus group.

Technology Tools

Technology tools can serve the analysis process in numerous ways. For example, technology may be used to collect data from many at a reasonable cost. Interviews can be conducted via e-mail, and with instant messaging it's not necessary to lose the benefits of follow-up questions. Time and distance become irrelevant because respondents can answer at their own convenience. Using prior notification with substantive explanations encourages participation.

Likewise, e-mail surveys are an excellent way to reach out for individual, anonymous opinions. Data collection is ongoing, and results are omnipresent. Listservs can be used to conduct focus groups by querying participants in a structured way. Participants respond to those questions, and to other participants' responses. Two-way videoconferencing presents a way to talk and see each other during analysis at remote sites by providing a means for conducting observations and examining visual cues. Finally, technology is useful for making sense of the data and to communicate it to others. Quantitative tools (such as SPSS and SAS) and qualitative tools (such as NUD*IST, the Ethnograph, and HyperResearch) can contribute to analysis of data.

Building Support for Analysis

According to one study (Rossett and Czech 1996), while analysis is judged to be critical to most learning professionals, leadership within an organization does not allow them to do as much of it as they believe is critical. Five strategies for increasing support for analysis include:

1. Conduct effective analyses, then document what has been done and how it has contributed to the bottom line. It is important to collect examples of how analysis has unearthed information and opinions that altered subsequent decisions and impacts.
2. Make a case for analysis through analogies to other professions. Would an engineer launch a project without serious scoping activities? Would a physician prescribe treatment without diagnostic tests? Would an urban planner develop low-income housing without constant interaction with community leaders?
3.

Avoid professional jargon, such as “performance analysis”or “needs assessment”or “task analysis,”words with little meaning beyond familiar professional boundaries. Until there is clarity and a successful history behind these phrases, consider using others that are more familiar in the customer’s world: “planning”or “auditing”or “customization.”

4. Step into the shoes of the customers, clients, or colleagues who are blocking analytical activities. Ask them about their hesitancies and respond accordingly. If analyses have delayed progress and failed to deliver useful information in the past, it’s not surprising to find halting acceptance. Why would a colleague in information technology or organizational effectiveness hesitate? Again, cultural and historical factors deserve attention.
5. Do whatever you do speedily and virtually. One of the best ways to encourage support for analysis is to speed up the process. Use technology. Gather data even before it is needed. Anticipate and repurpose existing data.

If every interaction with clients and customers involves tailoring solutions to particular needs and circumstances, then analysis provides the defining energy and direction. Trainers, instructional designers, educational technologists, and web-learning managers are examples of professionals who approach their work with an analytical and performance perspective. No solution is assumed until analysis is completed.

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See also

ADDIE Model; Evaluation; Instructional Design; Performance Support

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Anchored Instruction

Anchored instruction can be defined as an attempt to help students become actively engaged in learning by situating, or anchoring, instruction in interesting and realistic problem-solving environments. A primary goal of anchored instruction is to help students develop the confidence, skills, and knowledge necessary to solve problems and become independent thinkers and learners (Cognition and Technology Group at Vanderbilt [CTGV] 1990). Most of the education reform literature centers on the failure of traditional instruction to accomplish this goal. The concerns about traditional approaches to instruction have been influenced in part by A. Whitehead’s (1929) discussion of what he termed “inert knowledge.” Inert knowledge is the knowledge that can usually be recalled when people are explicitly asked to do so but is not used spontaneously in problem-solving even though it is relevant. Meaningful, problem-oriented approaches to learning are more likely than fact-oriented approaches to overcome inert knowledge problems (CTGV 1990).

Anchored instruction helps to overcome the problem of inert knowledge. Creating environments that permit sustained exploration by students and teachers enables them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools (CTGV 1990). Anchored instruction also helps students develop representations or mental models of their experiences in order to set the stage for positive transfer (CTGV 1993).

Educational technology provides an excellent medium for creating and implementing effective anchored instruction because: visual formats allow students to develop pattern recognition skills; technology allows a more vertical representation of events than text; it is dynamic, visual, and spatial; students can more easily form rich mental models of the problem-solving situations; and technology has random access capabilities. All this allows teachers to almost instantly access information for discussion.

Stages of Anchored Instruction

When using an anchor, the following steps or phases of instruction are distinct and sequential, each contributing to the process: (1) introduce the anchor; (2) develop shared experience around the anchor; (3) expand the anchor; (4) use knowledge as tools for problem-solving; (5) work on projects related to the anchor; and (6) share what was learned.

The students are introduced to the anchor in phase one. The anchor might be a video segment, which contains a complex problem with embedded data to help solve the problem. In another class, the video content might be rich with information that supports sustained thinking about target concepts or that is needed to comprehend related text and for class discussions. In another class, the anchor might be a videoconference with a subject-matter expert who poses a problem to the students. By using such anchors, students and the teacher have a shared learning context (McLarty et al. 1990).

In phase two, students develop shared expertise around the anchor. Multiple visits to specific scenes in the anchor will allow students to develop expertise on particular aspects. In this phase, the teacher might lead a discussion of the anchor. However, as their knowledge of the anchor increases, students might assume more responsibility for their own learning. Once the teacher and students have developed expertise on the anchor, the links across the curriculum and to their prior experiences become a common occurrence within the classroom.

The students expand the anchor by conducting their own research in phase three. Gaps in information provided by the anchor might require students to research related materials in the library or via the Internet. Students might learn new technologies using the anchor for content material. For example, the students might create a HyperStudio stack about one of the topics in the anchor.

In phase four, students use their knowledge as tools for problem-solving. They might use this knowledge to solve problems posed in the anchor itself or relate the information to problems in other content areas. In this phase, teachers might provide scaffolds to help students solve the problems, or students may collaborate with geographically disparate peers via e-mail, videoconference, or other electronic means. For example, teachers who are using the Jasper Woodbury series to teach problem-solving and math skills might encourage the students to determine how to approach the problem and then provide them with the resources necessary to make progress, or students may discuss their plans with students from another school via a newsgroup.

Students work on projects related to the anchor in phase five. In this phase, students are given the opportunity to extend their knowledge and relate it to other areas. Some examples of this phase might include reading more about the subject, writing a report or an essay, or creating a multimedia report.

In phase six, students share what they learned from the project. The process of sharing not only creates pride in their own work but also gives them valuable insight into how their classmates solved the problem. At this point the students are encouraged to compare their solutions with those developed by their classmates and by experts, as well as to evaluate the strengths and weaknesses of each approach.

Advantages of Anchored Instruction

Advantages of anchored instruction include student ownership of their learning because problems hold more relevance; development of deeper meaning and understanding, thus increasing the likelihood of transfer to other situations; and use of collaboration, cooperation, and negotiation skills.

There are several advantages to organizing instruction around an anchor and then moving to hands-on activities. First, it provides everyone involved with a common background about the subject. Because it is visual, it is easier for students who are not good readers to participate in class discussions. Teachers often find this approach more manageable than finding all the resources necessary to accomplish a community-based project. Students often focus on an issue from a macro context that was not noticed as a potential issue by other members of the class. Once this issue is noticed, further research can be done on it.

Challenges of Anchored Instruction

The current emphasis on student-centered instruction means that teachers need to change their role from a provider of information to coach and, often, fellow-learner. Anchored instruction provides the means to make the shift from a teacher-dominated to a learner-centered classroom. With anchored instruction, the teacher can no longer follow a fully scripted lesson plan. Students are encouraged to identify their own questions, goals, and issues that arise as they explore the anchors. Since the students construct their own learning, teachers struggle with how to help the students reconceptualize problems without being overly directive. Another challenge for teachers is how and where to fit anchored instruction into their existing curricula and make sure that it meets their needs with respect to mandated achievement testing common to K-12 environments (CTGV 1993).

Applications of Anchored Instruction

Anchored instruction has been used with students ranging from fifth grade through college. It has been used in a variety of disciplines: language arts, social studies, math, science, and educational technology. Some examples of anchored instruction have used the World Wide Web as a resource by anchoring students in the principles of aerodynamics to learn about science and math concepts, presenting multiple perspectives of the study of global warming and its effects on our environment, and putting students in the role of determining whether to defend or oppose nuclear research.

The Cognition and Technology Group at Vanderbilt has implemented several successful anchored instruction projects. The Young Sherlock Holmes project, organized around a movie on videodisc, was implemented in two fifth-grade classrooms. The students were below average and average in academic ability. The project was designed to help the students learn language arts and social studies content by helping them to observe relevant historical information in movie settings and use their observations to make inferences (Risko et al. 1990). This study found that the video motivated students to form well-defined goals when reading to learn. Students in the anchored group were more likely to spontaneously use new vocabulary terms than were those in the comparison group (CTGV 1993).

A second CTGC project, the Jasper Woodbury series, focuses on mathematical problem formulation and problem-solving. It also involves the development of applications to enable students to learn science, history, and literary concepts. Although the series was designed for fifth- and sixth-graders, it could be used with fourth-graders through college freshmen (CTGV 1989). An important feature of this series is that information needed to solve the problems is embedded in the story. The embedded data design allows teachers to help students try to generate what they need to know, attempt to retrieve this information from memory, and then review segments of the disc to see if they were accurate (CTGV 1989). The Jasper Woodbury series provides examples of problems that occur in everyday life and how they might be solved. The Cognition and Technology Group at Vanderbilt has also explored the anchored approach to science instruction in its Scientists in Action series.

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See also

Active Learning; Constructivism; Jasper Woodbury; Learner-Centered Environment; Problem-Based Learning

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Apple Classrooms of Tomorrow Project (ACOT)

The Apple Classrooms of Tomorrow Project, a ten-year, longitudinal research and development collaboration among public schools, universities, research agencies, and Apple Computer, began in 1985. The project set out to investigate how routine use of technology by teachers and students would affect teaching and learning. ACOT worked independently of the company’s product, sales, and marketing divisions. The results of this project have influenced staff development and technology integration plans throughout the country. This project is also one of the most widely cited longitudinal studies in the field.

After soliciting and reviewing proposals from interested school districts, ACOT began work in five schools in four states. The initial sites represented a cross-section of America’s K-12 schools in terms of grade level, socioeconomic status, and community setting. Each of the ACOT sites began with one classroom, then added classrooms, staff, and students in subsequent years. ACOT staff asked that the gender and ethnic composition of the classes mirror the school as a whole; all other decisions about student selection were left up to school personnel.

ACOT equipped project classrooms with computers, printers, scanners, laser-disc and videotape players, modems, CD-ROM drives, and a variety of software packages. ACOT provided participating teachers and students with two computers, one for the classroom and one for the home. Since hardware in 1986 was big and heavy, the two-computer formula was the only way to provide teachers and students with constant access to technology. This option offered a way to simulate a future time when technology would be more accessible because of its smaller size, portability, and lower cost.

Project teachers—all volunteers selected by the individual school districts—ranged from novices with one or two years of experience to veterans with more than twenty years in the classroom. Few had worked closely with technology before joining the project. ACOT staff provided training

for teachers on telecommunications, basic troubleshooting, and tools software such as spreadsheets, databases, and graphics programs. ACOT also helped fund a full-time coordinator at each site to provide technical and instructional assistance.

Technology was viewed as a tool to support learning across the curriculum. No attempt was made to replace existing instructional technologies with computers. Instead, project classrooms included—along with computers—multiple instructional resources such as textbooks, workbooks, and manipulative math materials. The operating principle in ACOT classrooms was to use the tool that best supported the learning goal.

When computers were first introduced to ACOT classrooms, the technology added another layer of complexity to the classroom, a whole new set of things for already overworked and stressed teachers to learn and manage. Yet as the project continued, teachers found strategic ways to use the technology. Its use in instruction and learning changed as teachers themselves changed. Researchers described these changes in a model of instructional evolution that includes five stages: entry, adoption, adaptation, appropriation, and invention. In this model, instruction is first strengthened through the use of technology and then gradually replaced by far more dynamic learning experiences for students.

Entry

Teachers who were beginning with the project had little or no experience with computer technology and were in various stages of trepidation and excitement. They spent the first weeks unpacking boxes, running extension cords, untangling cables, inserting cards, formatting disks, checking out home computers, and generally trying to establish order in radically transformed physical environments. During this unavoidable initiation, even experienced teachers found themselves facing problems typical of first-year teachers: discipline, resource management, and personal frustration. They expressed serious reservations about students’ access to computers and whether the new technology would ever fit in. Overwhelmed by other issues, the teachers showed little inclination to change instruction.

From the initial arrival of the computers, the students showed a high level of interest in and curiosity about technology. Students enthusiastically worked on the computers, sometimes becoming so intrigued that they resisted moving on to other classroom activities. Some students became so enamored with technology that they became unwilling to do work with pencil and paper. The children’s inquisitive nature often seemed like misbehavior to the teachers. For instance, students took apart the mice to see how they worked, experimented with magnets to see if they really would erase a disk, figured out how to get into the teacher’s management system, or unintentionally caused problems with the network. In this stage, students demonstrated a steady fascination with the technology, but teachers didn't yet know how to use that excitement to benefit teaching and learning.

Adoption

Although teachers continued to deal with technology issues in this stage, they began to show more concern about how technology could be integrated into daily instructional plans. They began to incorporate computer-based activities aimed primarily at teaching students how to use technology: keyboarding, word-processing, and saving, storing, and organizing work. Given their lack of experience with technology, teachers adopted it to replicate traditional instructional strategies and attempted to blend its use into the most familiar form of classroom practice: direct instruction. They searched for software they could adapt to established curricular and pedagogical preferences. Although much had changed physically in the classrooms, more remained the same.

Given frequent disruptions to normal classroom operation that came with beginning attempts to use the computers, researchers anticipated short-term declines in student performance. Traditional measures of achievement, however, showed no significant decline or improvement in student performance aggregated at the classroom level, and teachers reported that individual students were performing better. Site coordinators noted improvements in student attendance, self-esteem, and discipline. Teachers and researchers observed changes in student motivation and engagement. Students became more excited about learning, and their enthusiasm aided their own progress while also reinforcing teachers' efforts.

Adaptation

In this phase, technology became thoroughly integrated into traditional classroom practice. Lecture, recitation, and seat work remained the dominant form of student tasks; but students used word processors, databases, some graphic programs, and many computer-assisted instructional packages for approximately 30–40 percent of the school day. More frequent and purposeful use of technology began to return dividends.

The most significant change for students occurred in productivity. Students produced more and at a faster rate. In a self-paced computational math program, for example, sixth-grade students completed the year's curriculum by the beginning of April. Rather than beginning the seventh-grade curriculum, teachers decided to use the remainder of the year focusing the students on application and problem-solving. Students who were not usually enamored of math and rarely performed well became engaged in the hands-on, problem-solving approach. These students then became recognized as creative math problem-solvers. In subsequent years, teachers at this site assigned more of the computational math activities as homework to be completed on the home computers and used class time for application and problem-solving activities.

At an elementary site, teachers focused on basic math and language arts skills and used their computers purposefully to raise student test scores. For two years in a row, the district reported that ACOT students scored significantly higher on the California Achievement Test than non-ACOT students in vocabulary, reading comprehension, language mechanics, math computation, and math concepts and application. At other sites, which were less focused on basic skills development, teachers worried that time spent on developing technology skills (rather than on covering standard curriculum) might erode student test scores. Less time spent on the basics, however, did not have a negative impact on student performance on tests at these sites.

Increased productivity emerged at the high school level as well. In chemistry, for example, students learned to use a simple graphics program to illustrate molecules and the exchange of atoms in chemical reactions. The teacher reported that students learned how to write and balance chemical formulas faster and more accurately than in his previous experience. The instructional process also became more efficient, as students could access assignments on the network, work on assigned tasks, and send their work to the printer to be picked up by the teacher.

Teachers and researchers also noted improvement in students’ writing during this stage. Many students could type faster than they could write, thus preferring to prepare assignments with the word processor. Researchers who examined writing in one third-grade ACOT classroom determined that children maintained a high level of enthusiasm for and interest in writing; that computers made compositions more presentable to others, thus encouraging sharing and writing; and that students wrote more and better as a function of the accessibility of computers. The opportunity to write regularly on computers made a substantial difference for low-achieving students who demonstrated significant improvement in the quantity and elaboration of their writing. With increased productivity in writing, teachers could work with even young students on narrative skills. Students willingly reworked their papers because the process was much easier than with pencil and paper.

During the adaptation phase, teachers also noted changes in the quality of student engagement in classroom tasks. They found that students, during computer activities, were highly involved in their assignments and were frequently able to work with little assistance. Students spent more time on assignments and projects, and they chose to use the computers during recesses, lunch periods, and after-school hours. In addition, teachers reported that students were increasingly more curious and assistive learners, taking on new challenges far beyond the normal assignments. Some students developed technology-related skills that led to jobs in their communities.

Students started to take on new roles in the classroom as they led classes, became peer tutors, and spontaneously organized collaborative work groups. Teachers also discovered that students who did not do well in a typical setting frequently excelled when working with technology. For example, a first-grade student who was low to average on academics turned out to be a whiz at word-processing and finished all twenty-one lessons of a program in one day. Low achievers had a chance to experience success and began concentrating and applying themselves to their projects. Teachers saw less advanced students blossom, unpopular students gain peer approval, and unmotivated students stay in to work at recess.

Appropriation

Appropriation was less a phase in instructional evolution and more a turning point. It was evidenced less by changes in classroom practices and more by changes in personal attitudes toward technology. Appropriation was the point at which an individual came to understand technology and use it effortlessly as a tool to accomplish real work. As a turning point, appropriation marked the end of efforts simply to computerize their traditional practice and led to the next stage, where new teaching approaches promoted the basics yet opened the possibility of a new set of student competencies.

Invention

In the invention stage, teachers experimented with new instructional patterns and ways of relating to students and to other teachers. As more teachers reached this stage, the whole tenor of the sites began to change. Interdisciplinary project-based instruction, team teaching, and individually paced instruction became common. Students were busier, more active learners. ACOT teachers tended to see learning as an active, creative, and socially interactive process. In this stage, knowledge came to be viewed more as something that children must construct for themselves and less like something that can be transferred intact.

Teachers reported on students’ highly evolved skills with technology, their ability to learn on their own, and their movement away from competitive work patterns toward collaborative ones. Students helped other students over hurdles with the technology, and as teachers adapted to their students’ growing expertise, students helped their teachers as well. Students not only coached each other but also shared their expertise with people beyond the ACOT classrooms. In addition, some teachers began to allow students to teach one another subject-matter content in addition to technological information.

A researcher studying one of the elementary sites observed changes in communications patterns and the extent of collaborative work among even the youngest students. She reported that the children interacted differently at the computers. They talked to each other more, frequently asked for assistance from their neighbors, quickly interrupted their own work to help someone else, and displayed tremendous curiosity about what others were doing.

Another perspective on the benefits for students comes from examining the record of students at one high school who spent four years in the program. Their collective record compared to the entire 216-student, non-ACOT graduating class showed a marked difference. Although the ACOT graduating class did not constitute a technical random sample of the high school students, they were representative of the school as a whole. ACOT students' absentee rate was 50 percent less, and they had no dropouts, compared to the school's 30 percent rate. Although half of the students who joined ACOT as freshmen had not planned to go to college, 90 percent of them graduated and went on to college, compared to 15 percent for the non-ACOT graduates. Moreover, this ACOT graduating class amassed twenty-seven academic awards, including inductees into the National Honor Society and Who's Who among American High School Students, and recognition for outstanding accomplishments in history, calculus, foreign language, and writing. A four-year longitudinal study of these students showed the greatest difference was the manner in which they organized and accomplished their work. They routinely employed inquiry, collaborative, technological, and problem-solving skills uncommon to graduates of traditional high school programs. These skills are remarkably similar to competencies argued for by the U.S. Department of Labor.

Teachers who changed to more integrated and problem-solving teaching approaches found themselves hampered by traditional forms of assessment that emphasize basic skills, memorization of facts, and direct instruction. When ACOT students demonstrated new learning outcomes such as creative problem-solving strategies or greater abilities to collaborate in performing tasks, teachers struggled with how to translate those types of student gains into quantitative measures that could be entered into grade books. Rewarding students for their successes with new competencies proved difficult. In addition, some teachers interrupted the natural flow of project-based activities to "demonstrate" whole-class direct instruction for district evaluators using instruments too inflexible to accommodate more active classroom environments. Frequently the larger context of school, district, and state policies inhibited rather than encouraged change.

ACOT Teacher Development Centers

In 1992 ACOT, the National Science Foundation, and three school districts joined to create teacher development centers at three of ACOT's original sites. A primary goal of the program was to prepare teams of teachers who could become technology leaders at their own schools. More than 600 teachers—representing thirty districts, fifteen states, and two foreign countries—participated in the program during its first three years of operation. Participants represented a variety of grade levels and disciplines and ranged in teaching experience and technological expertise. At the centers, visiting teachers observed and worked in ACOT classrooms for one-week practicums during the school year or for four-week institutes during the summer. This model of staff development allowed participants to see expert teachers modeling instructional use of technology. Participants learned about integrating specific hardware and software into their instruction, and they explored issues such as interdisciplinary instruction, alternative assessment, project-based teaching, and team teaching. ACOT coordinators also provided follow-up support for participants for one year after visiting the centers.

Researchers investigating the impact of the teacher development center program on participants found that teachers' abilities to implement what they had learned in their classroom varied significantly, depending on access to equipment, administrative support, technical support, and collegial support. First, although ACOT considered the importance of access to equipment in designing their program, the project had little control once participants returned to their schools, and consequently teachers' classroom equipment ranged widely. Second, participants experienced a broad range of administrative support when they returned to their sites. Principals varied dramatically in their attitudes toward technology and consequently in what actions they took to help teachers. Third, unlike the original ACOT teachers, most participants returned to schools that did not offer on-site technical support. When teachers could not obtain sufficient technical assistance, they frequently altered or abandoned plans to use technology in their classroom instruction. Finally, although ACOT required participants to attend the center in teams to establish a source of collegial support for teachers once they returned to their schools, participants sometimes encountered resentment, rather than support, from their other colleagues. Given the limited enrollment in the ACOT program and the limited access to technology in many of the schools, faculties sometimes became fragmented and competitive. Clearly, the variations among ACOT participants in terms of computer access and administrative, technical, and collegial support naturally led to variation in their ability to integrate technology into instruction in their classrooms. When barriers such as limited access to technology and lack of support could be overcome or minimized, teachers made significant changes in their instructional practices and technology use.

Key Conditions for Effective Use of Technology

The experience of the ACOT project suggests that technology has the potential to improve education, but only under certain conditions. First, the successful use of technology requires teachers to confront their beliefs about learning and the efficacy of different instructional activities. Teachers experimented with new ideas until old habits gave way to new. As they successfully attempted new methods of instruction, they saw for themselves the value of different strategies and began to reevaluate their beliefs about learning and teaching. Second, technology should be viewed as one tool among many. As such, it should be used only when it is the most appropriate means of reaching the learning goal. Third, technology has little influence unless it is integrated into a meaningful curricular and instructional framework. The benefits of technology are best realized when the goal is to empower students as thinkers and problem-solvers. Technology provides an excellent platform for learning environments where students can collect information in multiple formats and then organize, visualize, link, and discover relationships among facts and events.

Fourth, the benefits of technology integration are not realized unless students and teachers have adequate access. Like any other tool for learning, technology should be in classrooms. The potential of technology goes unrealized if the goal is to teach technology, as frequently occurs in a lab setting; technology is best learned within the context of meaningful tasks tied to the curriculum. Fifth, teachers need contexts that support risk-taking and experimentation and that provide opportunities for collegial sharing and ongoing professional growth. Sixth, technology can be a catalyst for change, but the process of technology integration should be viewed as a long-term, challenging enterprise. Change is slow, even when teachers are willing. In addition, contextual supports are rarely in place when technology is added to schools. Teacher commitment will come only after they see positive benefits for themselves and their students.

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See also

Curriculum Integration; Diffusion of Innovations; Teachers: Preparation and Training; Technology in K-12 Schools

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ARCS: A Model of Motivational Design

Motivation refers to a person's desire to pursue a goal or perform a task (Keller and Litchfield 2002) and is typically used to examine work-related rather than play-related goals and behaviors (Weiner 1992). Motivation is influenced by internal factors, such as perceptions and personal goals, as well as external factors, such as opportunities and rewards. Because motivation affects learning and performance outcomes, it is important for instructional designers to understand how to use specific design strategies to increase learners' motivation. In 1979, John Keller proposed the ARCS model of motivational design as a framework for addressing four primary factors that influenced learners' motivation for learning: attention, relevance, confidence, and satisfaction.

The ARCS model was based on the premise that people's learning efforts can be influenced by changes in the learning environment, specifically those instructional events that define learners' perceptions of the relevance, or value, of the instruction and/or their expectations for success (Peters 2001). Prior to the 1970s, design models were based on the assumption that instruction would be effective if learners wanted to learn. However, little was written to describe how to make the instruction more appealing, especially for learners who were not motivated to learn. The ARCS model provided designers with an easy to remember and simple to use method for gaining and sustaining learner motivation, particularly when this did not occur naturally during the course of instruction. Currently, as we search for new and effective ways to promote students' learning through the use of new educational technologies (e.g., web-based instruction, sophisticated modeling tools), the ARCS model of motivational design will provide a useful foundation.

Components of the ARCS Model

In general, the *attention* and *relevance* components of the ARCS model relate to the need to make instruction exciting, to meet learners' needs, and to build on learners' previous experiences. The *confidence* and *satisfaction* components relate to the need to create positive expectancies of success for students, based on the amount and quality of the effort they expend (Peters 2001). Below, each category is defined further, and specific examples are included in Table 1.

Attention refers to students' overt curiosity or interest in the topic at hand and can be addressed by increasing perceptual arousal (heightened awareness or interest), inquiry arousal (an attitude of curiosity or inquisitiveness),

Table 1: Strategies for Increasing Student Motivation

To increase	The teacher/designer can
Attention	• Vary the methods, media, activities, and materials used during the instruction. • Use challenging questions, realistic problems, or novel situations to stimulate students' curiosity.
Relevance	• Include examples that are familiar to the students. • Show students how the content relates to some previous experience. • Show students how the content relates to some personal need or goal.
Confidence	• Provide students with clear requirements for course assignments. • Provide students with opportunities to exercise control over what and how they learn. • Provide students with exercises or assignments that gradually increase in difficulty.
Satisfaction	• Encourage students' enjoyment of learning for its own sake. • Provide students with positive feedback. • Provide students with verbal praise and other forms of tangible reward.

Source: Created by the author.

or variability of materials (inclusion of a variety of presentation tactics). Attention strategies typically include methods for capturing and sustaining learners' interest.

Relevance refers to students' perceptions that learning about the subject will meet personal needs or goals. Relevance can be established by considering learners' goal orientations, motives, and previous experiences and then linking instructional objectives, content, or examples to these needs and experiences.

Confidence refers to students' expectations for success. By providing opportunities for students to build positive expectations for their performances, as well as to actually experience success while learning, greater confidence can be built. Moreover, students must be able to see how their efforts and actions have led to their successes. Successful results that can be attributed to luck or other uncontrollable factors tend not to build students' confidence.

Satisfaction refers to the tangible and intangible rewards that students receive for completing the instruction. Satisfaction can be achieved by providing intrinsic reinforcement (a sense of accomplishment) or extrinsic rewards (payment or other symbolic awards, or verbal reinforcement like “Good job!”), and by ensuring consistent application of success criteria.

According to Keller (1987), instructors and instructional designers implement or incorporate these strategies into their instruction in somewhat of a sequential manner. First, the attention of the learners is gained as they begin to engage in the learning activity. Before proceeding very far, however, learners must be convinced of the relevance of the instruction to their own needs and goals. They must also be fairly confident that they will be able to succeed in the instruction. If learners believe that they have little to no chance of being successful, they are not likely to participate for long. During the instruction, it may be necessary to recapture learners’ attention, as well as to indicate to them how well they are progressing toward their learning goals. This will keep both interest and confidence high. At the end of the instruction, learners should have gained a sense of accomplishment that, hopefully, will then fuel their desire to learn more about the topic.

Application of the Model

The model is typically applied in four phases that integrate well with the processes of instructional planning and instructional design. These phases include (1) perform an audience analysis; (2) develop motivation objectives; (3) design a motivational strategy; and (4) try out and revise as needed. The selection of motivational strategies and tactics, including number as well as type, comprises a systematic design process, beginning with an analysis of audience motivation.

Analyze the Audience

The first step involves developing an audience profile, by using the ARCS model, to determine existing motivational gaps. Are the learners interested in the content? Do they have adequate levels of confidence to complete the instruction successfully? To complete this step, designers or instructors need to know the goals of the instruction so that they can identify learners’ levels of interest, perceptions of relevance, levels of confidence, and effective intrinsic and extrinsic rewards, specifically related to the content to be learned. Data on each of these categories, then, need to be collected and analyzed. If the designer should discover, however, that motivation is not a problem for this particular audience, it is neither necessary nor desirable to add motivation strategies to the instruction.

Develop Motivational Objectives

Based on the results of the audience analysis, motivational objectives should be defined, specific to the motivational needs of the audience. For example, if perceptions of relevance were determined to be low for the audience members, then objectives should indicate that learners would be able to state the relevance of the instruction to their needs. As is true for instructional objectives, motivational objectives should be written to convey what *learners* will know, or be able to do, by the end of the instruction.

Design a Motivational Strategy

Motivational strategies should be selected or developed based on the specific needs of the audience. Consider a variety of different ideas and then select those that best fit the specific situation. F. Peters (2001) recommended selecting strategies that: do not take up too much time; complement, rather than overshadow, the learning objectives; are feasible given the time, money, and implementation constraints of the instruction; are acceptable to the audience; and are compatible with the instructor's personal teaching style.

Try Out and Revise as Needed

Designers or instructors need to pilot the selected strategies to determine their overall effectiveness with the specific audience. This typically occurs during the normal course of implementing the instruction. Instructors should also consider including items specifically related to motivational factors in their course evaluations, including questions related to attention, relevance, confidence, and satisfaction. Based on the results, instruction and/or the motivational strategies may need to be modified prior to subsequent use.

General Guidelines for Use

Although motivational strategies can be added to any instructional materials, they are most effective when learners' initial motivation is low or nonexistent. Peters (2001) recommended the following guidelines for implementing motivational strategies: maintain a balance between motivational and instructional strategies; maintain a balance among the kinds of motivational strategies used; and match strategies to learner needs.

According to Peters, too few strategies will result in learners feeling bored, whereas too many strategies may cause learners to become annoyed or anxious. Consider your learners' initial levels of motivation and the inherent motivational appeal of the topic prior to selecting the appropriate number and types of strategies.

Research Support

A number of studies have been conducted that support the application of the ARCS model in instructional situations. For example, T. Newby (1991) found a strong positive correlation between elementary teachers' use of relevance strategies and on-task student behaviors. This was true despite the fact that teachers used relevance strategies only 7 percent of the time. Furthermore, a negative correlation was found between teachers' use of satisfaction strategies and students' on-task behaviors, even though teachers used this strategy 58 percent of the time. This suggests that relevance strategies, even when applied at relatively low levels, are related to higher levels of students' on-task behaviors. By contrast, satisfaction strategies are associated with higher levels of students' off-task behaviors. Based on these findings, instructors and designers might consider increasing their use of relevance strategies while decreasing their use of satisfaction strategies within their instruction.

The ARCS model has also been used to determine the motivational needs of adult learners. In one study (Small, Dodge, and Jiang 1996) college students were more likely to describe instruction as being interesting if attention and relevance strategies were used. Results from another study (Gluck and Small, cited in Peters 2001) suggested that adults perceive the value factors of attention and relevance to be significantly different from the expectancy factors of confidence and satisfaction, supporting the contention of Keller (1979) that different strategies should be used to address different motivational needs.

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See also

Adult Learners; Instructional Design; Learning Styles

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Assistive Technology

For the estimated 15 percent of the U.S. population with a disability or chronic health condition, assistive technology offers the potential to ameliorate problems associated with mobility, communication, and learning. Assistive technology encompasses the tools that are used to increase an individual’s functional capabilities and the services that assist with evaluation, selection, and use of technology by special populations. Students with disabilities in preschool through postsecondary institutions benefit from assistive technology that promotes independence and allows them to participate more fully in the general education curriculum and access educational technology products along with their peers. A vast array of technology solutions exist, ranging from high-tech devices such as a power wheelchair or talking computer to everyday, low-tech products such as a cane or a large-print book. Assessment of an individual’s need for assistive technology presents the challenge of matching the most appropriate technology devices and services with the user’s profile and the tasks or goals to be accomplished within a particular environment. Funding, training, availability of technical expertise, and strategies to reduce potential abandonment or failure to use a selected device are all critical to the effective provision and implementation of assistive technology.

Assistive technology plays a key role in allowing students with disabilities to interact with instructional technology products and bypass barriers associated with physical, sensory, or cognitive limitations. Beyond simply enabling equal access to educational tools, assistive technology contributes to the individual’s full participation in the learning environment and enhances potential vocational and continuing education opportunities. In some circumstances, educational technology that increases or improves learning outcomes can serve the dual purposes of assistive technology that increases, maintains, or improves functional capabilities. A typical example would be the use of a word-processing program by a student who cannot complete handwritten work due to paralysis of the dominant hand. The word-processing program represents assistive technology because it offers a functional way for written work to be completed.

Assistive Technology Devices

Thousands of assistive technology applications span across all disability types; however, some generalizations can be drawn for specific groups based on characteristic functional limitations. The following sections highlight typical possibilities.

Vision Impairment

Vision impairment technically encompasses all degrees of vision loss, including total blindness. Technology that enhances access to print and other information sources has made the most significant impact on educational and career options for individuals who are blind or visually impaired. Some low-tech solutions for difficulties with glare, contrast, or size include use of a small tensor lamp to increase illumination, color transparencies, a magnifying glass or hand-held telescope, and reversed text (white on black). Braille documents or books and tape recorders are familiar items used by the blind. A closed-circuit television unit allows magnification of any printed item. A refreshable Braille display replaces the embossed paper format with a display of vibrating pins controlled by an electronic circuit that can be interfaced with a computer for electronic storage and retrieval of information. Braille note-takers are similar to portable hand-held organizers and offer a convenient way for the blind individual to keep track of phone numbers, assignments, appointments, and other short pieces of information. Computer-based adaptations include screen readers with a speech synthesizer and headphone, screen magnification software, Braille or large print keyboard markers, and Braille printers. Special hardware and software make it possible to print tactile displays from a graphing calculator, map, or illustration. For those with low vision, computer use is enhanced by easily altered background and text color and font and built-in options for large icons, cursors modifications, and magnification tools. Scanners with optical character reading (OCR) capabilities store printed text electronically on computers where it can be read via speech synthesis or printed in large print or Braille.

Hearing Impairment

A hearing impairment is any type or degree of auditory impairment, whereas deafness is the inability to use hearing as a means of communication. Acoustic listening devices amplify and filter sounds, allowing for increased participation and comprehension for the user during classes and lectures. Most assistive listening devices consist of a receiver and a transmitter. The receiver is worn by the person with a hearing impairment, and the transmitter is worn by a speaker or installed as a stationary fixture in the environment. Amplification systems are available for listening to television, and a closed-captioning decoder is now a standard component of any TV set with a 13-inch or larger screen. Signaling systems convert sound to visual, tactile, or vibrating signals and alert the hearing-impaired or deaf individual to smoke alarms, telephones, doorbells, and alarm clocks. Computer use has been particularly helpful in providing the deaf community with a text-based form of communication.

Learning and Cognitive Disabilities

According to the National Joint Committee on Learning Disabilities (1990) “learning disabilities” is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. For individuals with learning and other cognitive disabilities, assistive technology offers strategies or compensatory tools that play to an individual's strengths. In some instances, the tools that assist students with learning disabilities are the same devices used by other individuals with similar functional limitations. Like students with visual impairments, individuals with a specific learning disability affecting reading may use an OCR/speech synthesis system to input text and have it read back with screen-reading software. A four-track variable-speed tape player used with talking books or access to electronic texts provides a way for students to listen to or review books. Students with auditory processing difficulties may use a personal FM listening system to help them focus on a speaker's voice. A personal data manager or hand-held computer could compensate for difficulties with memory and organization. Computer software programs with outlining and graphic organizer features support students with organizational difficulties. Written language disorders represent a common problem for students with learning disabilities. In addition to the use of a tape recorder as a backup for note-taking, various computer software applications provide a way to bypass the motor demands of writing and support written expression, spelling, and grammar usage.

Thus the availability of a word-processing program or portable word processor provides a way for students to prepare a more legible document that can be easily changed and edited. Word prediction can augment the features of a word processor by using rules of grammar, syntax, and vocabulary frequency to predict words the user is entering into the computer. Speech recognition systems have gained popularity with improved technology and more affordable prices. The user dictates into the computer via a microphone, and oral language is converted to written text. Speech recognition requires the user to have sustained patience and persistence in training the system for voice and vocabulary, adequate literacy skills, and good self-monitoring strategies.

Orthopedic and Mobility Impairment

Some orthopedic impairments are the result of a congenital condition such as cerebral palsy, whereas others may be acquired from an accident that results in a spinal-cord injury or other permanent or temporary physical problems. Some orthopedic/mobility impairments are due to neurodegenerative disease, such as muscular dystrophy, that may be compounded by scoliosis or other secondary problems as the disease progresses. Access and physical accommodations are the primary issue for students with orthopedic/mobility disabilities. Many of these individuals are nonambulatory and require power or manual wheelchairs or scooters with adapted seating. Assisted ambulation with canes, crutches, or walkers is adequate for mobilizing some students. Common dilemmas in assistive technology service delivery for this population involve orchestrating transportation to and from school, maintaining equipment, confirming compatibility with existing institutional resources, and ensuring that the student has appropriate positioning for accomplishing required tasks throughout the school day. An array of low-tech devices and adaptations are available to assist with activities of daily living (dressing, eating, bathing) and environmental control of appliances and equipment. Simple tools such as a universal cuff or splint can hold a pencil or typing stick in place for an individual with little or no hand function. Individuals who experience a tremor or uncontrollable movement may use a weighted wristband or pen. A book holder or slanted writing surface with a clip for holding papers can help to position books and writing materials. Students with orthopedic impairments, like those with visual impairments, have benefited immensely from computer technology. Depending on the individual's limitations and physical abilities, various devices positioned at the most functional body site can help to make input more efficient and accurate. Special keyboards or keyboard modifications, mouse alternatives such as a trackball, hands-free access achieved with a head-mounted device, speech recognition, or eye gaze, and switch interfaces with scanning or Morse code entry represent some of the possibilities.

Communication Disorders

Stuttering or fluency problems, poor articulation or unintelligible speech (particularly with unfamiliar communication partners), voice disorders, and aphasia (inability to comprehend words) are among the most familiar expressive language problems. Technology available to assist with some of these difficulties may include a voice amplifier to enhance weak or strident vocal quality or a device that records, analyzes, and then repeats back speech in a more intelligible format. Vocalizations, gestures, eye gaze, and written language, or a combination of these strategies, may be part of a communications system for an individual with more severe limitations who cannot speak. Adaptive assistance may be required as part of an augmentative and alternative communication (AAC) system. Low-tech options include a simple communication board with pictures, symbols, or words; a conversation book; or a simple device that speaks a limited number of messages. Computer-based electronic devices with high-quality digitized speech output, rate enhancement features, and access to a large vocabulary are at the other end of the AAC device continuum and are priced in the $5,000–6,000 range. Low-tech and high-tech devices satisfy interactive needs but may fulfill different purposes depending on the environment and situation.

Other Health Impairment

This category includes individuals who have disabilities that do not fall into any of the other major groups. Some conditions are progressive, whereas others are stable. A partial list would include AIDS, arthritis, asthma, burns, cancer, cardiovascular disorders, diabetes mellitus, epilepsy, psychological disorders, traumatic brain injury, and chronic pain. Depending on the nature of the disability and the expected activity, individuals with chronic or other health impairments could benefit from any of the assistive technologies described above. For instance, problems with memory or concentration may be addressed by suggested technology solutions for students with learning disabilities. Individuals experiencing physical fatigue or weakness may be assisted by tools discussed in the section on mobility/orthopedic impairments.

Assistive Technology Policy and Practice

Although canes and other adaptive tools have been used for centuries, it was not until recently that assistive technology gained legal recognition. The United States Congress first defined assistive technology devices and services in the Technology Related Assistance for Individuals with Disabilities Act of 1988 (P.L. 100–407). The following definition was adapted and used in the Individuals with Disabilities Act of 1990 (IDEA; P.L. 101–476) as amended in 1997:

> An assistive technology device is any item, piece of equipment or product system whether acquired commercially or off the shelf, modified, or customized that is used to increase or improve functional capabilities of a child with a disability.
>
> An assistive technology *service* is any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device. These services include:
>
> 1. The evaluation of the needs of the child with a disability including a functional evaluation of the child in the child's customary environment;
> 2. Purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by children with disabilities;
> 3. Selecting, designing, fitting, customizing, adapting, applying, retaining, repairing, or replacing of assistive technology devices;
> 4. Coordinating and using other therapies, interventions, or services with assistive technology devices such as those associated with existing education and rehabilitation plans and programs;
> 5. Training or technical assistance for a child with a disability and when appropriate, the child's family, and;

> Training or technical assistance for professionals (including individuals providing education or rehabilitative services), employers, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of a child with a disability. (20 U.S.C. Chapter 33 §1401)

The phrase “auxiliary aids and services” is another term used to reference assistive technology in legal statutes. Section 504 of the Rehabilitation Act of 1973 (P.L. 93–112) and subsequent reauthorizations require that public schools and postsecondary institutions be physically accessible. As a civil rights statute, section 504 protects the rights of individuals with a physical or mental impairment that substantially limits one or more life activities (e.g., learning or hearing). Reasonable accommodations and academic adjustments must be provided for those who qualify under section 504’s broad definition of “disability.” The availability of materials, printed in large type or Braille, is an example of an accommodation. A tape recorder used to tape a lecture, by a student who cannot take notes, represents an academic adjustment. Section 504 mandates that organizations that receive public funding must provide auxiliary aids and services that offer the individual with a disability an equal opportunity to access the full range of programs and activities. In addition to requiring that institutions provide adaptive and compensatory tools, the Rehabilitation Act and the Americans with Disabilities Act (ADA) of 1990 (P.L. 101–336) require that all students, including those with disabilities, must be able to access telecommunications and the available educational technology. The legal and ethical ramifications of these laws suggest that schools and postsecondary institutions should be proactive in reviewing the accessibility of educational technology products as part of the organization’s technology plan.

The reauthorization and amendments to IDEA in 1997 strengthened access to assistive technology aids and services for children who are eligible for special education services in early childhood programs through secondary school. According to IDEA, school systems are required to determine if the individual needs assistive technology, and the appropriate devices or aids and services must be provided free of charge as part of the child’s “individualized education program.” The process of considering a student’s assistive technology needs is ongoing since academic demands, requirements, and expectations change as the student progresses through school.

Assistive technology decisions should be informed by an evaluation that is completed by a collaborative interdisciplinary team. A team that includes the user, the family, professionals (i.e., teachers or vocational counselors and therapists), and at least one individual with expertise in assistive technology is considered best practice and implicit in the law. Maintaining a functional approach in conducting the assessment is pivotal to the ultimate goal of using technology to perform a task or compensate for a barrier imposed by an impairment. In striving to identify a device that matches the individual’s profile, an evaluation should include analysis of abilities and needs, the activities to be performed, the environment, characteristics of the devices being considered, and the user’s preferences. For youngsters of school age, the evaluation may be completed by a school-based team along with input from the family. Various assessment models and instruments have been developed to assist teams in arriving at a consensus, contribute to the development of an action or implementation plan, and facilitate ongoing review (see, e.g., Scherer 1991; Zabala 1996; University of Kentucky Assistive Technology Project 2000; Wisconsin Assistive Technology Initiative 2000).

Efforts to match an individual’s needs and a technology solution can be foiled by various organizational obstacles and human factors. A device may be unobtainable due to costs, fail to be useful, or abandoned altogether. Effective assistive technology implementation is enhanced by the availability of expertise; training for the user (as well as caregivers or teachers); administrative support; communication and coordination of service delivery; identification and maintenance of appropriate devices; and including the user and other stakeholders in the decisionmaking process. In a comprehensive study related to funding issues, the National Council on Disability (1993) found that the lack of funding and the intricacies of identifying financial resources to support assistive technology represent the most formidable barriers to delivery of assistive technology. Costs associated with the provision of assistive technology go beyond the purchase of a device and may encompass evaluation, setup of the device in the user’s environment, training, follow-up, adjustments, and maintenance or repairs. Payment for devices and services is further confounded by the fact that there is no single strategy or system for financing assistive technology in the United States. Funding may come from public, private, and community-based sources, with each agency having its own eligibility criteria, requirements for documentation of need, and contexts where assistive technology might be provided. Personal aids such as artificial limbs and orthotic splints or braces, adaptive seating, mobility aids, glasses, and hearing aids are usually prescribed by a medical professional or rehabilitation team and acquired through insurance, personal, or community-based funds. Tools provided by an educational institution allow access to the existing environment or provide the student with a learning or compensatory aid to accomplish a required activity. A school would be likely to provide a visual alert system in a college dormitory room, a special keyboard at a computer workstation, or a wheelchair lift on a school bus.

Until recently, there have been few resources to guide consumers and professionals in seeking quality and expertise in obtaining assistive technology. The Rehabilitation Engineering and Assistive Technology Society of North America has actively worked with other organizations to promote standards of quality assurance, outcome measures of assistive technology interventions, and certification of individuals with preparation and qualifications in assistive technology. A credentialing process has been established for assistive technology practitioners, assistive technology suppliers, and rehabilitation engineers (known as ATPs, ATSs, and CRE/CRETs, respectively).

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See also

Technology Planning; Usability; Web Accessibility

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Association for the Advancement of Computing in Education (AACE)

The Association for the Advancement of Computing in Education, founded in 1981, is an international, educational, and professional nonprofit organization dedicated to the advancement of the knowledge, theory, and quality of learning and teaching at all levels with information technology. This is accomplished through the encouragement of scholarly inquiry related to information technology in education and the dissemination of research results and their applications through: publications, conferences, societies and chapters, and interorganizational projects. AACE’s membership includes researchers, developers, and practitioners in schools, colleges, and universities, as well as administrators, policymakers and decisionmakers, trainers, adult educators, and other specialists in education, industry, and the government with an interest in advancing knowledge and learning with information technology in education.

Publications

Visit the AACE website (www.aace.org; link to Publications) for more information on the journals listed below.

***International Journal on E-Learning* (*IJEL*); Corporate, Government, Healthcare, and Higher Education (ISSN# 1537–2456; quarterly)**

IJEL provides educators and trainers with unique opportunities to enhance learning and teaching in corporate, government, health care, and higher education. *IJEL* serves as a forum to facilitate the international exchange of information on the current research, development, and practice of e-learning in these sectors.

***Journal of Computers in Mathematics and Science Teaching* (*JCMST*) (ISSN# 0731–9258; quarterly)**

JCMST is the only periodical devoted specifically to using information technology in the teaching of mathematics and science. The journal offers an in-depth forum for the exchange of information in the fields of science, mathematics, and computer science.

***Journal of Interactive Learning Research* (*JILR*) (ISSN# 1093–023X; quarterly)**

The published papers in the *JILR* relate to the underlying theory, design, implementation, effectiveness, and impact on education and training of the following interactive learning environments: authoring systems, CALL, assessment systems, CBT, computer-mediated communications, collaborative learning, distributed learning environments, performance support systems, multimedia systems, simulations and games, intelligent agents on the Internet, intelligent tutoring systems, microworlds, and virtual reality–based learning systems.

***Journal of Educational Multimedia and Hypermedia* (*JEMH*) (ISSN# 1055–8896; quarterly)**

Designed to provide a multidisciplinary forum to present and discuss research, development, and applications of multimedia and hypermedia in education. The main goal of the *JEMH* is to contribute to the advancement of the theory and practice of learning and teaching using these powerful and promising technological tools that allow the integration of images, sound, text, and data.

***Journal of Technology and Teacher Education* (*JTATE*) (ISSN# 1059–7069; quarterly)**

A forum for the exchange of knowledge about the use of information technology in teacher education, the *JTATE* content covers preservice and in-service teacher education, graduate programs in areas such as curriculum and instruction, educational administration, staff development, instructional technology, and educational computing.

***Information Technology in Childhood Education Annual* (*ITCE*) (ISSN# 1522–8185; annual)**

A primary information source and forum to report the research and applications for using information technology in the education of children—early childhood, preschool, and elementary. This annual is a valuable resource for all educators who use computers with children.

***Educational Technology Review* (*ETR*) (an electronic journal; ISSN# 1065–6901; quarterly)**

This member journal is the focal point for AACE members to exchange information among disciplines, educational levels, and information technologies. Its purpose is to stimulate the growth of ideas and practical solutions that can contribute to the improvement of education through information technology.

***Contemporary Issues in Technology and Teacher Education* (*CITE*) (an electronic journal; ISSN# 1528–5804; quarterly)**

An electronic publication of the Society for Information Technology and Teacher Education (SITE), established as a multimedia, interactive counterpart of the *Journal of Technology and Teacher Education.* Funded by the U.S. Department of Education's Preparing Tomorrow's Teacher to Use Technology catalyst grant, *CITE* makes possible the inclusion of sound, animated images, and simulation, as well as allowing for ongoing, immediate dialog about theoretical issues.

Conferences

- SITE: Society for Information Technology and Teacher Education International Conference (held in March)
- ED-MEDIA: World Conference on Educational Multimedia, Hypermedia, and Telecommunications (held in June)
- E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (held in October or November)
- ICCE: International Conference on Computers in Education (Asia-Pacific Chapter) (held in December)

Membership Benefits

Annual individual membership in the AACE includes:

- subscriptions to AACE's internationally respected journals
- discounts on journal subscriptions, conference registrations, proceedings books and CD-ROMs, and all AACE products
- access to AACE's two electronic journals (*Educational Technology Review* and *Contemporary Issues in Technology and Teacher Education*).

Resources for Members

AACE's Journal Table of Contents Alert Service (www.aace.org/dl/Search/TOC) will automatically e-mail the table of contents of any chosen journal issues whenever the latest issue is available in the AACE Digital Library. These notifications will include links to the issue abstracts weeks in advance of regular publication.

The AACE Digital Library (www.aace.org/DL) has collected thousands of journal articles and conference proceedings and will assist members in their efforts to conduct scholarly research; keep current on the latest research and publications in their field; have access to publications in an easy, searchable, and efficient manner; and maintain their academic interests in the area of information technology in education.

The goal of the Career Center (www.aace.org/careers) is to assist members and others in their efforts to search for new positions and advance their careers within the educational technology and e-learning communities. Included is a job board and career book resources.

The new AACE Store (www.aace.org/store) initially offers conference CD-ROMs at a discount to members. Many new products will be added, all offering member discounts.

Societies and Chapters

The Society for Information Technology and Teacher Education is an international association of individual teacher educators, and affiliated organizations of teacher educators in all disciplines, who are interested in the creation and dissemination of knowledge about the use of information technology in teacher education and faculty/staff development. The society seeks to promote research, scholarship, collaboration, exchange, and support among its membership and to actively foster the development of new national organizations where a need emerges. This is the only organization that has as its sole focus the integration of instructional technologies into teacher education programs.

In 1995 a group of professionals from several Central European countries met at ED-MEDIA 95 (the World Conference on Educational Multimedia and Hypermedia in Austria) and discussed the establishment of a Central European Chapter (CEC) of AACE. It was clear that this chapter was needed and should be formed to promote educational technology research and development in the region. Thus the CEC was established. Member countries are: Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Romania, Russia, Ukraine, and all other republics of the former Soviet Union and Yugoslavia. CEC's objectives are to:

- enhance awareness and promote the conduct and dissemination of research and development related to computing technologies in education both within and outside the Central European region
- encourage collaborative activities within the CEC countries and with other countries throughout the world
- organize and hold an international-level Central European conference series within the CEC countries
- encourage and support academic activities of AACE subchapters of CEC member countries.
- obtain greater representation of active researchers from the Central European region in the committees of related leading professional organizations and the editorial boards of reputable journals

Interorganizational Partnership Projects

The *IMEJ of Computer-Enhanced Learning* is an electronic journal focused on ideas and innovations in education technology. *IMEJ* presents articles in a dynamic format including pictures, videos, sound, discussion forums, and interactive tutorials and exercises. This journal is published biannually at Wake Forest University in association with AACE.

Computers in the Social Studies Journal is an educational electronic publication dedicated to the encouragement of the use of personal computers and related technology in social studies classrooms (K-12 and above).

Marianne Williams

See also

Society for Information Technology and Teacher Education

Association for Computing Machinery (ACM)

The Association for Computing Machinery is a major force in advancing the skills of information technology professionals and students. Founded in 1947, ACM is the world's first educational and scientific computing society. ACM serves its global membership of more than 71,000 by delivering cutting-edge technical information and transferring ideas from theory into practice. ACM hosts the computing industry's leading portal to computing literature. With its journals and magazines, special interest groups, conferences, workshops, electronic forums, career resource center, and professional development center, ACM is a primary resource to the information technology field. For more information, visit www.acm.org.

ACM was founded, provisionally, as the Eastern Association for Computing Machinery at a meeting at Columbia University in New York City on September 15, 1947. This was the logical outgrowth of increasing interest in computers as evidenced by several events, including a January 1947 symposium at Harvard University on large-scale digital calculating machinery; the six-meeting series in 1946–1947 on digital and analog computing machinery conducted by the New York chapter of the American Institute of Electrical Engineers; and the six-meeting series in March and April 1947 on electronic computing machinery conducted by the Department of Electrical Engineering at Massachusetts Institute of Technology. In January 1948 the word "Eastern" was dropped from the name; in September 1949 a constitution was instituted by membership approval.

The original notice for the September 15, 1947, organization meeting stated in part: "The purpose of this organization would be to advance the science, development, construction, and application of the new machinery for computing, reasoning, and other handling of information." The first and subsequent constitutions for the association have elaborated on this statement, although the essential content remains. The current constitution states that the association "is an international scientific and educational organization dedicated to advancing the art, science, engineering, and application of information technology, serving both professional and public interests by fostering the open interchange of information and by promoting the highest professional and ethical standards.”

ACM membership is drawn from all sectors of the computing sciences and their applications, from the design and construction of computers to the development of appropriate programming theory and languages and the utilization of computers in scientific investigation, industrial control, management data processing, and the humanities. Originally, membership in ACM was open to all interested in the purposes of the association.

In 1966, ACM adopted grades of membership, which currently include “professional member” and “student member.” Eligibility for these grades is defined as follows: professional members are those who subscribe to the purposes of the ACM and satisfy one of the following qualifications: bachelor’s degree; equivalent level of education; or two years’ full-time employment in the information technology field. Student members are those who subscribe to the purposes of the association. Institutional memberships for companies and universities were introduced in 1960. As of 2002 some 750 companies and universities had become institutional members. Professional membership is approximately 54,000, and student membership totals some 17,000, for a total of more than 71,000 members.

ACM is governed by a council consisting of sixteen members that is the highest governing authority in ACM. The council is composed of the president, vice president, secretary-treasurer, the immediate past president, the Special Interest Group Governing Board (SGB) chair, three SGB council representatives, the Publications Board chair, and seven at-large members. The president, vice president, and secretary-treasurer are elected to two-year terms by the members; the chair of the Publications Board is elected to a three-year term by the council; and at-large members are elected to two-year terms by members. The council meets two times per year, and the executive committee meets as necessary.

The headquarters office houses a staff of approximately seventy-five under the supervision of the chief executive officer. The staff performs necessary organization functions (membership, accounting, subscription fulfillment, etc.); coordinates and supports the activities of ACM chapters and committees; provides membership services (professional development center, career resource center, job center, etc.); acts as a liaison for meetings sponsored by the association; and produces ACM periodicals. It serves as an information center for members, news media, and the general public on a diversity of subjects in the general area of computers and their applications.

Four boards, comprising numerous volunteer committees and subgroups, work together with the headquarters staff to manage ACM products and services. These boards are the Publications Board, the Special Interest

Group Governing Board, the Education Board, and the Membership Activities Board.

ACM and the ACM Special Interest Groups (SIGs) sponsor, cosponsor, and cooperate with more than 150 technical meetings annually. Because ACM provides an objective arena for the discussion of novel and often competing ideas, many of these conferences have become premier world events.

ACM SIGs, in thirty-three distinct areas of information technology, address varied interests: programming languages, graphics, computer-human interaction, and mobile communications, to name a few. Each SIG organizes itself around those specific activities that best serve both its practitioner- and research-based constituencies. Many SIGs sponsor conferences and workshops and offer members reduced rates for registration and proceedings. SIGs also produce newsletters and other publications or support lively e-mail forums for information exchange.

ACM Special Interest Groups

SIGACT	Algorithms and Computation Theory
SIGAda	Ada Programming Language
SIGAPL	APL Programming Language
SIGAPP	Applied Computing
SIGARCH	Computer Architecture
SIGART	Artificial Intelligence
SIGCAPH	Computers and the Physically Handicapped
SIGCAS	Computers and Society
SIGCHI	Computer-Human Interaction
SIGCOMM	Data Communication
SIGCSE	Computer Science Education
SIGDA	Design Automation
SIGDOC	Systems Documentation
SIGECOM	Electronic Commerce
SIGGRAPH	Computer Graphics
SIGGROUP	Groupware
SIGIR	Information Retrieval
SIGKDD	Knowledge Discovery in Data
SIGMETRICS	Measurement and Evaluation
SIGMICRO	Microprogramming/Microarchitecture
SIGMIS	Management Information Systems
SIGMOBILE	Mobility of Systems, Users, Data, and Computing
SIGMOD	Management of Data

SIGMULTI-MEDIA	Multimedia
SIGOPS	Operating Systems

SIGPLAN	Programming Languages
SIGSAC	Security, Audit, and Control
SIGSAM	Symbolic and Algebraic Manipulation
SIGSIM	Simulation and Modeling
SIGSOFT	Software Engineering
SIGSOUND	Electronic Forum on Sound Technology
SIGUCCS	University and College Computing Services
SIGWEB	Hypertext, Hypermedia, and Web

Publications

ACM publishes, distributes, and archives original research and firsthand perspectives from the world's leading thinkers in computing and information technologies that help computing professionals negotiate the strategic challenges and operating problems of the day. ACM publishes twenty-five journals, more than thirty newsletters, and eighty-five conference proceedings annually. ACM is also recognized worldwide for its published curricula recommendations, for colleges and universities as well as for secondary schools that are increasingly concerned with preparing students for advanced education in the information sciences and technologies.

ACM's flagship publication, *Communications of the ACM*, keeps information technology professionals up to date with articles spanning the full spectrum of information technologies in all fields of interest. Examples include object-oriented technology, multimedia, internetworking, and hypermedia. *Communications* also carries case studies, practitioner-oriented articles, and regular columns, the ACM Forum, and technical correspondence. The monthly magazine is distributed to all ACM members. For a complete list of publications, visit www.acm.org/dl.

The ACM Press books program is a collaborative effort between ACM and Addison Wesley Longman Publishing Company to develop, publish, and distribute a broad range of new books in computer science and engineering. The program also includes a book series with ACM SIGGRAPH, the ACM SIG in computer graphics. ACM also publishes the Portal to Computer Literature, which is the gateway to the ACM Digital Library and the ACM Online Guide to Computing Literature. The ACM portal includes a sophisticated search capability, which is free to all browsers.

The ACM Digital Library contains the citations and full text of 100,000 articles, representing all of ACM's journals, newsletters, and proceedings. Each citation contains links to other works by the same author; clickable references to their original sources; links to similar articles and critical reviews, if available; and digital object identifiers to easily manage electronic linkages to vendors.

The ACM Online Guide to Computing Literature consists of a bibliographic database of more than 500,000 citations, dating back to 1985.

These citations come from a broad range of information technology publications and publishers. Many of these citations contain abstracts and/or reference sections as well. The books database, for example, contains citations to nearly 50,000 volumes, with links to commercial vendors that facilitate online purchasing.

Chapters

ACM professional chapters and local SIG chapters unite colleagues in particular geographical areas, offer the opportunity to gain immediate access to technological advances, and establish a personal networking system in the locale. There are currently more than 160 ACM professional and local SIG chapters worldwide, 25 percent of which are outside the United States. The chapters host lectures by internationally known computer professionals, sponsor state-of-the-art seminars on the most pressing issues in information technology, conduct volunteer training workshops, and publish informal newsletters.

ACM has established student chapters to provide an opportunity for students to play a more active role in the association and its professional activities. More than 600 colleges and universities throughout the world participate in the ACM Student Chapter Program, whose aims are to enhance learning through exchange of ideas among students and among established professionals and students. By encouraging organization of student chapters on college and university campuses, the association is able to introduce students to the benefits of a professional organization. These benefits include periodic meetings.

Student chapter members may take advantage of the activities and services provided by the association, such as the Distinguished Lectureship Program, the International Collegiate Programming Contest, the Student Research Competition, and the Publications Program. Student chapters provide an obvious setting to develop and demonstrate leadership capabilities—an important factor both to students in career development and professional growth, as well as to the future of the association.

Awards

ACM recognizes excellence through its eminent series of awards for outstanding technical and professional achievements and contributions in computer science and information technology. ACM sponsors eight major awards, named for the foremost luminaries in the computing field, as well as several other awards that honor distinguished service in information technology. It also names as fellows each year those outstanding members who have demonstrated achievements in computer science and information technology and who have made significant contributions to the ACM’s mission. A prize of $100,000 accompanies ACM’s most prestigious technical award, named for A. M. Turing, a pioneer in the computing field. It is awarded to an individual selected for contributions of a technical nature made to the computing community. The contributions should be of lasting and major technical importance to the computer field.

In addition to the A. M. Turing Award, other ACM awards include:

- ACM Software System Award
- ACM/AAAI Allen Newel Award
- Grace Murray Hopper Award
- Karl V. Karlstrom Outstanding Educator Award
- Paris Kanellakis Theory and Practice Award
- Eugene Lawler Award for Humanitarian Contributions within Computer Science and Informatics
- Distinguished Service Award
- Outstanding Contribution to ACM Award
- Doctoral Dissertation Award

Professional and Public-Service Activities

Many of ACM's professional and public-service activities are conducted by standing committees. Examples include Computers and Public Policy, Constitution and Bylaws, Nominating, Elections, USACM Public Policy, Committee on Professional Ethics, and the ACM International Collegiate Programming Contest.

ACM is committed to bringing potentially significant technical and public policy issues to the attention of the ACM membership and community. It sponsors several committees to address these issues, including: the Committee on the Status of Women in Computing; the Committee on Computers and Public Policy; and the U.S. Public Policy Committee (USACM). The ACM Office of Public Policy works with the USACM to assist policymakers and the public in understanding information technology issues and to advance a policy framework that supports innovations in computing and related disciplines.

As the first society in computing, the Association for Computing Machinery continues to provide quality content and information, community-building, reliability, and global vision to its members. With its unique role in advancing the art, science, education, and application of computing, ACM is a leading resource for advancing the skills of information technology professionals and for interpreting the impact of information technology on society.

Virginia Gold

See also

Association for the Advancement of Computing in Education; Association for Educational Communications and Technology

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Association for Educational Communications and Technology (AECT)

The Association for Educational Communications and Technology is an international association representing professionals in a range of occupations who have an interest in improving learning through the use of media and technology. AECT is the oldest professional home for this field of interest, having been founded in 1923, and it has continuously maintained a central position in its field, promoting high standards in scholarship as well as in practice.

The history of the association is summarized by Paul Saettler (1998) in the seventy-fifth anniversary issue of AECT’s monthly magazine. The association was formed in 1923 as the Department of Visual Instruction of the National Education Association (NEA), and it remained a unit of the NEA, located within its Washington, D.C., headquarters for forty-eight years. The immediate charge of the organization was to help teachers and school administrators make more effective use of motion pictures in schools. Scholars of visual instruction of that period were motivated by the belief that students were hindered in their learning by teaching that was abstract, sterile, and limited to verbal representation. The antidote was to infuse teaching with more active experiences and more richly visualized presentations, as indicated by the title of the leading textbook of that era, *Visualizing the Curriculum* (Hoban, Hoban, and Zisman 1937). In the early years participation was open to all NEA members, and there was not a separate membership list; however, attendance at the national convention was in the range of 100–200 people, predominantly school administrators.

In 1947 the name changed to the Department of Audiovisual Instruction to reflect the emerging importance of sound recording. In the post–World War II period a new paradigm was gaining influence: the communications movement. Gradually, people in this field began to see themselves not just as visualizers but also as designers of communications systems and the messages that flowed through them. This orientation is reflected in the name of the first scholarly journal, *AV Communication Review*, founded in 1953.

Membership rose steadily throughout the 1950s and 1960s, spurred by the passage of major federal legislation supporting research and infrastructure development in audiovisual media (the National Defense Education Act of 1958 and the Elementary-Secondary Education Act of 1965). Also in the 1960s, the emergence of the programmed instruction movement stimulated another paradigm shift in the field, incorporating the mission of designing and utilizing interactive self-instructional systems. The concept of technology of teaching was popularized by B. F. Skinner (1968) to describe his view of programmed instruction as an application of the science of learning. Thereafter, technology had the dual meanings of application of scientific thinking and the various communications media and devices. Stimulated by these new ideas and by the funding of research and development in these areas, membership rose dramatically, peaking in 1970 with about 10,000 members.

As the focus of the association shifted away from helping teachers use media to designing self-instructional systems, the rationale for staying with the NEA, which was increasingly functioning as a teacher's union, waned. In 1971 the association became independent, moved to separate quarters in Washington, D.C., and changed its name to the current Association for Educational Communications and Technology—with the key words reflecting the two dominant paradigms: improving communications, and applying technology to education. The scholarly journal was also renamed to *Educational Communication and Technology: A Journal of Theory, Research, and Development,* consistent with the association's new name. Since its inception, the association has also published a more practice-oriented monthly journal, originally named *Educational Screen,* later *Audiovisual Instruction,* then *Instructional Innovator,* and currently *TechTrends.*

For the middle fifty years of its existence AECT predominantly represented professionals working at the elementary-secondary school levels as administrators of audiovisual services, with college professors as the next largest group. In the mid-1970s the balance shifted toward higher education as audiovisual directors began to disappear as a separate job classification at the school building level (Molenda and Cambre 1977). By 2002 professors and graduate students represented about 60 percent of the membership, with school media specialists—building, district, and regional—representing about 30 percent.

Membership numbers declined through the 1970s, 1980s, and 1990s as new telecommunications and information technologies rose to prominence, each stimulating its own professional organization. AECT continued as a generalist organization, retaining 2,000–3,000 core members attracted to its broad scope, bringing together teachers, school and district media specialists, professors and graduate students of instructional technology, corporate instructional designers, military training designers, multimedia developers, and others. The current interests of the membership are indicated by the special-interest groups of the association: instructional design and development; distance learning; information and technology management; school media and technology; research and theory; teacher education; training and performance; systemic change; and international.

AECT has long served as an umbrella organization for more specialized organizations with overlapping concerns. Affiliated organizations include the International Council for Educational Media, the International Visual Literacy Association, and the National Association of Regional Media Centers, among others. In addition, AECT supports seven local chapters and several state affiliates.

The major means by which the association and its members exert influence in the field of educational technology is its program of periodic and nonperiodic publications. In addition to the quarterly scholarly journal, now known as *Educational Technology Research and Development,* AECT publishes *TechTrends,* a practice-oriented magazine (six issues per year), as well as the online journal *Interpersonal Computing and Technology Journal.*

AECT also offers a wide range of nonperiodic publications on instructional technology research and theory, school media programs, distance learning, educational uses of computers and the Internet, copyright law, and administering media programs. Professional development and communications are encouraged by means of an annual convention featuring hundreds of educational sessions, numerous workshops, and the International Student Media Festival. AECT also sponsors a summer institute devoted to leadership development and professional updating. It also conducts an awards program, recognizing outstanding contributions to educational technology.

As befits an organization that advocates electronic communications, AECT offers a wide range of electronic services, including: a website (www.aect.org); a roster of listservs, most linking members of special-interest divisions; online publications (periodic and nonperiodic), including

Handbook of Research for Educational Communications and Technology; and mailing lists, databases, and other electronic services.

The association is governed by a board of directors of seventeen members, with an executive committee composed of the president, president-elect, past president, and secretary-treasurer. There is a full-time professional staff (four people in 2003) at the permanent headquarters (located since 1999 at 1800 N. Stonelake Drive, Bloomington, IN 47404).

Michael Molenda

See also

Instructional Design; International Society for Performance Improvement; Research on Media and Learning

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B

Behaviorism

Behaviorism is the study of the observable, or outward, aspects of behavior in relation to changes in the environment. From the behaviorist's perspective, the processes that go on inside the head (planning, deciding, thinking, creating, etc.) are merely internal behaviors and, as such, are governed by the same mechanisms that can be seen externally. Behaviorism is the belief that behavior itself is the appropriate object of the study of learning and teaching. That is, behavior is not to be studied because it is an indirect means of studying something else (such as cognition, or the mind, or constructions); it is the end, not the means. Studying the cause and effect of behavior, therefore, is studying the cause and effect of learning. Behaviorism focuses on the connections among contexts, acts, and consequences. Changing context or outcome can change behavior.

Behaviorism has been a force in the psychology of learning beginning around 1900. Its distinguishing precept has always been the belief that people are biologically based systems as opposed to intersections between biology and spirit. In essence, behaviorists believe that it is not necessary to divide mind and body simply because humans are conscious beings. Consciousness—indeed, all mental processes—are simply extensions of the same biology that we see throughout the animal kingdom.

Behaviorism often distinguishes three types of learning: respondent, operant, and observational. Each type relies on the human ability to discriminate among different situations (contexts) and therefore respond differently. Additionally, each relies on our ability to generalize (extend) our behavior to situations or contexts that are similar to ones we have experienced in the past.

Respondent learning (i.e., classical conditioning) involves pairing a cue that produces a behavior or emotion or attitude with a new cue or stimulus. Over time, the new stimulus is associated with the old one and produces a version of the original response. Respondent learning is the basis of advertising. It is why attractive young women appear in advertising targeted toward young males and why distinguished couples in evening dress appear in luxury automobile advertisements targeted to older, more affluent men and women. It is also the basis of political advertisements (and is particularly evident in negative political advertisements) and propaganda. Respondent conditioning has been popularized in the public mind by Ivan Pavlov's famous studies to condition dogs to salivate to a light or bell.

Operant learning is based on the notion that behaviors (the ones we can see and the ones inside our heads) are selected just like genes: because certain physical traits or "instinctive" behaviors will work in certain environmental conditions. Some conditions might favor long necks, warm blood, and so on. Behaviorists believe that, given a certain environmental situation, certain behaviors will "work." Thus in operant learning, environmental cues "tell" us what to do, what will be "functional," what will "work." Behaviors that work in a situation are said to be "reinforced" and are more likely to be used again. Behaviors that don't work in a context will eventually not be used in that situation (they will be "extinguished"). If the behavior not only doesn't work but actually costs the individual (i.e., losing something valuable or "gaining" something painful), then we say the individual has been "punished" for behaving that way in that context and is less likely to behave that way again. Operant learning is most associated with the writings of B. F. Skinner.

Observational learning is the notion that we can learn new behaviors by watching others. In general, it is assumed to be an extension of operant learning in that we watch what people do in a situation; if what they did "worked," then we are likely to do it ourselves in a similar situation. We know that the model can be live, filmed, or even cartoons. Albert Bandura's social learning theory is generally considered to be the most influential work in this area.

Several major assumptions of behaviorism are directly relevant to educational technology. These focus on the role of the learner, the nature of learning and the generality of the learning, and instructional procedures and processes. First, the learner is not passive but must play an active role in learning. Learners learn by doing—by behaving—often through trial and error with feedback from the environment (including *people* in the environment). Similarly, the learner has to behave in some way (even by responding to a test item) to validate that learning has occurred.

Second, and of particular importance to educational technology, is the requirement of behaviorism to focus on the individual in the learning process because an individual’s genetic endowment and reinforcement history are unique. Learner goals are developed in terms of what the learner will accomplish based upon the instructional event *and* must consider where the individual “is” relative to that behavior. Learning complex skills often involves learning a series of incremental behaviors that are ordered in small steps and learned through the use of reinforcement based upon successful achievement at each step.

Third, behaviorists place a great deal of emphasis on the context or cues present during learning because cues “cause” behavior in the sense that cues tell us what behaviors will work. Naturally, the more closely the cues mirror the actual conditions under which the behavior should occur, the better. Just as obviously, if the behavior has a “real-world” context, it should be taught in the presence of those cues. Naturally, technology can help bring such “reality” into the classroom.

Fourth, in order for learning to take place in educational settings there has to be feedback; this can be something typically thought of as a reward, or it could just be knowledge of whether the behavior was “right” or “wrong.” In an educational technology sense, this means that the learner must be given lots of opportunities to behave (or respond) with feedback. For human beings, social feedback is very powerful.

Finally, behaviorists believe that learners obey universal laws of learning. This means that all learning in all species on the planet respond to the same laws. From the perspective of educational technology it means that if the program or lesson doesn’t work, then it was designed wrong. Behaviorism is never getting to say one is finished.

The practical aspects of the theoretical notions of behaviorism were demonstrated in the 1920s with the development of “teaching machines.” These machines are designed to be a single device capable of testing, scoring, and informing students of their errors and finding correct solutions all in one step. These machines did not become popular, however, until the 1950s, when Skinner used them to test and develop his operant conditioning principles. As a result, the teaching machine (and programmed instruction) became a primary research emphasis in the 1960s in both instructional psychology and instructional technology. These early efforts involved taking complex content and breaking it down into component parts that were arrayed in a linear fashion. Each step required students to behave and provided feedback for their responses, then comparing responses and taking small steps to learn content. The teaching machines and programmed instruction actually took the theoretical constructs of operant learning and created a working instructional device.

Closely akin to teaching machine technology, and undergirding theoretical concepts, was *programmed instruction*, which usually took the form of teaching texts or programmed books. These materials essentially were carefully arranged sequences of stimuli that required overt interaction and feedback for a particular instructional objective. These materials were generally found in two formats, linear and branching. Although both used the tenets of behavioral theory, branching was more flexible and less rigid in terms of reinforcement, the size of the steps, and type of feedback.

The impact of the military, during and immediately after World War II, on the research of learning, learning materials, and instructional approaches was driven by the need to train millions of military and nonmilitary individuals for the war effort and the technology-oriented future that was to follow. Much of this research stressed the stimulus, response, and reinforcement characteristics of various instructional strategies and devices. These studies looked at such behavioral components as the role of active responding in learning, the optimal size of an informational step in procedural learning, and the use of prompts (cues) in the instructional setting. During this era, major research programs looked at the use of instructional films and, later, television programs. Stimulus-centered techniques stressed the meaning, structure, and organization of stimulus materials while response-centered techniques dealt with the design techniques to ensure that materials produced adequate responses. The techniques of programmed instruction that were combined with film and television depended on the effective design of the stimulus materials (and the theoretical basis for this) as well as the design of the appropriate response practice. Thus research on stimuli, and on response, became major components of educational technology research during and following World War II.

One of the more prominent impacts of behavioral theory on educational technology and on education in general is its influence on *instructional design,* usually defined as the systematic development of instructional sequence. As such, it is a clear combination of the use of a learning theory to guide the development of instruction. In fact, many of the current instructional design models use major components of methodological behaviorism such as the specification of behavioral objectives, the importance of student behavior changes, and the emphasis on the learning environment (stimulus). The behavioral influence is also evident in the association between the stimulus and the student response. Instruction, in this view, must be evaluated by its ability to change the behavior of an individual student. In most instructional design models the following components are found: Objectives of the instruction are stated; all objectives are measurable and observable and meet standards of reliability and validity; and the concept centers on the changes of the student (learner).

At least three modified instructional models have been developed around behavioral concepts and used in recent years: the personalized system of instruction (PSI), precision teaching, and direct instruction. All three share the basic tenets of the behavioral approach. Each instructional approach involves scripted lessons, the requirement of overt student response, and the provision of immediate feedback. PSI, developed by Fred Keller, contained features such as interlocking instruction, highly sequenced progressive tests, individualized learning activity, and self-pacing with reinforcement through the sequence of instruction.

O. R. Lindsley's concept of precision teaching emphasized the counting of specific behaviors with a special emphasis on analyzing both correct and incorrect responses. This program made "second nature" responding plus speed of performance a key feature of each student's progress. The third behaviorally inspired instructional system of note is direct instruction design. This system stressed three types of analysis: learner behavior, communication, and knowledge systems. This system looked at how to prompt and reinforce responses and how to correct errors that are made. Communication was viewed in terms of logical design and sequence of presentation. The analysis of knowledge stressed logical organization and progression of content, from simple to complex.

John K. Burton
David M. Moore

See also

Cognitive Psychology; Constructivism; Instructional Design

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Bloom, Benjamin S. (1913–1999)

Benjamin Bloom led an effort by educational psychologists in the mid-1950s to develop a comprehensive system of describing and assessing educational outcomes. The development of educational objectives—often according to Bloom's taxonomy—has become a critical part of almost any curriculum development effort or instructional design process.

Although he was made famous throughout the world by the taxonomy of educational objectives that bore his name, it was not his only noteworthy work: Bloom also championed the relatively progressive idea that most students had more potential than educators gave them credit for, and he pushed the establishment to question some long-held assumptions about the roles of educators and education in helping students learn. By any measure, Benjamin Bloom had an astonishing impact on the practices and philosophies of educators around the world during the latter half of the twentieth century. His work ranged from the purely practical to the philosophical; his ideas, dynamic though they were during his lifetime, can hardly be easily categorized.

Born in 1913 to an immigrant family in Pennsylvania, Bloom went to Pennsylvania State College to become a teacher. He received his bachelor's and master's degrees there by 1935. He wanted to continue his education, however, and determined to become a protégé of progressive educator Ralph Tyler by studying under him at the University of Chicago. Bloom also worked under Tyler's direction on the famous Eight-Year Study, a laboratory school arrangement whereby individual schools could assess students without using traditional grades and students' acceptance to participating universities would not be affected.

During his doctoral studies and after their completion in 1942, Bloom worked on staff at the University of Chicago Board of Examiners, overseeing the creation, administration, and scoring of the exams taken by undergraduate students in fulfillment of their degrees. He became an instructor in the university's department of education two years later and eventually became the university examiner, directing all of the school's assessment efforts. His early research, influenced by his testing work, focused on how educational outcomes could be categorized in terms of their cognitive complexity; this led to what became arguably his best-known contribution to the field.

In the late 1940s, along with colleagues from around the world, Bloom began an effort under the auspices of the American Psychological Association to create a systematic and organized model of educational objectives. *The Taxonomy of Educational Objectives: The Classification of Educational Goals (Handbook 1: Cognitive Domain),* published in 1956 and known by many simply as the *Handbook,* was hardly the work of one person, but it nonetheless came to be known simply as "Bloom's taxonomy."

The work in part reflected the dichotomy of perspectives that was Benjamin Bloom. Although he is commonly considered to be a behaviorist thinker, concerned with developing in students particular behaviors that reflect whether learning has occurred, his work also reflects a cognitive perspective, concerned with how students engage in learning and construct knowledge. Although the structure of the taxonomy focuses on measurable student behaviors resulting from instruction, Bloom looked at the taxonomy as a way to encourage educators to think critically and systematically about how to plan educational experiences to achieve certain goals.

The taxonomy is hierarchical in nature. Behavior that demonstrates mastery at each level is a prerequisite for moving to the next level, and objectives at higher levels are more cognitively complex. Likewise, the behavior that demonstrates competency at lower levels is necessarily more concrete and observable than that of the more complex levels. The taxonomy consists of the following six levels:

1. *Knowledge:* This lowest level of the taxonomy represents basic interactions with information, or the basic recall of data. The learner's primary cognitive activity is remembering—both basic facts as well as more complex ideas and theories. In practice, most educational activities fall into this category.
2. *Comprehension:* Objectives at this level focus on the translation, interpretation, and extrapolation of information. Learners are required to demonstrate broader recognition and understanding of information in formats unfamiliar to them.
3. *Application:* At this level of the taxonomy, students must correctly demonstrate the use of information, preferably in realistic environments.
4. *Analysis:* This level represents learners' abilities to deconstruct information and describe both the organizational structure and the relationships between component parts.
5. *Synthesis:* These objectives reflect a student's ability to put individual parts of previous learning together to form a new whole; Bloom referred to it as the most "creative" category of the hierarchy for that reason.
6. *Evaluation:* In this top level of the taxonomy, students begin to assess work by themselves and others. These judgments are not only cognitive ones based on previous learning; evaluation is also the point where learners begin to connect cognitive processes with affective behaviors like interest, attitudes, and values.

The *Handbook*, besides outlining the taxonomy in great detail, also focuses on the design and implementation of testing for each level of the taxonomy. Lower levels are relatively easy to assess, because behaviors are easily observable and can be objectively measured. As cognitive complexity increases, assessment becomes more difficult. At higher levels, students need more time and greater creative freedom to complete the tasks, and assessment becomes more inherently subjective. Thus large-scale testing at higher levels becomes difficult to do economically.

Bloom credited the taxonomy with filling a dire need in education—never before had there been such a systematic way to design instruction for particular outcomes. Since Bloom's groundbreaking work, the taxonomy, as well as the process of developing educational objectives for learning experiences based on it, have become ubiquitous in all types of instructional endeavors.

After the publication of the *Handbook*, Bloom grew into new areas of interest and research. During the 1950s education as a field—particularly as reflected in Bloom's work as a university examiner—was largely focused on the "sorting" role: determining the relatively small number of students who were the most intellectually capable, then allowing them access to further education. The vast majority of students, it was assumed, were in the middle range of intellectual capability; a few were much less capable.

Bloom started to question these fundamental assumptions about students' potential in the 1960s. He began doing research about a fundamentally different pedagogical method, which he called "learning for mastery": He theorized that most students could master basic educational skills if given appropriately focused instruction and the time they needed to learn. Bloom's method included formative assessments early in the instructional process to identify students' weaknesses and allow teachers to craft appropriate instruction; students who mastered the skill early could then go on to enrichment exercises or serve as peer tutors for those still working toward mastery. The process would take much longer than traditional classroom teaching practices initially, although the need to revisit subject matter on a regular basis would diminish over the long term. Students' mastery of concepts would render such repetition unnecessary.

Later in life, Bloom extended his mastery learning ideas and began to study the development of talent in high-performing individuals from a variety of fields. His discoveries, which have broad implications for education in general, were astounding to many: Those whom we think of as outstanding performers in their fields were, in fact, usually not prodigies as children. They achieved their levels of mastery by constant practice over time, coupled with instruction from increasingly more capable mentors as their abilities increased. Bloom deconstructed and analyzed the processes by which these individuals learned and found that their performance had reached the point of automaticity—they no longer thought about their actions. Many activities taught in school, Bloom theorized, could be taught so that they became as familiar to students as walking; in this way, many more learners could then go on to higher levels of cognitive activity.

Gabriel Reedy

See also

Bloom's Taxonomy; Instructional Objectives

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Bloom's Taxonomy

Bloom's taxonomy (originally known as the taxonomy of educational objectives) is a classification of educational goals. The idea for an educational taxonomy was proposed at the 1948 convention of the American Psychological Association by a group of researchers led by educational psychologist Benjamin S. Bloom. The purpose of the taxonomy was to classify student behaviors that represented the intended outcomes of the educational process. Insofar as it was successful in accomplishing this objective, it was believed that the taxonomy would also facilitate communication among teachers, especially regarding test materials and ideas about testing. The original plan for the taxonomy included three domains of behavior: the cognitive, the affective, and the psychomotor. The cognitive and affective domains have been structured and described in two published handbooks (see Bloom 1956 and Krathwohl, Bloom, and Masia 1964). Although they did not develop a framework for the psychomotor domain, one has been outlined in print (see Simpson 1966; Harrow 1972).

The cognitive domain consists of six major classes of behaviors, listed here from the simplest to the most complex. They include *knowledge, comprehension, application, analysis,* *synthesis,* and *evaluation.* Bloom and the other developers of the taxonomy asserted that the objectives in any given class are likely to make use of, and build upon, behaviors found in the preceding class.

Knowledge includes, first, the recall of specific information, such as terminology, dates, events, people, and places. It also includes recalling ways and means of dealing with specific information—in other words, how to organize, study, judge, and critique it. Third, knowledge involves recalling the larger structures, theories, and generalizations by which the specific information is organized.

Comprehension represents the lowest level of understanding. More specifically, it refers to a type of understanding in which the individual knows what is being communicated and can make use of it but cannot necessarily relate it to other material or appreciate its full implications. There are three major types of comprehension. First, translation is the paraphrasing of a communication, or its conversion to another language. Second, interpretation is simply the explanation or summary of a communication. Third, extrapolation is an extension beyond the given data to determine its implications and consequences.

Application refers to the use of abstractions in specific, concrete situations. These abstractions may take several forms: general ideas, rules of procedures, generalized methods, or technical principles.

Analysis is the fourth class of behaviors in the cognitive domain. This includes the systematic application of the elements of a communication, of the relationships between those elements, and of the organization, arrangement, and structure that hold the communication together.

Synthesis involves the joining of separate elements to create a whole. This can involve the creation of a unique communication, such as the recounting of a personal experience. It might also include the development of a plan of work or a proposed set of operations. Finally, synthesis may involve deriving a set of abstract relations, in order to classify or explain some data or phenomenon, or to make deductions about it.

Evaluation is the most complex class of behaviors in the cognitive domain of the taxonomy. It refers to judgments about the value of certain materials and methods for some purpose. These judgments are based, first, upon internal evidence, such as logical accuracy and consistency. They are also based upon external criteria or standards of evaluation.

Several years after the development and structuring of the cognitive domain of the taxonomy, three of the project’s original members published a second handbook that outlined the *affective domain.* The affective domain is composed of five classes of behaviors. Listed from the simplest to the most complex, they include *receiving* (attending), *responding, valuing, organization,* and *characterization* by a value or value complex. Like the levels of the cognitive domain, each class of the affective domain should build upon the behaviors found in the preceding class.

The most basic outcome in the affective domain is for the individual to be open to receiving (or attending to) certain phenomena and stimuli. The three subcategories of receiving are the awareness or consciousness of something’s existence, the willingness to receive or tolerate it rather than avoid it, and the ability to control one's attention or select those things to which one pays attention.

Responding to the phenomenon, rather than just passively receiving it, is the second objective. The concern here is with the individual's acquiescence in responding, willingness to respond, and emotional satisfaction with the response.

Valuing, the third class of objectives, refers to the internalization by an individual of a set of specified, ideal values. This involves an individual's acceptance of, preference for, and commitment to a particular value or values. Beyond simply internalizing values, the individual also finds the need for some kind of value organization. The organization of values into a system first requires conceptualizing each value, then organizing the value system according to an ordered relationship.

The most complex class of objectives within the affective domain is the characterization by a value or value complex. At this level, the individual has already received and responded to certain phenomena, created a value hierarchy, organized it into a consistent system, and allowed that value system to guide his behavior. The two concerns here are the degree to which the value system controls the individual's behavior (or how widely the individual has generalized the value system), as well as the integration of the value system—including the individual's beliefs, ideas, and attitudes—into a total philosophy of life or outlook on the world.

Teachers can use both the cognitive and affective domains of the taxonomy to make decisions about assignments, readings, and teaching strategies. The taxonomy can also prove useful for making choices among the many technological tools and media applications currently available to educators. Teachers may choose, for example, to utilize a video documentary to enable students to build and expand a knowledge base about a particular phenomenon, such as the civil rights movement in the United States. In addition to viewing the documentary, students may be asked to conduct an Internet search for more information about the movement. That undertaking could utilize a popular search engine such as Google or an academic database like JSTOR. One way in which the teacher may choose to assess students' comprehension of the material presented in the documentary is by asking them to summarize important dates, events, places, and people or to describe and explain the causes of the movement.

Students might be asked, further, to apply their conclusions about the causes of the civil rights movement to some other social movement (the women's movement, for instance) in an effort to formulate some general ideas or principles about the rise of social movements. The application of students' ideas could be accomplished through the presentation of another documentary on the women's movement, or through another Internet-based homework assignment that involves searching for information on the women’s movement. In the process of applying their conclusions about the civil rights movement to the women’s movement, students would be forced to thoroughly analyze the relationships between the causes of the respective movements as presented in the two documentaries.

Teachers could also utilize technology to assess students’ progress from one level of the taxonomy to the next. Students might be required—individually or in small groups—to prepare a slide presentation to the class, utilizing an overhead projector or computer software to demonstrate their knowledge about and comprehension of the important aspects of the two social movements. Again, students’ knowledge about the movements could come from the documentaries shown in class and/or from individual homework assignments in which they are required to search for relevant information on the Internet.

An in-class presentation might be utilized in which students must present an application of their thoughts about the rise of the civil rights movement to the rise of the women’s movement. A thorough analysis of each movement’s precipitating factors could also be accomplished using overhead slides or a computer-based presentation. A final course project might involve the synthesis of all of these ideas into one theory about the rise of social movements, as well as the critical evaluation of the ability of that theory to explain the rise of different movements. Again, one can see how a computer-based in-class presentation could be beneficial here.

As students move from one class of behaviors to the next during a project such as that outlined above, they must use technology and media applications (in-class documentaries, Internet searches, overhead projector and computer presentations) to demonstrate their mastery of each level. In this way, Bloom’s taxonomy contributes to a classroom in which active learning is the means of education. Using the taxonomy as a guide to instructional design, teachers are better able to decide what media applications and technological tools are most useful to accomplish the objectives outlined at each level. The taxonomy also serves as a guide for teachers in evaluating students’ progression from one class of intended behaviors to the next highest class.

Though the implications of Bloom’s taxonomy for educational technology have only recently begun to be explored, the taxonomy itself has been widely influential in a variety of academic disciplines since its development. In an effort to incorporate new knowledge and ideas into the original framework, one of the original project’s members recently published a revision of the taxonomy (see Anderson and Krathwohl 2001). Benjamin Bloom, the originator of the idea of the taxonomy and the editor of the original handbook on the cognitive domain, did not live to see this revision. He died in 1999, shortly before the book’s publication.

Michael DeCesare

See also

Behaviorism; Bloom, Benjamin S.; Cognitive Psychology; Instructional Design; Instructional Objectives

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Bruner, Jerome S. (b. 1915)

It would be a difficult, if not impossible, task to find another figure that has had more of an impact on educational technology and instructional methods than Jerome Bruner. During the latter part of the twentieth century, when research and educational practices were dominated by the behaviorist perspectives of psychologists and scholars, a new movement was born that offered educators and researchers a new way to approach learning. This movement, now known as the cognitive revolution, owes much of its inception and energy to Jerome Bruner.

Born in New York in 1915, Jerome Bruner was the youngest of four children. His father, a watchmaker, died when Jerome was a boy, and the youngster then traveled extensively with his mother. At the age of seventeen he entered Duke University. In 1937 he completed his baccalaureate degree from Duke and then moved to Harvard University, where he completed a Ph.D. in psychology in 1941. His work in the field of psychology, specifically in cognition, would later alter instructional practices in classrooms across the country.

In the 1940s, when Bruner began his work, the perspective that most educators held about learning and cognition was influenced greatly by behaviorist principles. These principles dictated that learning was the process of an observed behavioral change in a student and followed a basic pattern: The instructor introduced a stimulus, the student generated a response, and the teacher then reinforced the response. If there was no observed behavior, then learning didn’t occur.

The behaviorist perspective came about as an effort to elevate psychology into the realm of a true science by relying only on empirical data for theory development and research. Internal cognitive processes were largely ignored. In the midst of this prevailing perspective, Bruner published *The Process of Education* (1961). This work would serve as the catalyst for new research aimed at exploring the internal processes involved with learning and cognition such as mental structures and schemas. Bruner's research was novel in that he used creative methodologies to study internal processes experimentally so that empirical data could be generated. This seemed to inspire other researchers who followed Bruner into new territories of cognitive research. Interested primarily in how learners make use of categories, representations, and the formation of concepts, Bruner continued his research throughout the 1960s and was one of the founders of the Cognitive Research Center at Harvard.

Bruner served on the President's Science Advisory Committee during the terms of John F. Kennedy and Lyndon Johnson. His contributions helped guide policy and practice in the U.S. public education system. Bruner was also one of the principal designers of Head Start, the program that was created to better prepare young children for entry into K-12 education. In 1966 he published *Toward a Theory of Instruction,* in which he outlined four critical aspects of instruction: (1) consider the student's predisposition toward learning; (2) consider ways of structuring knowledge so that it is easily grasped by the learner; (3) consider how to best sequence the content so as to maximize learning; and (4) consider the nature and pacing of rewards and punishments. From Bruner's ideas about learning came several educational practices that are still in use today, such as the spiraling curriculum, learner analysis, and the idea that learning is an active, social process.

In the 1970s Bruner began to study other aspects of learning such as language acquisition and scaffolding. His ability to look at learning with fresh ideas led him to define discovery learning, which holds that students learn best through discovery and that they are problem-solvers, interacting with the world and developing and testing hypotheses. He is also given credit for pioneering constructivism, which has become a predominant perspective in education with many conceptual definitions and has gained rapid momentum over the years, particularly in educational technology. Bruner's brand of constructivism holds that new ideas or concepts are constructed by the learner based upon prior knowledge. When information is acquired by the learner, it is placed into a cognitive structure that assists in organizing and assigning meaning to it (Bruner 1983, 1986).

Never one to become stagnant, Bruner next turned his attention to the social and cultural influences on learning and the interaction of narrative on modes of thought. According to Bruner, narratives provide us frameworks for assigning meaning to the information we are processing. Through our own stories and the stories of others we experience the world and form the bulk of our reality (Bruner 1991).

Bruner's recent work has focused on the interaction of mental development, culture, narrative understanding, and interpretation. He is concerned with the passing of culture, specifically through legal praxis, legal codes, and schooling (Bruner 1996).

Bruner has held several academic posts during his career at Harvard, Oxford, Princeton, Cambridge, and New York University. He holds honorary doctorates from Yale, Sorbonne, Berlin, Rome, Columbia, and elsewhere. His work has won him the Balzan Prize in 1987 and the CIBA Gold Medal in 1974. Bruner's current academic home is New York University, where he is a research professor of psychology and a senior research fellow at the school of law.

George O. Hack

See also

Cognitive Apprenticeship; Cone of Experience; Constructivism; Elaboration Theory of Instruction

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Campus Computing Project

Begun in 1990, the Campus Computing Project (www.campuscomputing.net) is the largest continuing study of the role of computing and information technology in U.S. higher education. The project is widely cited by campus officials and others across and beyond the campus community as the definitive source for information about and insight into campus information technology (IT) planning and policy issues that affect U.S. colleges and universities.

A key component of the project, the annual Campus Computing Survey, collects data on campus planning, programs, and policies linked to the deployment and utilization of computing and IT resources to support and enhance instruction and scholarship. The survey respondents, typically the chief academic computing or IT officials at their institutions, are individuals specifically responsible for and knowledgeable about the current direction of technology planning, policy, IT finances, and technology implementation efforts on their campuses.

The 2002 Campus Computing Survey was conducted during the summer of 2002. The questionnaire was mailed to the chief academic computing officers at 1,339 two- and four-year colleges and universities across the United States. Where it was not possible to identify a specific individual with a senior academic computing title, the questionnaire was sent to the senior academic officer. The survey results summarized below are based on data from 632 two- and four-year public and private colleges and universities across the United States, reflecting a response rate of 47.2 percent. (More than 30 private two-year colleges were included in the 2002

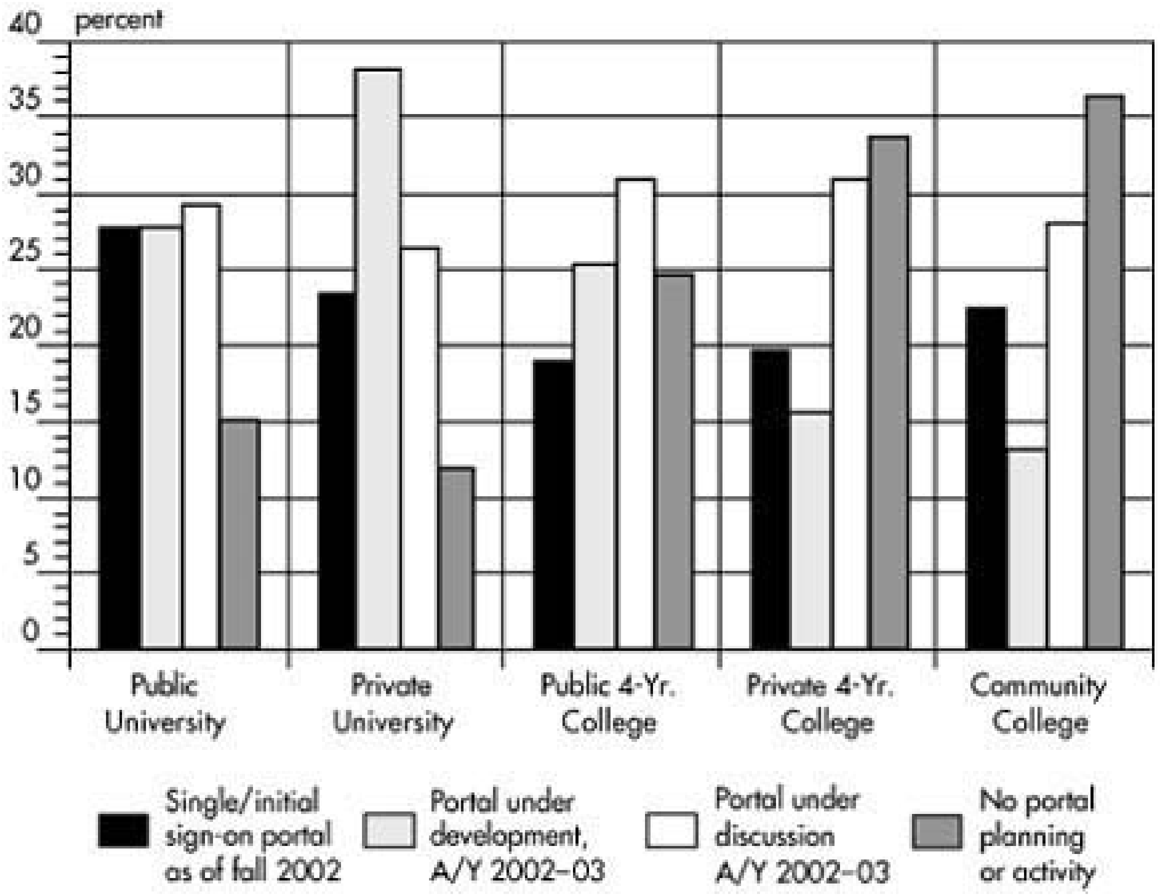

Figure 1:

Campus Portals
(percentages by campus sector, 2002)

Source: Used with the permission of the Campus Computing Project.

survey mailing. However, only eight institutions completed the questionnaire. The low response rate from this group should not be viewed as being representative of the larger population of the 615 private, nonprofit, degree-granting, two-year colleges in the United States.)

Campus Portals

The 2002 Campus Computing Survey reveals that U.S. colleges and universities are making steady progress in developing and deploying campus web portals (see Figure 1). Just over one-fifth (21.2 percent) of the campuses participating in the 2002 survey report that they have a “single/initial sign-on campus portal” up and functioning as of fall 2002. Another fifth (20.4 percent) report that their campus portal is “under development” or being installed in the current academic year. Just under one-third (29.5 percent) indicate that portal issues are now “under review/discussion” at their institutions, and a similar proportion (29 percent) indicates that there has been no portal planning or related portal activity at their institution.

For all practical purposes, the campus conversation about the role and value of web portals began in the late 1990s. Consequently, the 2002 survey data suggest that web portals are finally making the transition from an

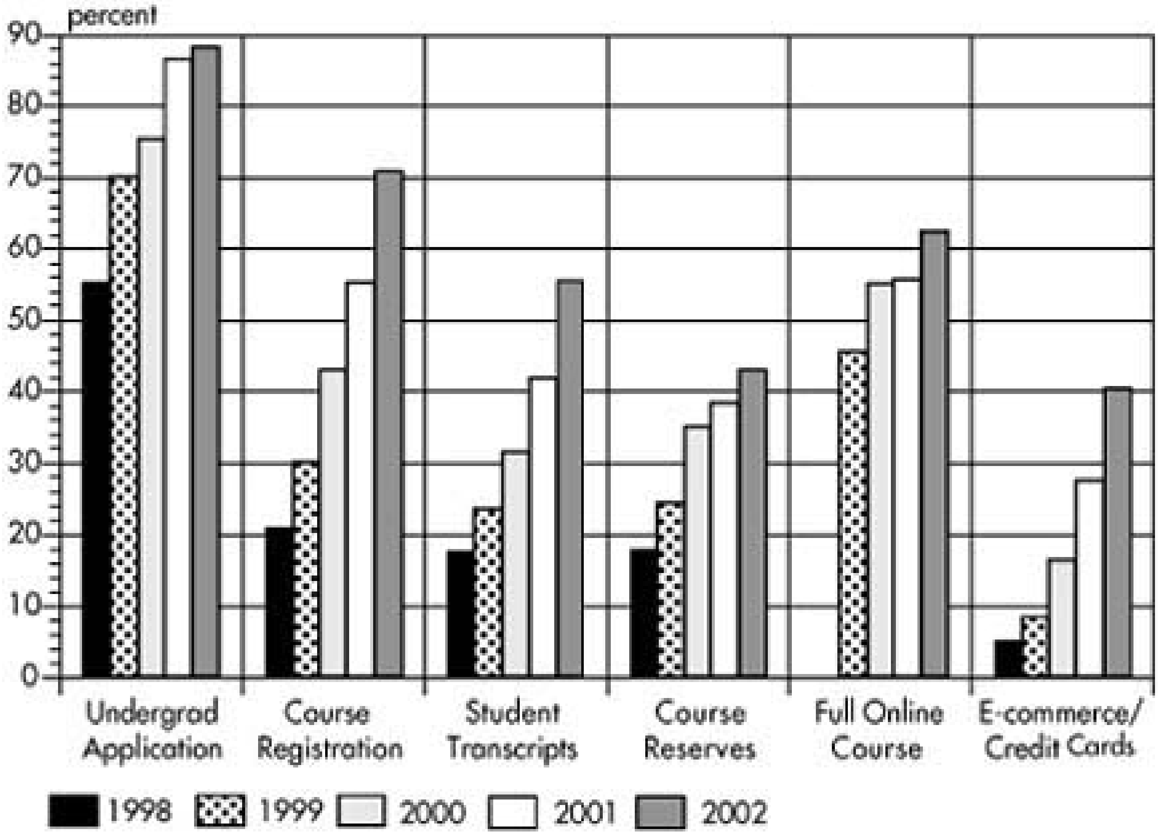

Figure 2:

Trends in Website Services
(percentages by sector, 1998–2002)

Source: Used with the permission of the Campus Computing Project.

abstract concept into a real institutional service. Moreover, the campus investment in portals can (and should) be seen in the broader context of a new institutional commitment to enhanced campus services across all sectors of higher education.

Other data from the 2002 survey reflect the campus commitment to web portals. For example, one-fourth (24.9 percent) of the campuses participating in the 2002 survey currently have a strategic plan for portal services; another third (32.7 percent) are now developing these plans. Survey respondents rate providing a campus portal for web-based student services at 5.5 on a 1–7 scale (1 = not important; 7 = very important), up from a scale score of 5.3 in 2001 and 5.2 in 2000.

E-commerce and E-service: Progress Marked by Continuing Challenges

The 2002 survey data also document some significant gains on a number of e-commerce and e-service measures across all sectors of higher education (Figure 2). For example, two-fifths

(40.1 percent) of the campuses participating in the annual Campus Computing Survey can now process credit card payments from the campus website, up from 27.6 percent in 2001 and more than double the number in 2000 (18.6 percent). In contrast, just 5.1 percent of campuses participating in the 1998 survey could process online credit card transactions. More than two-thirds (70.9 percent) of the survey respondents report that their campus now offers online course registration, compared to just over half (55.4 percent) in 2001, 43.1 percent in 2000, and just a fifth (20.9 percent) in 1998.

Additionally, the proportion of campuses that now provide online access to student transcripts has tripled from 1998 to 2002, rising from 17.6 to 55.2 percent. Course reserves are now available online at more than two-fifths (43 percent) of the institutions participating in the annual Campus Computing Survey, up from just over one-sixth (17.9 percent) in 1998.

These numbers and other data shown in Figure 2 and provided in the annual Campus Computing Report (Green 2002a) reflect significant gains on a number of key e-commerce and e-service measures across all sectors of U.S. higher education. And as noted above in the discussion about campus portals, the gains reflect, in part, what should be described as a new institutional commitment to enhanced campus services across all sectors of higher education.

However, while all sectors of higher education have registered significant gains on the range and scope of online services offered to students, the 2002 survey data continue to provide ample evidence that some sectors are well ahead of others. Not surprisingly, as shown in Figure 3, public and private research universities typically offer more online services while community colleges continue to lag behind other sectors.

Additionally, while the gains in online campus services between 1998 and 2002 may seem striking, they are less impressive when seen in the context of the experience and expectations of U.S. college students—ages seventeen to sixty-seven—who come to campus to learn *about* and to learn *with* technology. For today's college students—only one-fifth of whom are "traditional" students (i.e., full-time undergraduates living on/adjacent to campus)—web-based services are best represented by their off-campus online experiences at retail websites, including banks and credit card companies. Retail and consumer sites provide increasingly customized services and support that are not available from college and university websites.

Indeed, consumer and commercial websites foster students' expectations about the kinds of services that should be on campus websites. Large numbers of college students—full-time undergraduates living in college dorms or campus-adjacent apartments, community college students who come to campus once or twice a week, and executive MBA students on campus two weekends a month, among others—can easily access information about their bank, credit card, and cell phone accounts on the web. Yet these same students often do not have access to parallel services from the colleges they attend (e.g., online transcripts, course registration, and financial account or financial aid information).

	Public University	Private University	Public 4-Yr. College	Private 4-Yr. College	Community College
Undergraduate application	98.6	91.2	90.2	89.4	79.6
Financial aid application	84.9	70.6	72.0	61.7	72.1
Course catalog	100.0	94.1	92.3	89.9	92.5
Program requirements	84.9	88.2	86.7	84.1	75.5
Course registration	91.8	85.3	79.0	52.4	80.3
Online courses	90.4	55.9	77.6	36.1	78.2
Library/card catalog	98.6	94.1	90.2	89.0	77.6
Course reserves	74.0	64.7	49.7	43.6	17.7
Student transcripts	75.3	73.5	61.5	40.5	61.2
IT support resources	98.6	88.2	83.2	76.7	53.1
Instructional software	74.0	64.7	49.7	41.4	24.5
College bookstore services	71.2	79.4	72.7	60.8	55.8
E-commerce (fee payment)	69.9	47.1	49.7	23.8	42.2

Figure 3:

Website Services
(percentages by sector, 2002)

Source: Used with the permission of the Campus Computing Project.

Other data from the 2002 survey also support the notion of a lagging e-commerce/e-service infrastructure. One key indicator: The 2002 survey respondents rated the campus capacity for e-commerce eleventh on a list of twelve technology infrastructure metrics that include network and telecommunications services, user support services, online reference resources, network security, and IT training for students and faculty (Figure 4).

Taken together, these data suggest that many campus websites and online campus services lag the consumer sector by as much as two years. Moreover, the budget cuts now affecting all sectors of U.S. higher education could impede institutional efforts to expand and enhance e-learning and online services.

Key IT Priorities

As in the past years, survey respondents identified assisting faculty to integrate technology into instruction as the single most important IT issue confronting their campuses over the next two or three years (Figure 5). One-fourth (24.4 percent) of the 2002 survey respondents tag instructional integration as the key IT issue for their institutions, down from one-third

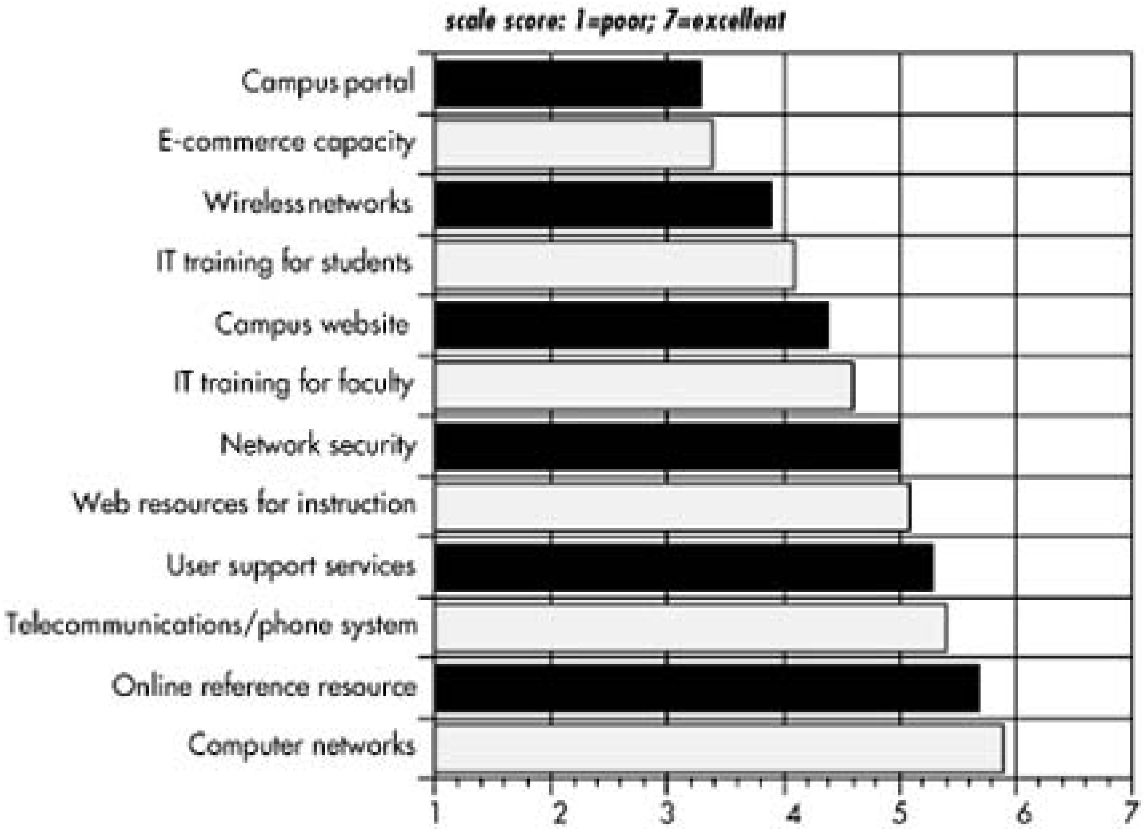

Figure 4:

Rating the Campus IT Infrastructure
(all campuses, 2002)

Source: Used with the permission of the Campus Computing Project.

(31.5 percent) in 2001, and a dramatic drop from the two-fifths (40.5 percent) posted in 2000.

Ranked second in 2002 are enterprise resource planning (ERP) upgrade/replacement issues: Almost one-fifth (18.9 percent) of that year’s respondents tag ERP issues as the key IT priority for their campus, up from 12.6 percent in 2001. IT financing rose to third place in 2002 at 15.1 percent of respondents, up from 11.7 percent the prior year. Providing adequate user support, which held the number-two position for many years, fell to fourth in 2002, dropping to 13 percent, down from 15.4 percent in 2001, 22.3 percent in 2000, and 25 percent in 1997.

Yet the aggregated data mask important differences in institutional priorities across the various sectors of U.S. higher education. For example, ERP issues ranked first in both public and private universities: Almost a third identify ERP replacement/upgrade issues as the single most important IT issue for their institutions (Figure 6). In contrast, assisting faculty with instructional integration of information technology remains the top issue for public and private four-year colleges and also for community colleges. ERP upgrade/replacement ranks second in both public and private four-year colleges; community colleges rank ERP upgrade/replacement third, just behind IT financing.

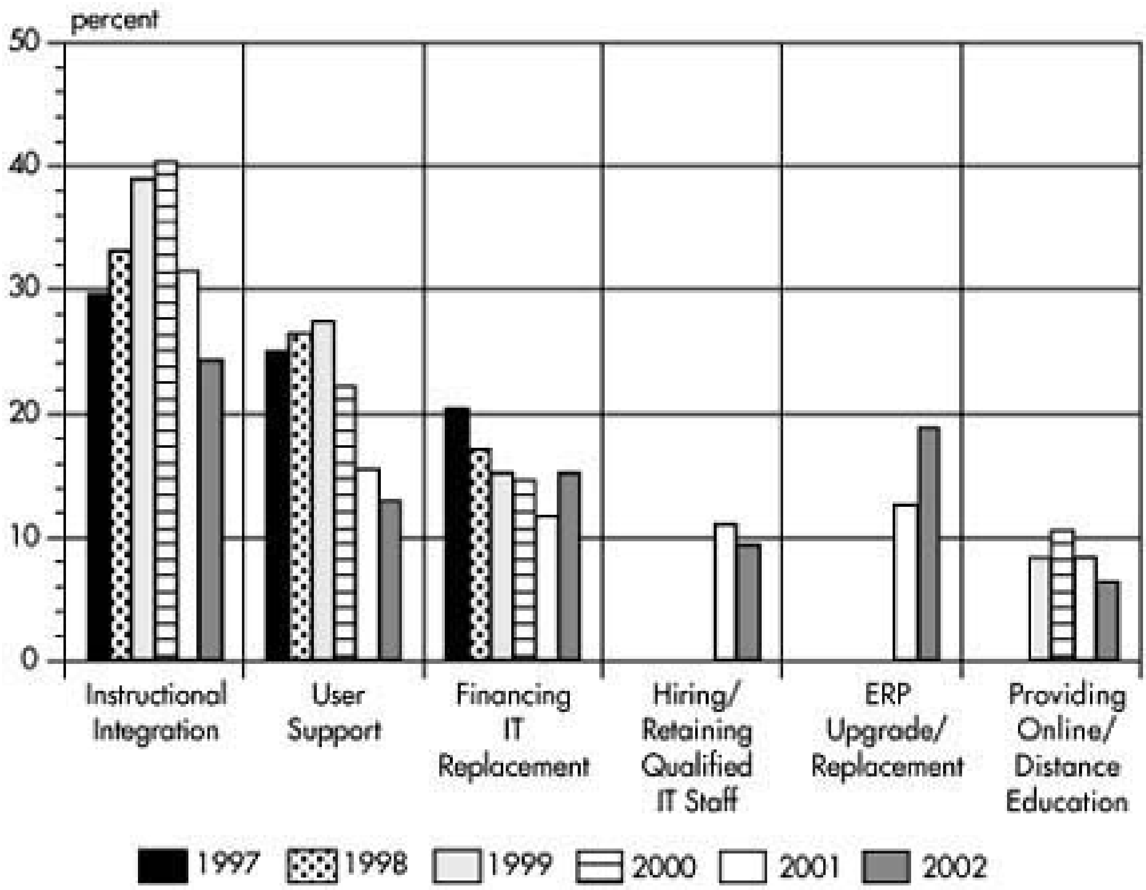

Figure 5:

Single Most Important IT Issue
(percentages, 1997–2002)

Source: Used with the permission of the Campus Computing Project.

The survey data also highlight the strategic issues of most concern to campus IT officials. The strategic issues shown in Figure 7—clarifying campus IT goals, IT training for IT personnel, web resources for instruction, course management systems—are the four issues that received the highest ratings from a larger list of twenty-nine items that cover instruction, personnel, budgets, and web services.

Not surprisingly, the data presented in Figure 7 highlight the continuing concern for instructional resources on the web. Finally, Figure 7 confirms the emergence of course management software (CMS) or learning management software (LMS) as a key component of the instructional technology infrastructure.

Yet somewhat surprising are the topics that are *not* high on the list of strategic campus IT issues. For example, notably absent among the top issues are: electronic commerce (scale score: 4.8), policies regarding intellectual property (5.2), and providing a campus portal for web-based student services (5.5). Perhaps one way to explain the lower ranking of these three items is that they are not exclusively IT planning and policy issues. Rather, portal planning, intellectual property issues, and e-commerce/e-service planning and implementation each involve multiple campus offices:

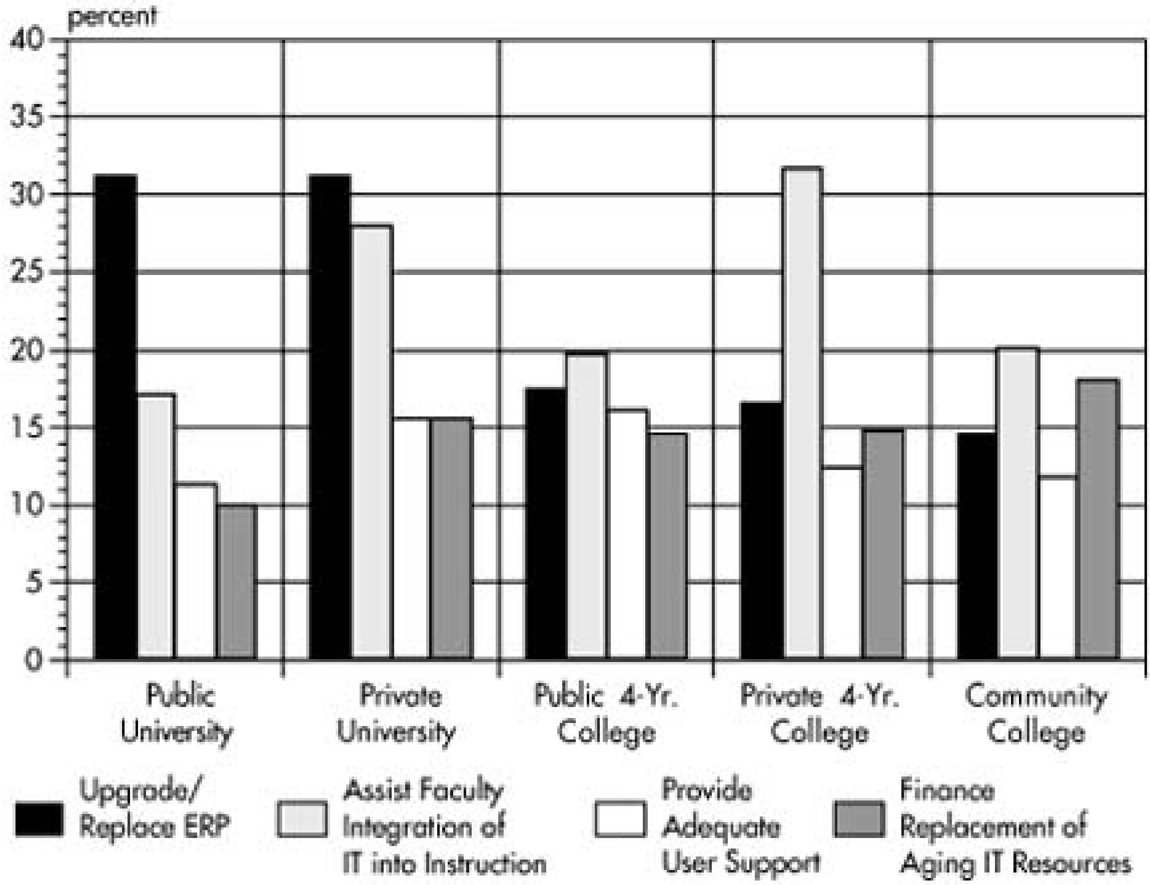

Figure 6:

Single Most Important IT Issue
(percentages by campus sector, 2002)

Source: Used with the permission of the Campus Computing Project.

information technology, academic affairs, finance, and in the case of intellectual property, probably legal affairs. Consequently, because senior campus IT officials do not "own" these issues the way that their units own other issues—professional development for IT personnel or the IT infrastructure for e-learning (including the deployment of course management systems)—it may not be surprising that senior campus IT officials rank these "collaborative" issues lower than others.

Technology Planning

The 2002 survey data highlight the continuing challenge of IT planning in U.S. colleges and universities. More than two-thirds (70.6 percent) of the institutions participating in the 2002 Campus Computing Survey report a campus strategic plan for information technology, up from 63.3 percent in 2001 and just 48 percent in 1998.

At one level, these numbers suggest important and impressive gains in campus efforts to anticipate and to address a wide array of critical information technology challenges. Yet as in past years, additional data from the annual Campus Computing Survey suggest that many of these campus strategic plans may be incomplete.

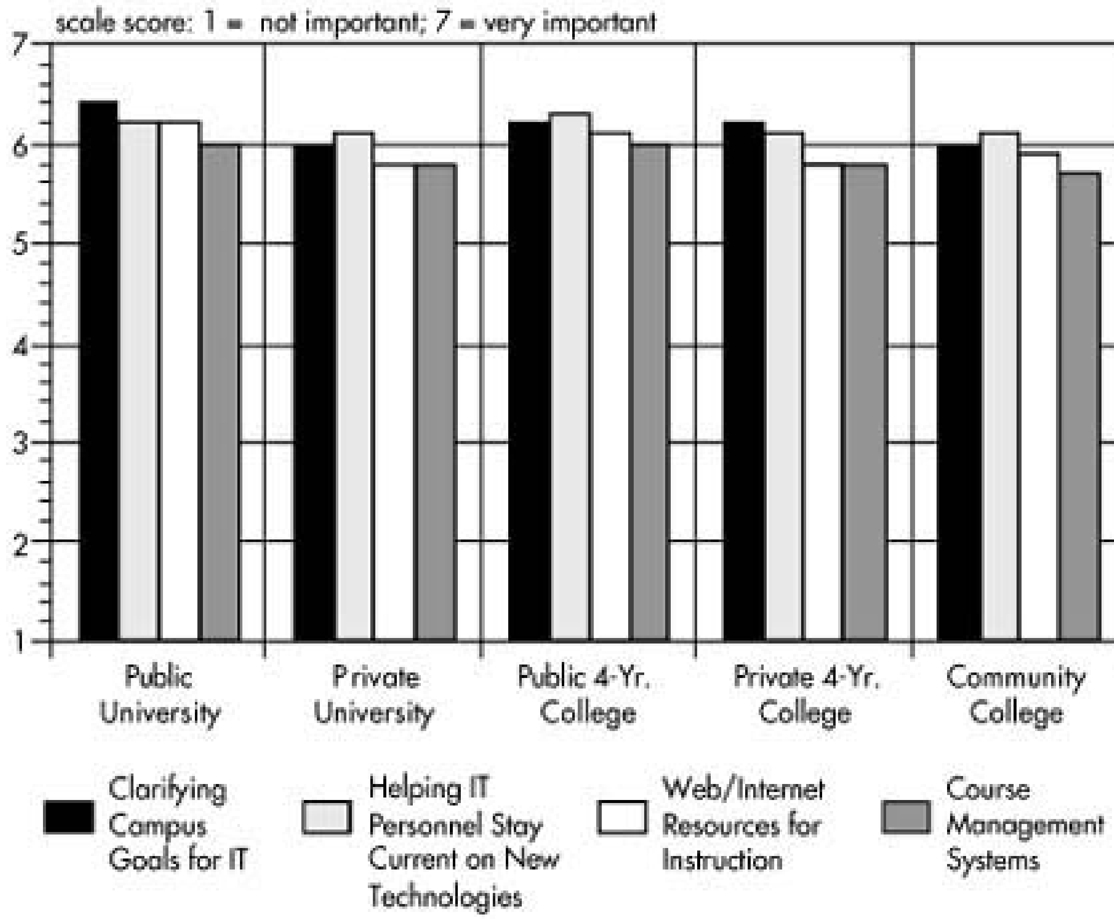

Figure 7:

Key Strategic IT Issues
(percentages by sector, 2002)

Source: Used with the permission of the Campus Computing Project.

Indeed, probe just a bit below the surface and it is clear that many of the institutions that claim to have a strategic plan for information technology frequently are missing some key components of an overall IT strategic plan. For example, just over half of the 2002 survey respondents (54.7 percent) report an IT financial plan that acknowledges the need to acquire and retire aging equipment. This compares to 52.2 percent reporting a financial plan in 2000 and just a fifth (21.9 percent) in 1994. Again, while the gains between 1994 and 2002 are impressive, the survey data also reveal that almost half (45.3 percent) of the institutions participating in the 2002 survey *do not* have IT financial plans.

Other metrics from the 2002 survey confirm that some campus IT planning efforts may be incomplete (Figure 8). For example, only one-seventh (13.4 percent) of the campuses participating in the 2002 survey report strategic plans for electronic commerce (up from 11.8 percent in 2001 and more than double the 6.8 percent posted in 2000). A fourth (24.5 percent) report a plan for student portal services, compared to one-fifth (21.4 percent) in 2001 and one-eighth (12.6 percent in 2000). Less than two-fifths (37.1 percent) report a strategic plan for distance learning (up from 34.3 percent in 2001 and 29.2 percent in 2000). Although these metrics show

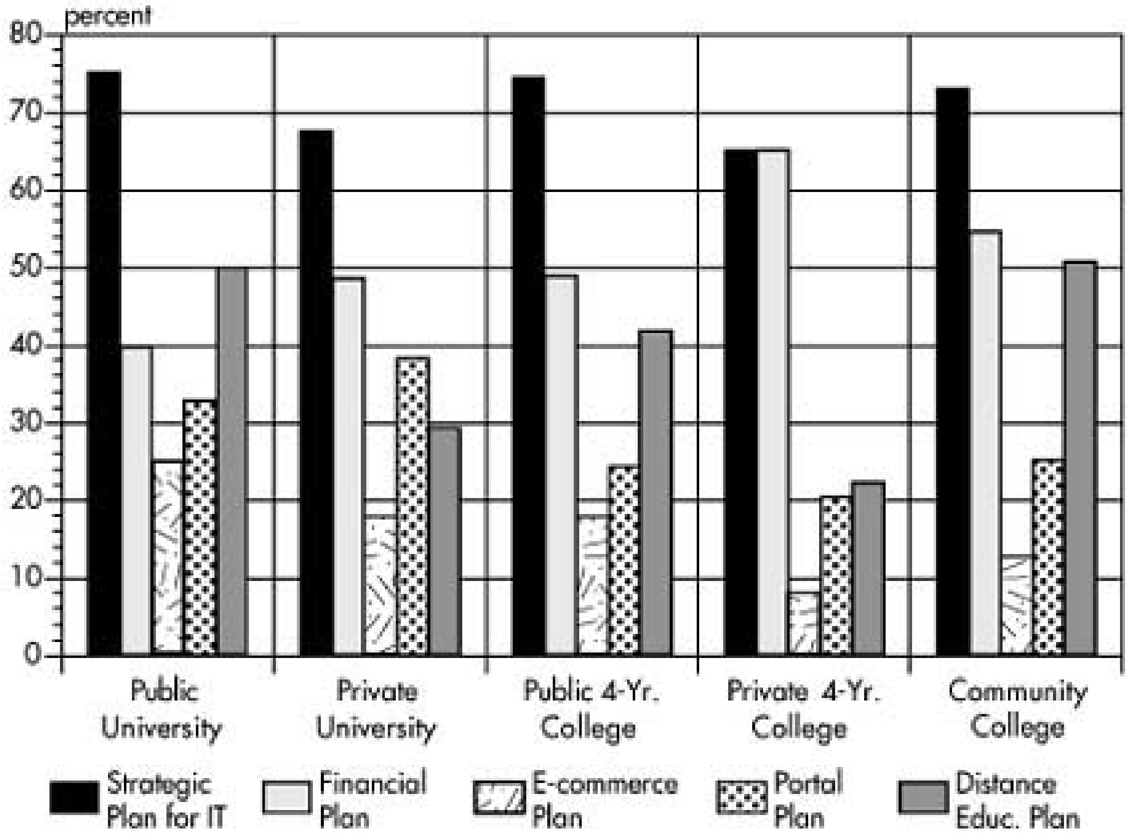

Figure 8:

IT Strategic Planning
(percentages by sector, 2002)

Source: Used with the permission of the Campus Computing Project.

impressive gains from 2000 to 2002, the numbers are still well below the percentage of institutions reporting that they have a strategic plan for information technology.

Rising Use of IT in Instruction

Yet even as campuses and campus officials continue to struggle with technology planning, the annual survey data continue to document the rising use of technology to support instruction (Figure 9). More than two-thirds (69.5 percent) of all college classes now utilize e-mail, up from (64.1 percent) in 2001, 59.5 percent in 2000, and 20.1 percent in 1995. Similarly, fully half (50.3 percent) of all college courses now use Internet-based resources (e.g., URLs in the course syllabus), compared to 10.9 percent in 1995, 33.1 percent in 1998, 42.6 percent in 2000, and 47.4 percent in 2001.

The 2002 survey data also highlight the growing role of webpages for individual courses: Survey respondents estimate that one-third (34.8 percent) of all college courses now have a webpage, compared to 30.7 percent in 2000, 22.5 percent in 1998, and 9.2 percent in 1996.

Concurrently, the 2002 data indicate that more than one-fourth (26.9 percent) of all college faculty have a personal webpage not linked to a specific class or course, compared to 19 percent in 1999. (See Figure 10.)

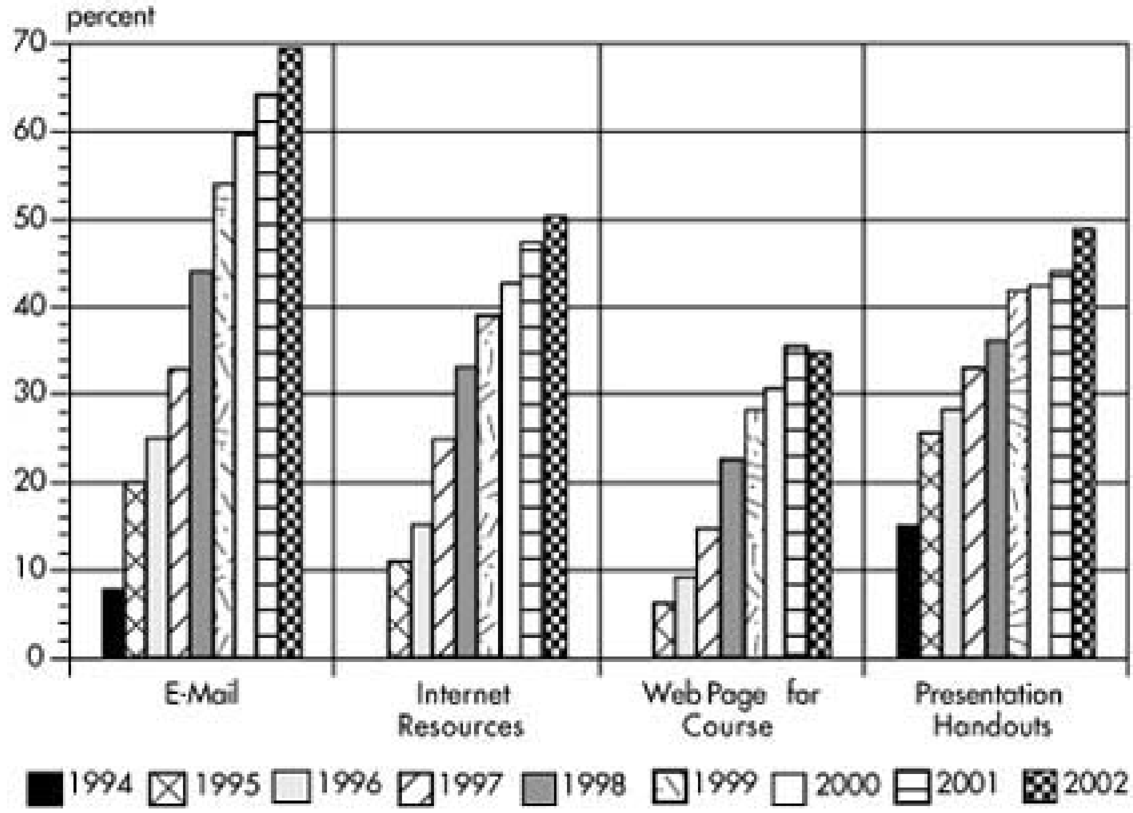

Figure 9:

Rising Use of Technology in Instruction
(percentages for all institutions, 1994–2002)

Source: Used with the permission of the Campus Computing Project.

As in past years, the 2002 survey reveals important variations in the deployment of IT resources across sectors. For example, almost half (49.0 percent) of all courses in public research universities have an individual webpage for class materials and resources, up from 33.7 percent in 1999 and more than double the number from 1997 (17.7 percent). In contrast, while the number has also doubled over five years in private four-year colleges (from 15.2 percent in 1997 to 31.1 percent in 2002), it is almost a two-fifths below the level in private universities (51.6 percent, up from 28.8 percent in 1997). The pattern for using e-mail as a course resource is similar: large gains within sectors but significant variation across sectors.

Course Management Software

The 2002 survey data again confirm the increasingly important role of course management software or learning management software as a core instructional resource. Overall, the percentage of college courses that use a CMS/LMS tool has risen from 14.7 percent in 2000 to 26.5 percent in 2002. While the numbers vary by sector (Figure 11), the growing deployment of (some might say campus dependency on) CMS is consistent across all sectors.

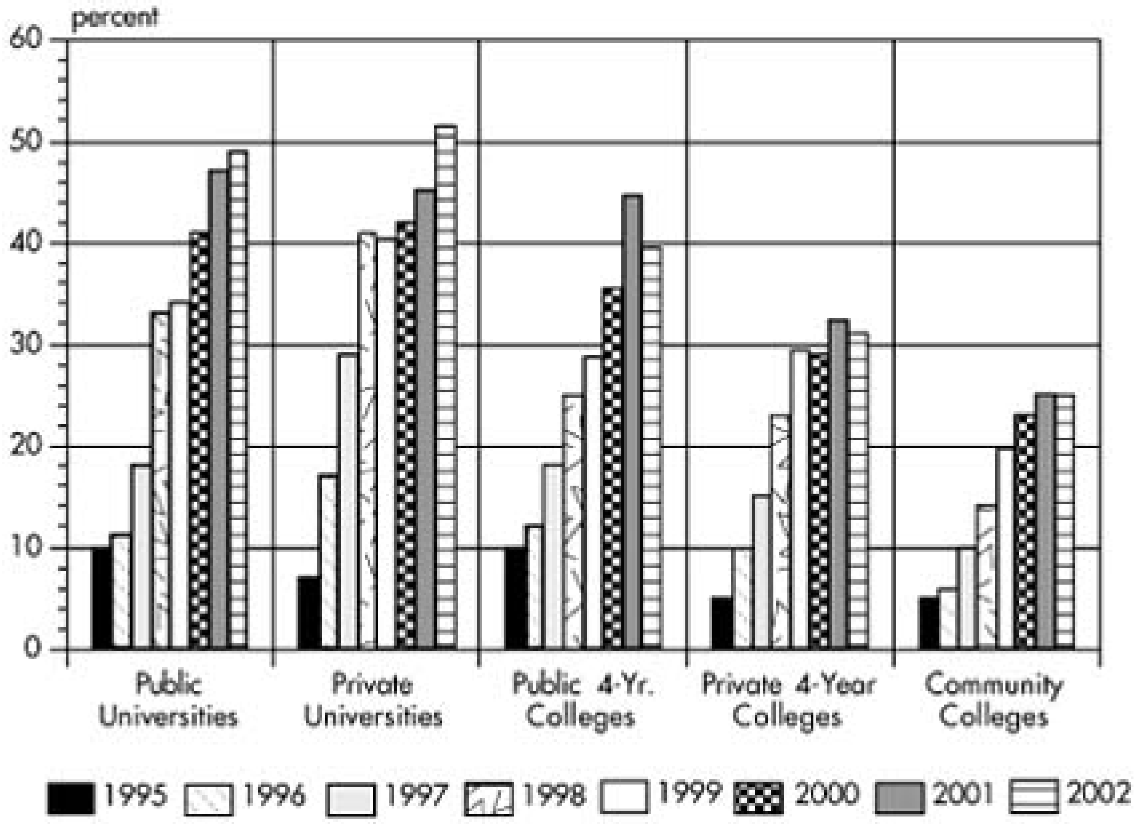

Figure 10:

College Courses with Website
(percentages by sector, 1995–2002)

Source: Used with the permission of the Campus Computing Project.

The survey data also indicate that almost half (47.5 percent) the institutions participating in the 2002 survey report a strategic plan for CMS/LMS deployment, up from 41.8 percent in 2001 (Figure 12).

Concurrent with the rising use of CMS/LMS has been the willingness of campuses to establish a single CMS/LMS standard for their institutions. Fully four-fifths (82.1 percent) of the survey respondents report that their institution has established a single product CMS/LMS standard as of fall 2002, up from 55.4 percent in 2000 (Figure 12).

Taken together, the survey data may actually underestimate the percentage of institutions that have established broad campus CMS/LMS standards. For example, some institutions have reached a kind of “CMS détente,” allowing one or two academic units to use one CMS/LMS product while the rest of the campus uses another one. Alternatively, the distance education program may have opted for one particular product while the rest of the institution may use a CMS/LMS from a different provider.

CMS/LMS deployment standards represent a rare example of institutional policy moving ahead of campus practice: Rather than supporting several CMS products or waiting for market forces to determine the “winning” application, the vast majority of campus officials and instructional

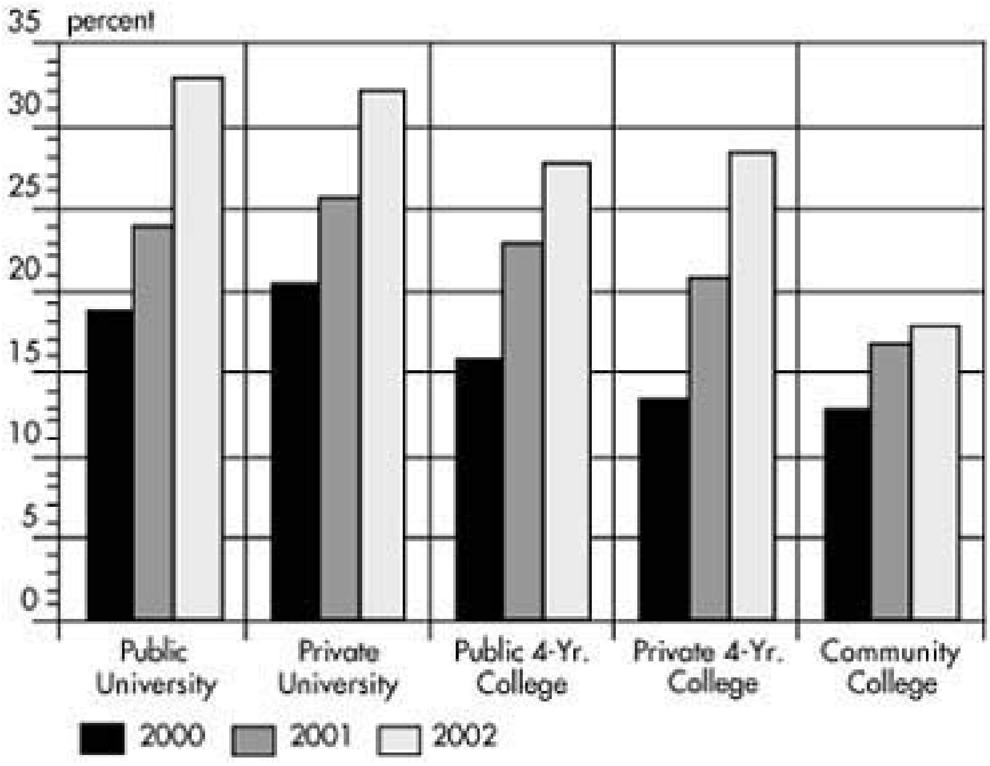

Figure 11:

Classes Using Course Management Software
(percentages by sector, 2000–2002)

Source: Used with the permission of the Campus Computing Project.

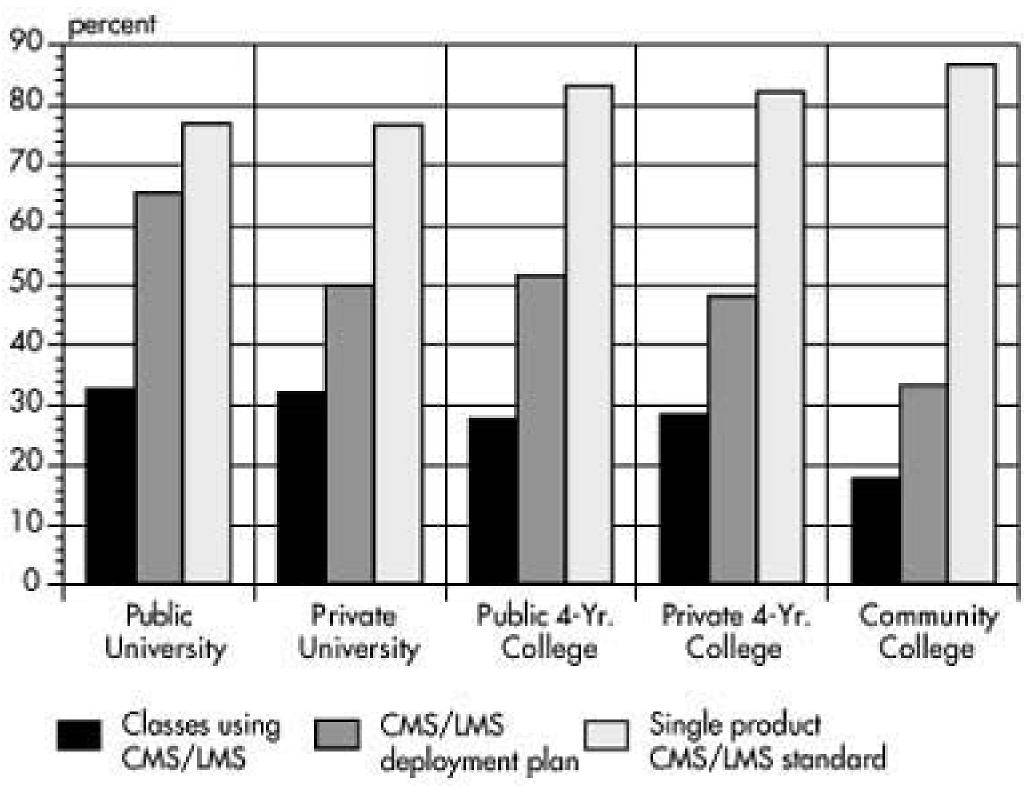

Figure 12:

CMS/LMS Deployment, Planning, and Standards
(percentages by sector, 2002)

Source: Used with the permission of the Campus Computing Project.

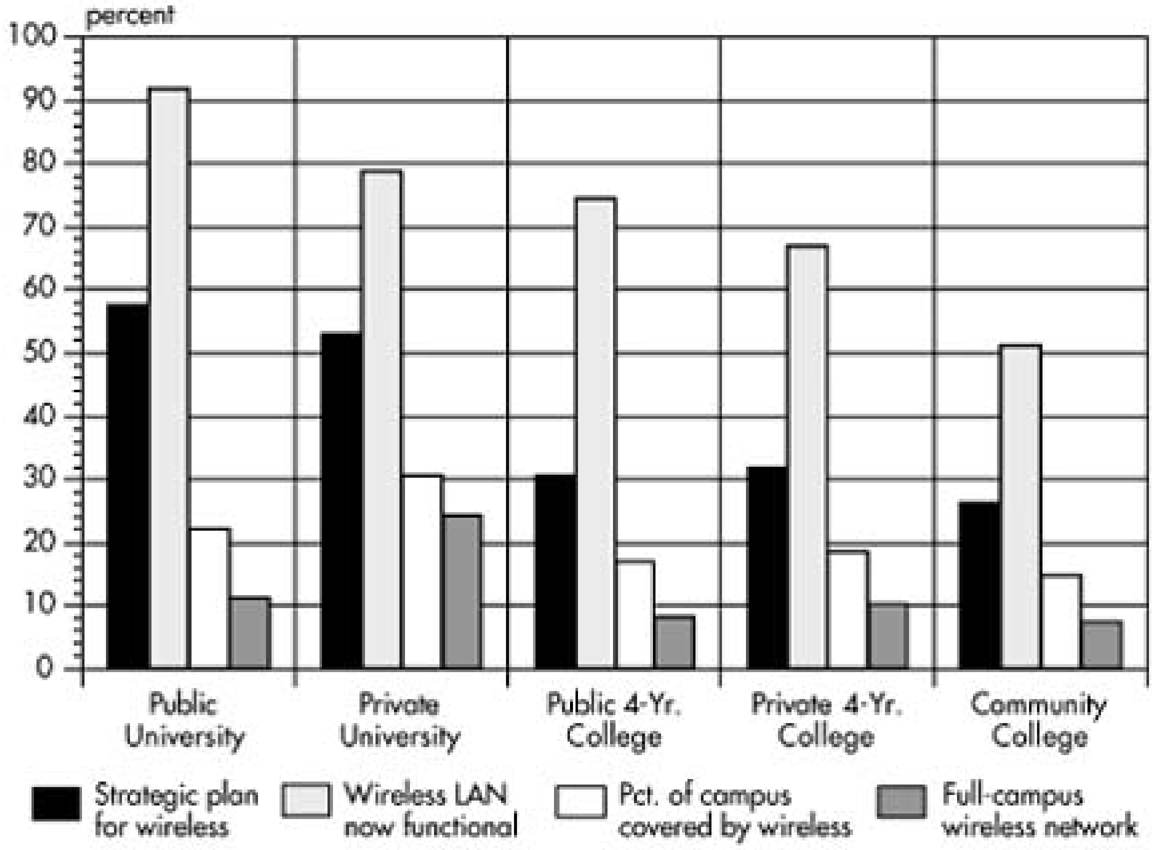

Figure 13:

Wireless Planning and Deployment
(percentages by sector, 2002)

Source: Used with the permission of the Campus Computing Project.

technology committees are selecting a single CMS product for their institutions. These decisions reflect an effort to make a clear statement about the role of CMS applications in instruction. Additionally, the movement to early campus standards should help promote broader and faster deployment and also simplify and facilitate user support services.

Moving toward Wireless

The 2002 survey data track the growing movement toward wireless networks across all sectors of U.S. higher education. Fully two-thirds (67.9 percent) of the surveyed campuses report wireless local area networks (LANs) as of fall 2002, up from half (50.6 percent) in 2001 and less than one-third (29.6 percent) in 2000.

One-tenth (10 percent) of the survey respondents indicate that *full-campus* wireless networks are up and running at their institutions as of fall 2002, compared to 6.4 percent in 2001 and 3.8 percent in 2000. Another one-tenth (9.5 percent) report that their institutions should have working, full-campus wireless LANs by fall 2003. One-third (34.7 percent) of the campuses have a strategic plan for wireless networks, up from one-fourth (24.3 percent) in 2001 (Figure 13). Across all sectors, for institutions with wireless LANs, the 2002 data indicate that wireless services cover about a

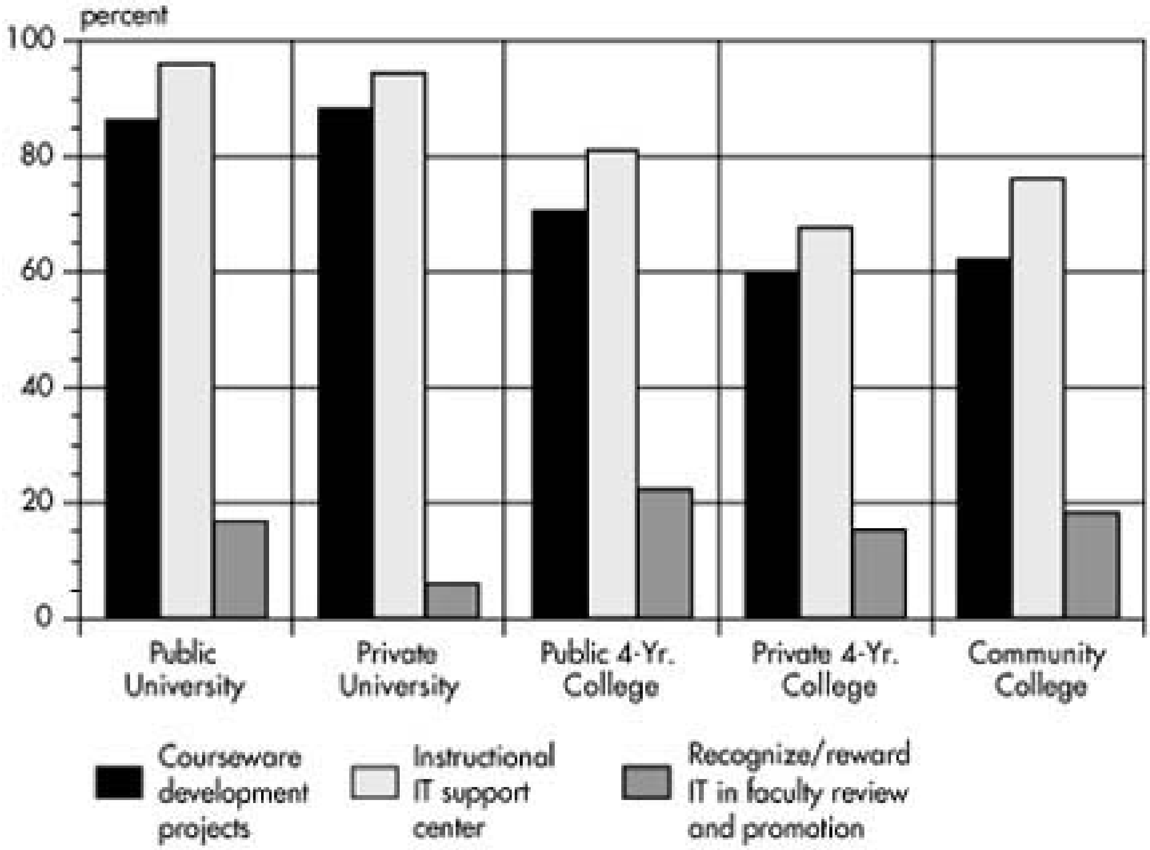

Figure 14:

IT Support versus Faculty Recognition and Reward
(percentages by sector, 2002)

Source: Used with the permission of the Campus Computing Project.

fifth of the physical campus (18.3 percent), almost double the level of wireless campus access/coverage reported in the 2001 Campus Computing Survey (10.9 percent).

Faculty Recognition and Reward

One of the continuing (and unfortunate) ironies of campus efforts to promote the instructional use of information technology is the fact that comparatively few campuses provide formal recognition and reward for faculty efforts at instructional integration (Green 2002b). Although the majority of institutions provide some support for faculty efforts to develop instructional applications and have campus technology centers to support instructional integration, few institutions recognize faculty IT efforts in the review and promotion process. (See Figure 14.)

Consistent with past years, the pattern for 2002 is similar across all sectors: Institutional support for courseware development projects is common, as is the campus presence of technology support centers to assist faculty with instructional integration. The percentage of campuses reporting that IT is now to be part of the review and promotion process has increased from 13.4 percent in 1999 to 17.4 percent in 2002. However, despite these gains, only a small minority of colleges and universities have a formal program that provides recognition and reward for individual faculty efforts at instructional integration.

Additional Information About the Campus Computing Project

Readers interested in additional information about the Campus Computing Project should consult the project's website (www.campuscomputing.net), which provides more information about the annual survey reports, plus reprints of articles that draw on the survey data.

Also of potential interest may be the emerging international network of affiliated scholars from universities in Brazil, China, Hong Kong, Japan, South Korea, and elsewhere who are developing their own campus computing projects based on the research model and methodology developed in the United States. The Asian Campus Computing Project, which includes China, Hong Kong, Japan, and other Asian nations, maintains a website that provides additional information about the individual and collective campus computing projects in these countries (www.accsonline.net).

Kenneth C. Green

See also

Computer-Mediated Communication; Courseware; Diffusion of Innovations; Technology across the Curriculum; Technology Planning; Web Portals; Web-Based Course Management Systems; Wireless Networks

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CaseNEX

CaseNEX is the first web-based environment to use case-study methods to challenge students to examine theories they have learned or are learning and to apply these theories to situations they may encounter in the future via interactions with cases (Bronack and Kilbane 1998). In his 1985 presidential address to the American Educational Research Association, Lee

Shulman advocated the use of case methods in teacher education (Shulman 1986). Cases, according to Shulman, are more than simply reports of events; they are stories placed in a larger theoretical context. He pointed out the obvious fit of case methods in teacher education as a natural consequence of the movement toward viewing teaching as situated cognition, decisionmaking, and reflection. Shulman also associated the use of cases with technology, looking ahead to such innovations as simulations and videodiscs for extending capacities of professional practice. Researchers and practitioners have begun to instantiate these ideas in teacher education. The CaseNEX website provides course packages and a variety of tools for designing and delivering teaching cases within and among groups of preservice and in-service teachers.

Case methods have been used successfully in business schools, law schools, and medical training for years as an alternative to direct instruction, seminar, and didactic lecture strategies (Merseth 1996). Most case methodologies, whether in teacher education or other professions, share a common element: Student discussions form the foundation of case-based learning. In small groups or instructor-guided Socratic discussions, students must consider various issues in the case. Typically, expert analyses assuming various perspectives accompany cases and suggest that there are no “right” answers but instead a variety of acceptable perspectives that teachers can assume as they learn to make reasoned, ethical decisions about teaching and learning. Although it is impossible to address completely the complexity of teachers’ jobs, case methods can provide realistic environments through which various problem-solving strategies and tactics can be applied and investigated.

Cases may be presented using a variety of media formats, including text, graphics, video, audio, or some combination of these. Most teaching cases are text-based. Text-based cases can be an efficient way to communicate complex classroom scenarios, but they do not reflect the richness of real life, as do cases presented in visual forms. Newer technologies allow case studies to communicate the intricacies of classroom practice with various media. Cases communicated through video formats, for example, can encourage viewers in ways that text-based cases cannot. Videocassette, laserdisc, CD-ROM, and more recently the World Wide Web are popular choices to communicate these vivid presentations of real people in real situations.

The emergence of hypermedia and the World Wide Web offer the latest vehicle for delivering cases. These tools enable the delivery of multiple technologies that, when combined, can create and enhance the verisimilitude of cases and the human interaction deemed essential in case-based teaching and learning. Whereas video and text formats are generally linear, hypermedia enables students to choose their own pathways through the case materials. Collections of digital documents cross-referenced by links allow viewers of a case to move easily from one text page to another, or to other media such as audio, video, or graphics. Students can manipulate the case materials, allowing them to determine their own questions and frames of inquiry. Such student-constructed analyses mirror more closely the actions of classroom teachers (Merseth and Lacey 1993). Novices can also build their own knowledge about teaching. The innovative instructional design of such multimedia cases reflect important dimensions of the classroom, including multidimensionality, simultaneity, and immediacy (Merseth and Lacey 1993). The WWW also allows for a highly interactive environment that enables richer transactions among people than any of its technological predecessors. Computer networks enable synchronous and asynchronous conversations that contribute to the construction of knowledge by bringing various perspectives to bear on case analyses and discussions. Such interactions would otherwise be hindered by space and time boundaries. (See Figure 1.)

CaseNEX offers approximately thirty multimedia case studies combining text with video and audio files, pictures, and other graphics. CaseNEX currently provides cases about life in K-12 classrooms in the United States, Cuba, India, South Africa, and Norway. Participants from approximately twenty universities in four countries and fifteen school districts in the United States use CaseNEX. Participants use the Internet and communications technologies to learn to analyze multimedia cases and to connect with participants at different geographical sites. They meet physically at local sites with an instructor or team of instructors who use case methodology to guide and assist learning.

A set of integrated tools supports the CaseNEX site. These enable participants from several countries and regions in the United States to analyze the cases online and to interact with each other in a variety of ways. Participants use an internal messaging system (CaseMail) to set up synchronous conferences, group messaging (AOL Instant Messenger), and videoconferencing (iVisit) programs to discuss cases and share educational approaches. A feature called Knock Knock allows users who are logged on at the same time to identify one another. Students' pictures and bios make the connections even more personal. The time-independence of asynchronous, online discussion groups offers students opportunities to reflect, evaluate, summarize, and communicate perspectives about their shared case experiences. Electronic journals make it possible for users to record reactions to cases and receive individual feedback from instructors.

Studies of CaseNEX highlight several important factors that characterize students' involvement with cases. T. W. Kent (1997) collected data over a two-year period on the use of the first web-based multimedia teaching case to be used in CaseNEX. This case, entitled Project Cape Town, combines text, graphics, audio, and video to describe four events taken from four South African schools experimenting with racial integration. Kent identified several navigational patterns through Project Cape Town. Asking participants to do what comes naturally when navigating Project Cape Town, he characterized three user styles—impulsive, response-focused, and balanced—based on the degree of structure imposed by participants moving through a case. The impulsive style of use is characterized by

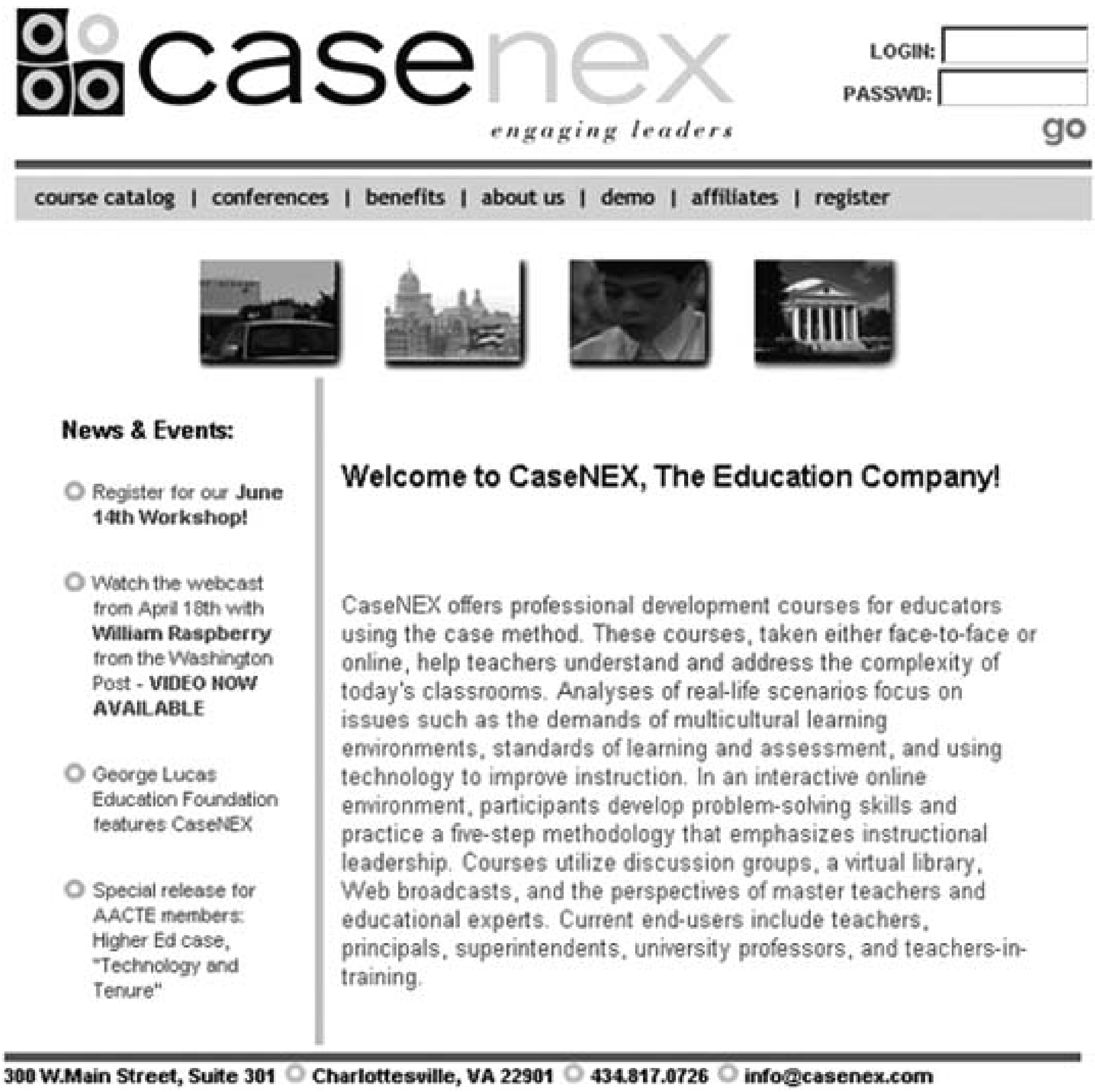


Figure 1:

Sample Web page from CaseNEX Project.

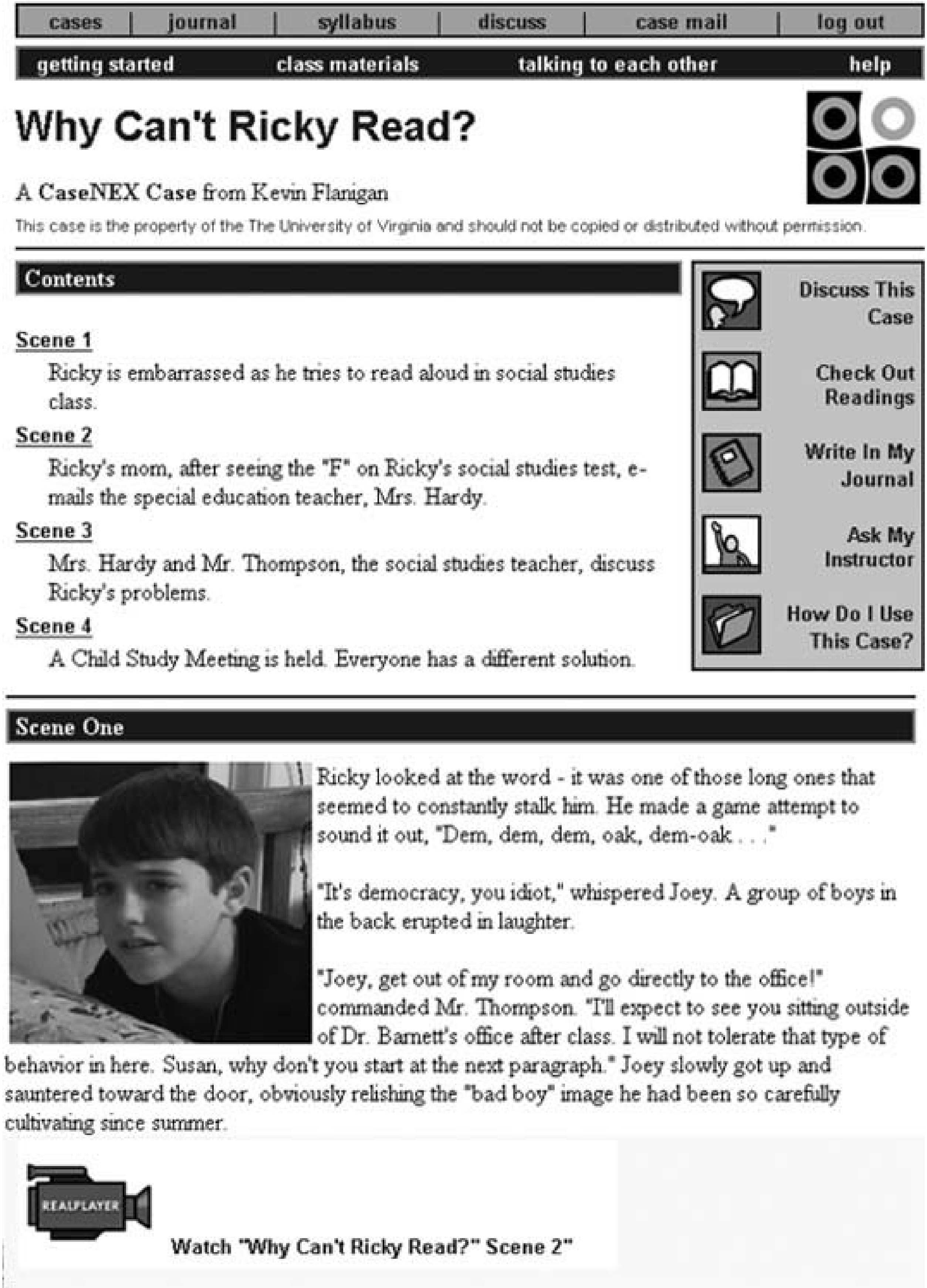
Source: Used with the permission of the CaseNEX Project.

breaking routines and by following lines of interest related to the content presented in the resource. In contrast, a response-focused user considered answering all of the questions a priority, postponing access to much of the material until after completing the four case events and their questions. The balanced style reflected a more thorough, systematic exploration of all areas and resources of Project Cape Town. Kent also found that the media increased the realism of the case and that most users considered the nonverbal information valuable in helping shape their analyses. Kent urged other researchers to investigate cultural factors influencing student thinking and students' responses to cases.

S. C. Bronack (1998) took Kent's challenge to investigate the possible effects of multimedia cases on teachers' thinking. More specifically, he compared the decisionmaking skills and level of concern demonstrated by teachers enrolled in CaseNET (the name prior to summer 2000) with those of teachers not participating in the online community. He also examined the effects of course participation and nonparticipation on teachers' concerns about web-based instruction. About 95 percent of Bronack's participants believed that the program helped them bridge the gap between theory and practice. Approximately the same percentage agreed or strongly agreed that CaseNET helped prepare them to face classroom situations similar to those described in cases. The results suggested that participation in CaseNET positively influenced participants' concern about all seven items of innovation, yet no statistically significant difference was found between the treatment groups' performances. Although the CaseNET participants' analysis scores showed a slight improvement over those of nonparticipants, the gain was not great enough to differentiate one group from the other. Bronack suggested that the small number of participants and limitations of the instrument used to measure participants' analyses might be explanations for the failure to find significant results. Understandably, the Bronack study raised questions about instructor effects on the success and execution of the CaseNET experience.

Like Bronack, C. Kilbane (2000) studied the efficacy of the CaseNET problem-solving method in an experimental study. She examined effects of learner control on participants' experiences with a multimedia case and investigated the problem-solving proficiency of participants enrolled in CaseNET and two additional groups of students not participating in the online community. Kilbane's results suggest that preservice teachers in CaseNET were able to learn the problem-solving strategy and to apply it to a multimedia case study. The experimental group was better at identifying issues and applying knowledge from various sources than were participants in the other groups. Participants in CaseNET used professional knowledge from the case resources (lesson plans, student progress reports, etc.) to identify problems and propose actions but were limited to using knowledge from case resources they knew how to locate and interpret. (See Figure 2.)

To date, no studies of multimedia cases have compared variations in the CaseNEX treatment or the match of treatment to participants. Can teacher educators use cases to encourage teachers to engage intellectually in solving real-life educational and moral problems? Can the CaseNEX method, or any other web-assisted approach, be delivered to students virtually without diminishing significantly the quality of the experience? Moreover, do case-based strategies influence deeper structures of moral reasoning?



cases | journal | syllabus | discuss | case mail | log out

getting started | class materials | talking to each other | help

Why Can't Ricky Read?

A CaseNEX Case from Kevin Flanigan

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Contents

Scene 1
Ricky is embarrassed as he tries to read aloud in social studies class.

Scene 2
Ricky's mom, after seeing the "F" on Ricky's social studies test, e-mails the special education teacher, Mrs. Hardy.

Scene 3
Mrs. Hardy and Mr. Thompson, the social studies teacher, discuss Ricky's problems.

Scene 4
A Child Study Meeting is held. Everyone has a different solution.

Discuss This Case

Check Out Readings

Write In My Journal

Ask My Instructor

How Do I Use This Case?

Scene One

Ricky looked at the word - it was one of those long ones that seemed to constantly stalk him. He made a game attempt to sound it out, "Dem, dem, dem, oak, dem-oak . . ."

"It's democracy, you idiot," whispered Joey. A group of boys in the back erupted in laughter.

"Joey, get out of my room and go directly to the office!" commanded Mr. Thompson. "I'll expect to see you sitting outside of Dr. Barnett's office after class. I will not tolerate that type of behavior in here. Susan, why don't you start at the next paragraph." Joey slowly got up and sauntered toward the door, obviously relishing the "bad boy" image he had been so carefully cultivating since summer.

REALPLAYER

Watch "Why Can't Ricky Read?" Scene 2"

Figure 2:

Sample Web page from CaseNEX Project.

Source: Used with the permission of the CaseNEX Project.

Case-method teaching and learning provide opportunities for the discussion of complex educational dilemmas that challenge one's current level of moral understanding. With the development of ever-newer and faster technologies, as well as the growing technological adeptness of teachers and teacher educators, it may be reasonable to consider the conditions of web-assisted and distance case-study methods of teaching and learning that are critical for facilitating teacher development. Currently, research is under way to examine the complex and dynamic relationship of live and virtual case method contexts, case discussions, and the moral development of teachers.

Marsha A. Gartland
Robert F. McNergney

See also

Active Learning; Situated Cognition; Teachers: Preparation and Training

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Clark, Richard E. (b. 1940)

Richard E. Clark, Ed.D., is a professor of educational psychology at the University of Southern California, where he has been a member of the faculty and has held various administrative posts since 1978, including division head for educational psychology and technology and director of professional studies and community programs. He has been elected a fellow of the American Psychological Association, the American Psychological Society, and the Association for Applied Psychology, exceptional recognition for someone who does not have a degree in psychology.

He is best known among educational technology professionals as a critic of the theory that media have direct causative influence on specific types of learning. His 1983 publication “Reconsidering Research on Learning from Media” touched off a controversy sometimes summarized as the media-methods debate. Throughout the 1980s and early 1990s he continued to defend his position through point-counterpoint articles in professional journals and panel discussions at academic conferences.

Clark has devoted his efforts since then to exploring what *does* work—the positive side of his media critique. This quest has led him into study, in turn, of human cognition, instructional methods, instructional design processes, motivation theory, and performance interventions. In 2001 he was focusing on writing several books to synthesize these studies into a cognitively based theory of designing learning environments incorporating motivational features to maximize the transfer of learning to real-world accomplishments.

Clark’s professional quests have been shaped by his life experiences, like most other people. Born September 15, 1940, in Howell, Michigan, near Detroit, he was the eldest of nine children, so he took on parental-type responsibilities early. From his mother he learned the indispensability of making lists and planning ahead in order to cope with the demands of taking care of others as well as oneself. He attended a small rural elementary school that featured multigrade organization, not as a progressive experiment but as a necessity. The inquisitive child was able to move ahead without hindrance, reading above his grade level right from the start. As he says, “I didn’t get bored with school until high school.” High school was more conventional, leading to the more conventional sort of indifference to academics. However, during his teen years Clark suffered a back injury that led to a lifelong disability that altered the course of his life. A doctor warned him that he had better prepare to make his way in the world with his mind since his physical capabilities would be limited. From that point on young Dick began to plan for postsecondary education, the first in his family to do so.

After a false start at the University of Michigan he found a place and a mentor—Bob Dye—at Western Michigan University; he majored in history and political science, graduating in 1963. Looking for a practical career and needing financial aid, he took advantage of an offer of a full scholarship to enter the new Annenberg School for Communication at the University of Pennsylvania to study journalism. By the time he completed a master's degree he was married and had a son, so finding a job became a top priority. Coincidentally, the founder of the Annenberg School, Walter H. Annenberg, was also the owner of the Philadelphia TV station WFIL, which was undergoing a strike at the time. Annenberg hired virtually all the J-school's graduates to fill vacant jobs at the station, including Clark, who became an associate producer. Such an entry-level job did not provide enough income to support a family, so Clark took another position, working mornings at WFIL and evenings at WHYY, the public TV station in Philadelphia.

After about a year, an opportunity arose out of connections made while producing the public TV series *The Compleat Gardener*. It led to the agricultural extension program at Rutgers University, where Clark had responsibility for a radio network and other communications operations. Shortly, though, Bob Dye, his mentor at his alma mater, Western Michigan University, beckoned. There he became director of broadcasting, including oversight of a campuswide dial-access audiovisual delivery system. The position also included an appointment as assistant professor in general studies. As he now seemed to be on a career path in higher education rather than commercial television, Clark realized that he would need to undertake doctoral studies at some point.

After exploring options for doctoral study, Clark in 1967 decided on the mass communications program at Indiana University, attracted by the chance to work with Keith Mielke, then a leading researcher on the effects of television on children, later senior researcher for the Children's Television Workshop. After a year, Clark qualified for a National Defense Education Act fellowship and transferred to the Ed.D. program in the educational media (soon to be instructional systems technology [IST]) department, entering what was to become his ultimate professional home, the school of education.

In IST he was influenced by researchers such as Malcolm Fleming, who encouraged young researchers to have confidence and pursue their own interests, and Gavriel Salomon, who pursued hard and important questions. His classmates included a number of future leaders of the field, including Sivasailam Thiagarajan, Thomas Schwen, W. Howard Levie, Diane Dormant, and Harold Stolovitch.

On completing doctoral studies, Clark was recruited to Stanford University, in 1971 joining the staff in the Research and Development Center on Teaching, later becoming one of the founding leaders of the ERIC Clearinghouse on Educational Media and Technology (renamed *Information* and Technology in 2001). Although he had an adjunct appointment in the school of education, this was not a tenure-track position, so when Syracuse University asked him to become an associate professor, later full professor, and chair of the instructional technology program in 1974, he left Stanford for upstate New York.

The Syracuse program, then known as the area of instructional technology, had recently gone through a major curriculum revision, but Clark felt that inquiry was not sufficiently embedded in the graduate program. In a detailed memo to the faculty he argued,

> My personal concern is to communicate my strong desire that we grow away from the training of people who are primarily concerned with technical skills in developing instruction, evaluating programs, managing resource centers, producing films and television programs, etc. That we change our focus to grow towards the training of people who are more skilled in inquiring about problems and their solutions. . . . All student activities therefore that involve the actual development of instruction or production of films, etc. should be conducted in an atmosphere of *constant critical discussion of the usefulness of the concepts being acquired and the process being employed.* (Ely 1998, 59; emphasis added)

The theme of "constant critical discussion" could be said to be one of the hallmarks of Clark's career. He consistently exemplifies a questioning attitude, looking at fundamental problems and seeking evidence to reach a conclusion. This stance is neatly summarized in his article (Clark 1984, 230) responding to propositions about the central concerns of instructional technology: "As responsible professionals, our only ethical choice is to ensure that we accept the evidence for the products we advocate."

That search for evidence led Clark into the center of the debate that prompted a hundred websites and became virtually synonymous with his name: the media-methods debate. The debate revolved around the issue of whether media in themselves affect learning. Throughout his graduate studies Clark had struggled with this question, unable to fully accept the intuitively obvious supposition that media, such as films and TV programs, have a dramatic impact on audiences in ways that books and lectures cannot. It's probably fair to say that his insistent quest for proof of this supposition was found to be annoying to his colleagues, although tolerated and sometimes encouraged by his teachers.

A decade later Clark was still unsatisfied with the answers being proposed, so he took a sabbatical in 1981 and devoted himself full-time to combing through every bit of the research literature related to media and learning. It was an intense and exhaustive effort. The result was his famous critique, "Reconsidering Research on Learning from Media," published in the prestigious *Review of Educational Research,* which has become the most frequently cited source in its field. In it he presented evidence for the hypothesis that instructional methods have been confounded with media and that methods are what influence learning. He offered the analogy that different media were similar to the different delivery systems developed by pharmacists to introduce medicine into the body. Tablets, liquid suspensions, suppositories, and injections are all different “media,” but their effect is dependent on whatever the “active ingredient” is. Pepto-Bismol soothes traveler’s dysentery whether it is taken in tablet or liquid suspension form. What matters is the active ingredient, bismuth. The “medium,” of course, has an effect on the speed of the effect, the cost of the effect, and the convenience of the effect, but it does not *cause* the effect. That is, media selection ought to be based on logistical considerations—availability, expense, production requirements, and the like—because there is always more than one medium that has the capacity to provide the cognitive experience needed for effective learning.

This hypothesis was not new or original, as Clark went to pains to point out, as it had been offered earlier (e.g., Mielke 1968; Schramm 1977). The greater attention attracted by Clark’s version may be attributed to the times, the venue, or, more likely, the strength of the claim made by Clark. He made the explicit and clear claim that there were *no* learning benefits possible and urged that researchers not continue to waste effort on the question until a “new theory” was developed.

This unpopular position was not one that Clark arrived at on purpose. He reports that he started out expecting to find evidence that media *did* make a difference:

> In 1980, when I began the two years of focused reading of media research which resulted in the original publication, I was taking a challenge from Bob Heinich (the former editor of *AV Communication Review*) to develop a specific taxonomy of media and learning outcomes. I was also working with Gabi Salomon on what became our *Handbook of Research on Teaching* review of media studies. . . . In those days before electronic mail, we were sending each other ten or more single-spaced letters of detail and argument as our manuscript developed. I began with the expectation that media were a significant element in any educational reform which sought achievement gains. The problem was that as I reviewed the evidence it seemed clear that it did not support my expectations or intuition. (Clark 1991, 35)

A flurry of responses to Clark’s 1983 article were published between the mid-1980s and 1990. Most of those attempted to suggest qualifications to the hypothesis or to define terms more precisely in order to explicate the constructs of media and method. It was not until 1991 that someone accepted the challenge to propose a new theory. Robert Kozma’s (1991) retort focused on the distinction between “learning *from* media” (Clark’s phrase) and “learning *with* media” (Kozma’s phrase). Kozma, principal scientist at the Center for Technology in Learning of SRI International (at the time of the publication he was an associate professor in the school of education at the University of Michigan), presented a new theoretical framework—basically the constructivist one—that envisions the learner actively collaborating *with* the mediated message to construct meaning. His argument essentially was that capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, *interact with and influence the ways learners represent and process information* and may result in more or different learning when one medium is compared to another for certain learners and tasks (Kozma 1991, 179; emphasis added).

This reframing of the issue stimulated even more debate, which raged in the pages of instructional technology journals and in panel discussions at professional conferences for several years, culminating in two special issues of *Educational Technology Research and Development* (vol. 42, nos. 2 and 3 [1994]) devoted exclusively to this debate. Clark’s conclusion to this climactic debate is captured in the title of his contribution to the special issues, “Media Will Never Influence Learning” (Clark 1994). He contends that Kozma did not directly address the distinction between medium and method or how the effects of those interacting variables might be separated or provide convincing evidence to support his theory. On the other side, Kozma has continued to espouse his viewpoint:

> But it seems to me that the interaction between medium and method (that is, the extent to which they *share* the variance) is the crux of the whole argument. The most powerful attribute of any medium is its ability to enable and constrain methods. The methods you can use with computers are very different than the methods you can use with video and this is because of the unique capabilities of the computer vis-à-vis video. (Kozma 2000)

After 1994 Clark decided to move on from defending an essentially negative point back to his original quest to discover what *does* make a difference in instruction. His platform after 1978 has been as a tenured full professor in the school of education at the University of Southern California. From 1992 to 1996 he was head of the division of educational psychology and technology. In response to invitations from institutions around the world he has traveled widely, with extensive immersion as a teacher and consultant, particularly in Ireland, Germany, the Netherlands, and Indonesia. In the early 1990s he took leave from Southern Cal to spend two years residing in Dublin, Ireland, creating and managing his own training consulting firm, Atlantic Training, Inc. He managed to outcompete some of the largest and most prestigious international consulting firms to win training contracts with the Irish Electricity Supply Board and the European Patent Office. These provided the opportunity to test his ideas about “what works” in training and education.

His focus in this latter period has been on the cognitive processes underlying teaching and learning, seeking instructional methods that facilitate the sorts of cognitive processes that lead to long-term retention and transfer to real life. Along the way he discovered the polar opposite of robust instructional methods, coining the term “mathemathantics” to refer to instructional methods that “kill” learning, that is, experimental treatments that turn out to be significantly *inferior* to the control treatment (Clark 1989).

This pursuit of powerful interventions has led to an increasing appreciation of the importance of motivation and the development of Clark’s own model of motivation (Clark 1999). This, in turn, opens the door to the world of interventions beyond instruction, leading to the domain of human performance technology. So his most recent research has been on the larger issue of what sorts of interventions in the whole working environment make a difference for human performance. His commitment to this larger issue led to the founding of a new doctoral program (human performance in the workplace) at Southern Cal in 1996. This program has attracted national renown as the most prominent doctoral program devoted to human performance technology. Some fifty scholars have completed doctoral degrees in this program.

These vast and highly influential accomplishments have been spurred by a passionate conviction that one can accomplish great things by focusing attention on basic, urgent problems and then investing one’s total effort on the pursuit of a solution. His advice to young researchers: “Believe in your vision, but follow the evidence!”

Michael Molenda

See also

Instructional Technology; Performance Support; Research on Media and Learning; Schramm, Wilbur; Television and Learning

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Cognitive Apprenticeship

Cognitive apprenticeships are modeled after traditional apprenticeships. Whereas traditional apprenticeships involve learning a visible activity or skill, cognitive apprenticeships involve using mentors to model processes that are often invisible, such as problem-solving, comprehension, and computation. Apprenticeships can be distinguished from traditional instructional methods because they provide opportunities for practice rather than specifications for practices (Berryman 1991).

Traditional Apprenticeship Learning

In traditional apprenticeships, apprentices learn to become part of a community of expert practitioners by modeling the performance of the teacher. Some characteristics of traditional apprenticeships include: learning related to bodily-kinesthetic endeavors; learning for the immediate value of getting a job done rather than for a symbolic goal such as a diploma;

learning that moves from simple to more complex; learning with standards that develop naturally from and are embedded within the work environment; and learning in which teaching is often undetectable because instruction is guided by what the apprentice does rather than by what the teacher says (Berryman 1991). In some ways the traditional apprenticeship model is not transferable to many of the skills needed to succeed in modern society because such skills are frequently cognitive in nature and thus cannot be learned solely through observation and modeling.

Cognitive Apprenticeship Learning Models

Cognitive apprenticeship can be described as follows:

> Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop and use cognitive tools in authentic domain activity. Similarly, craft apprenticeship enables apprentices to acquire and develop the tools and skills of their craft through authentic work at and membership in their trade. Through this process, apprentices enter the culture of practice. So the term apprenticeship helps to emphasize the centrality of activity in learning and knowledge and highlights the inherently context-dependent, situated, and enculturating nature of learning. (Brown, Collins, and Duguid 1989a, 39)

The cognitive apprenticeship model (Collins, Brown, and Newman 1989) strives to maintain as many of the key characteristics of traditional apprenticeships and aims to explain a process by which a novice becomes a member of a community of expert practice. The cognitive apprenticeship model is intended to cross the traditional boundaries between academic and vocational education because each requires knowledge and expertise in the other's domain. For example, an automobile mechanic must now be able to understand and operate the many computer-based systems associated with newer models. In the past, automobile mechanics has been classified strictly as a vocational discipline, computer systems strictly as an academic discipline.

The cognitive apprenticeship model has four building blocks that help to define and implement an effective learning environment for students of all ages: *content, methods, sequence,* and *sociology* (Collins, Brown, and Newman 1989)

Content

Four types of content are typically required for a successful cognitive apprenticeship model. First, students must be exposed to the concepts, facts, and procedural knowledge of a subject. This is often the only type of content considered in traditional instructional methods and is typically taught out of context. This type of content must be integrated with problem-solving strategies used by experts, metacognitive strategies such as planning, setting goals, evaluating, and monitoring one's own learning, and learning strategies that enable students to recognize relationships among fields, relate prior experiences and knowledge to new knowledge, and learn how to learn versus learning how to memorize for a test.

Methods

In a cognitive apprenticeship model, instructional methods must move beyond the traditional lecture model in which the teacher acts as a dispenser of knowledge and the students as sponges charged with soaking up this knowledge. Students should be given opportunities to observe, invent, discover, and collaborate, with the teacher serving as a facilitator who offers hints or guiding questions and monitors individual as well as class progress toward the desired goals.

Sequencing

Learning should be structured in such a way that students participate in increasingly complex tasks. Many skills and knowledge are required to operate in any domain, and skills should be learned in a logical sequence in which students gradually build upon what has previously been learned.

Sociology

The learning environment should reflect an environment as close to the real world as possible. Students retain and transfer knowledge best when it is learned within an authentic context. For all domains this includes the need to learn to collaborate with others to solve problems and carry out solutions.

Educational Technology and Cognitive Apprenticeships

Educational technology has been used to implement cognitive apprenticeship learning models. The use of computer-mediated communication to facilitate such strategies has assumed many names in recent years (e.g., distance mentors, cybermentoring, telementoring, and teleapprenticeships). The use of multimedia to facilitate cognitive apprenticeships has also received attention (Casey 1996).

The Electronic Emissary (Harris 1998) is one of the most in-depth examples of this strategy in K-12 schools. The Emissary maintains a database of volunteer subject-matter experts and matches these experts with K-12 students and classrooms from around the world who are studying in their areas of expertise. For example, a student interested in how weather forecasters use Doppler radars could communicate with a professional forecaster to learn the nuances of this community of experts.

The Teaching Teleapprenticeship Model (www.ed.uiuc.edu/TTA/) is another cognitive apprenticeship model that uses electronic networks to connect key individuals in the education of preservice and in-service teachers. The project is funded by the National Science

Foundation and aims to improve mathematics and science teaching by connecting teacher education students, practicing teachers, and university faculty via electronic networks that enhance and expand traditional face-to-face mentoring.

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See also

Active Learning; Electronic Emissary; Telementoring

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Cognitive Flexibility Theory (CFT)

Cognitive flexibility theory is a theory of learning and instruction that was developed to address four main goals:

Goal 1: Helping people to learn important but difficult subject matter. Often the most central topics are the ones we find hardest to teach and learn. Too often a superficial understanding of concepts and memorization of facts substitute for more meaningful and deeper understanding.

Goal 2: Fostering adaptively flexible use of knowledge in real-world settings. A key goal of CFT is to prepare people to apply their knowledge flexibly, adapting prior understandings and experiences to fit the needs of new situations that often differ radically from the initial conditions of learning ("transfer" in cognitive and educational psychology). As such, CFT is a theory that puts a premium on *assembling* knowledge and experience as required by some new problem, text, or case (rather than relying on finding a stored "prescription" for how to think and act). We call these ensembles of knowledge and experience, drawn and then assembled from different learning occasions of the past, *schemas of the moment.* Again, CFT is a theory that emphasizes an adaptively creative response to new situations rather than the more mechanical following of routinized schemes that already exist in memory.

Goal 3: Changing underlying ways of thinking. CFT seeks to change not only the specific knowledge that an individual acquires but also—and more important—the underlying worldviews (epistemological beliefs, habits of mind) that an individual employs when approaching the acquisition and use of knowledge. The kind of knowledge one constructs, and the way that knowledge is deployed, depends on the “lenses” that filter one’s view of the world. More often than not, we find that individuals’ worldviews are premised on assumptions of simplicity (single right answers, compartmentalized knowledge components, knowledge in the abstract and not tied to contexts of application, etc.) that interfere with the development of complex understanding and the ability to apply knowledge to a wide variety of real-world contexts. In order to deal with important complexities, one must have a mind-set to open perception, to look for multiplicity, for interconnectedness, for subtlety and nuance. Systems based on CFT are designed to achieve these aims.

Goal 4: Developing hypermedia learning environments to promote complex learning and flexible knowledge application. The tenets of CFT are the basis for the design of computer learning environments that provide the kind of nonlinear and multiperspectival organization of material necessary to achieve the first three goals. To paraphrase one researcher, a flexible medium can make possible a flexible cognitive “message.”

As our work and everyday lives become increasingly complex and more rapidly changing, the kinds of skills described in the first three goals have become most essential for us to instill in students and professionals. And yet they are the most difficult for us to teach (Feltovich, Coulson, and Spiro 2001; Feltovich, Spiro, and Coulson 1997; Spiro, Coulson, Feltovich, and Anderson 1988). In the twenty-first century, as all organizations become more horizontal and less vertical, with responsibility and individual initiative required at even low levels of job hierarchies (where workers are closer to the realities on the ground and thus have a better sense of the situations that must be responded to), getting a good job will require these skills and abilities. Fortunately, we now have technology, driven by learning theories that target difficult learning, that can enable the attainment of essential skills. It is a time of fortuitous confluence in needs and resources to address those needs.

Background and Principles

CFT had its origin in the mid-1980s (Spiro, Vispoel, Schmitz, Samarapungavan, and Boerger 1987; Spiro et al. 1988). That was a time when a dominant model of learning was *schema theory* (e.g., Anderson 1978; Ausubel 1968; Bartlett 1932; Bransford et al. 1977; Minsky 1975; Schank and Abelson 1977; Spiro 1980), an approach that placed a premium on using organized packets of knowledge in memory (“schemas,” or “schemata,” after Immanuel Kant; also sometimes “frames” and “scripts”) as a basis for understanding and applying knowledge. The problem we noted was that one could not have a prestored schema for everything that one might encounter

(Spiro and Myers 1984). Thus the notorious difficulty in producing “transfer,” the reconfigured use of old knowledge in new situations that differ from the initial conditions and contexts of learning.

CFT was developed as a successor to schema theories, one that would replace rigidly prepackaged knowledge structures with more open and adaptable ones—knowledge that would be applicable across the wide range of situations in which it might be required. This is a challenging goal because most domains of knowledge and all domains of professional practice (medicine, engineering, business, teaching) are made up of events or cases (real-world occasions of using knowledge) that are at best irregularly related to each other (we call these *ill-structured domains*). In most real-world domains, wide-scope abstractions and general principles do not account for enough of the variability in the way knowledge has to be used. Instead one must have experience with a large number of cases to see “how things go,” to see the different ways that conceptual knowledge is combined and applied in real contexts.

In order to produce such more open and widely applicable knowledge structures, it became clear that learning could not proceed in a single direction, organized into neat categories. Instead, CFT employs the metaphor of criss-crossing a landscape (Spiro et al. 1987, 1988; Spiro, Feltovich, Jacobson, and Coulson 1992a, 1992b; the metaphor was first used by Wittgenstein 1953, in the preface to his *Philosophical Investigations,* in a more limited context). In teaching and learning, one proceeds from case to case (example to example) following different routes of organization on successive traversals of the knowledge landscape. Sometimes one returns to the same site (case), but coming from a different direction, bringing a different set of perspectives. Thus different facets of each case are highlighted when juxtaposed to varying other cases (and seeing those multiple facets is essential in producing transferable knowledge). Thus, in CFT, *revisiting is not repeating.*

We soon came to realize that the best way to deal with this kind of nonlinear and multiperspectival learning and instruction is by capitalizing on the random access capabilities of computers (Spiro et al. 1988; we have at times referred to this kind of nonlinear teaching as “random access instruction”; see Spiro and Jehng 1990). Thus in 1987 we began an effort, continuing to the present day, to design cognitive flexibility hypermedia systems (CFHs), based on the tenets of CFT, for domains as diverse as medicine, high school biology, literary interpretation, military strategy, and teacher preparation. By using the criss-crossed landscape approach in the design of case-based learning environments we have been able to have some success in producing the often elusive finding of learning transfer (see, e.g., Jacobson and Spiro 1995). (To see hundreds of discussions, applications, and tests of CFT, some of which accurately render CFT and some of which do not, use a search engine such as Google with the following keywords: Spiro cognitive flexibility.)

Since its earliest days some of the principle tenets of CFT and its applications to CFH learning environments have been the following (Spiro et al., 1987, 1988, 1992a, 1992b, 1997; Spiro and Jehng 1990; Spiro, forthcoming):

Multiple knowledge representations. Knowledge that has to be used in many ways has to be represented in many ways. Whenever one sees a complex situation with a different conceptual "lens" or from a different perspective, new and important features of the situation are revealed. Thus CFT proposes a "principled pluralism" (Spiro 2001). This is not an anything-goes mentality but rather one in which new ways of assembling and applying knowledge from different perspectives that students provide must be accompanied by associated justifications with evidence drawn from the facts of the case. CFHs aid in this assembly and justification process. Furthermore, by constructing open knowledge structures and instilling a cognitive ethos of internal dialogue among alternative perspectives, applications of CFT permit individuals to become better prepared to participate in group and collaborative learning and prepare individuals to simulate the benefits of groups when they are alone and must think for themselves (Feltovich, Spiro, Coulson, and Feltovich 1996).

Interconnectedness. Conceptual and case knowledge cannot be "boxed" into separate mental compartments or presented in separate "chapters" always organized with the same "table of contents." In CFHs, it is as if the material was organized with a near infinitude of different organizing bases, different tables of contents. And each organization juxtaposes material in ways suitable to application to different kinds of cases, thereby supporting the goal of widely applicable or transferable knowledge. This is an important aspect of CFHs' *nonlinearity* of teaching and learning.

Context-dependency and conceptual variability. Conceptual knowledge is essential, but in real-world situations concepts are used in somewhat different ways, at different times, and in different combinations with each other. CFHs put a premium on illustrating the variable uses of concepts across contexts in order to prepare people to better apply conceptual knowledge on their own.

Cases and minicases. In order to prepare people to apply knowledge across a wide variety of real-world cases—especially when general principles do not provide an adequate basis for action—one must have experience with *many* cases. In order to accelerate the acquisition of that experience, CFHs make extensive use of minicases and employ the trope of *synecdoche* at the core of instruction. A synecdoche is a part-whole relationship; unlike metonymy (another part-whole trope), in which the parts of the whole do not resemble each other, in a synecdoche there is a microcosm-macrocosm relationship. By looking closely at a dense, well-chosen strip of a larger case, one gets a view of how things go over larger segments of the domain (much as is the case with fractals). To paraphrase another researcher, when we do not have the time or ability to show people an entire world of knowledge, the *only* way to see a whole world may be in a “grain of sand.” Of course, the world that is seen in any grain of sand will be incomplete and somewhat imperfectly rendered; in ill-structured domains, any microcosmic view will only partially capture the features of the macrocosm. Thus, as in all CFT applications (whether involving minicases or cases), criss-crossing in different directions is required to gradually build a more complete and accurate synoptic view of the complex whole. However, that building process moves forward with greater rapidity when appropriately chosen minicases, ones that are both rich and at the “crossroads” with many other parts of the domain’s landscape, are chosen for instruction.

Another benefit of organizing instruction around minicases (and then building to larger case structures) is that it solves a difficult problem in instructional sequencing: The traditional incrementalist approach, building from simple to complex, does not work because the early simplifications interfere with the later attainment of complex understandings (Fetovich et al. 1989; Spiro et al. 1988; Spiro, Feltovich, Coulson, and Anderson 1989; Feltovich et al. 2001). But to start with unbridled complexity would be confusing and discouraging to the learner. CFHs begin with “bite-sized chunks” of complexity, minicases that retain the basic features of complexity (e.g., multiplicity, interconnectedness, context-dependency, etc.). So the worldview of complexity is instilled from the beginning (instead of having an inappropriately oversimplified mind-set initially established and then having to be undone) but beginning with cognitively manageable amounts.

Thus there are at least three important benefits of a focus on minicases: (1) *experience acceleration* (more information is quickly conveyed about “how the world goes”); (2) a *new logic of instructional sequencing* that avoids initial oversimplifications that prove harmful in building more advanced understandings; and (3) *early establishment of complex underlying habits of mind* or ways of thinking. (There are many other benefits of the use of minicases, a list too long to go into here. See the extensive discussion in Spiro and Jehng 1990 and Spiro, forthcoming.)

New Directions

Currently, CFT has been developing most rapidly in the area of digital video cases for professional training, especially teaching. There is a large volume of work being done with video cases, and it is very valuable. However, that work has mainly involved showing, talking about, and archiving teaching cases. As important as these activities are, it seems clear that the bandwidth, both of the technology and the user, is not being sufficiently exploited. CFT is being applied in new ways to permit more *learning* to occur with video cases. Some of the special emphases of this work are the following (for a more detailed presentation of these new directions in CFT, see Spiro, forthcoming).

One of the most important aspects of the current work is the concentrated effort to *change underlying ways of thinking* (habits of mind, worldviews) toward those more compatible with complexity and flexibility (Spiro et al. 1996; we referred to these as “*prefigurative* schemas” in Feltovich, Spiro, and Coulson 1989 and Mishra, Spiro, and Feltovich 1996). Habits of mind are hard to change. We are employing various kinds of video special effects to alter perception, to get people to see more in a video case, to anticipate more complexity and then be able to detect it and work with it, learning to harmonize and organically balance the multiple agendas of complex activity. Our special effects are intended to *shake up* established ways of thinking, to call attention in the most salient ways possible to the various kinds of complacency of perception, thought, and action that so frequently are observed. When a learner habitually looks at one part of a scene, we put a spotlight (figuratively, and sometimes literally) on the periphery of habitual vision to redirect the gaze and make it more encompassing. When some pat way of thinking is induced during the course of a case, we use video techniques to create *dissonance,* to get people to say “But wait! It’s not that simple!”

Another important aspect of current CFT media applications is their return to an earlier emphasis of CFT on making use of *experiential* modes of representation to convey *conceptual* information (Spiro 1980; Spiro, 1982a, 1982b; Spiro, Crismore, and Turner 1982). We make greater use of nonverbal processing channels to convey additional complexity, including information about the trajectory of the ebb and flow of conceptual themes as they intertwine in the course of real-world cases. We call these representations *metaphorical experiential symbol spaces* (MESSes)—overlearned correspondences between conceptual information and perceptual symbols. Experiential modes of representation can be overlaid upon each other and upon conceptual/verbal understandings to capture more complexity without exceeding limits of cognitive capacity (think of how much complexity is encoded in a single image of a face; or how we can be saying one thing while seeing and feeling something else simultaneously).

Finally, and perhaps most important of all, is the current CFT focus on *experience acceleration.* It is commonly believed that it takes ten years of experience for a professional to attain a reasonable degree of expertise (Feltovich et al. 1997). We need to shorten that amount of time. By the efficacious arrangement of minicases and the use of new video techniques, that can be accomplished. In CFT, cases are revisited in different contexts to bring out other aspects of their multifacetedness. Since these revisited video scenes rapidly become *overlearned,* it becomes possible to present them in greatly attenuated form in subsequent criss-crossings, greatly accelerating the rate of case-based learning. (We call the learning that is related to previously overlearned parts of video cases that are *not* re-presented in subsequent presentations—that only employ increasingly smaller "stand-ins" for the rest of the case—the "along-for-the-ride" effect.)

This new media paradigm, accelerated criss-crossing of densely packed, distinctive extracts from overlearned minicases (case *signatures*), utilizes the kind of *quick-cutting* (sometimes interspersed with commentary) that is so pervasive in contemporary film, television, and advertising, especially that targeted for more youthful audiences (see also Stephens 1998). Although frequently bemoaned as an attention-attenuator, when appropriately applied for educational purposes it simply involves a *different* kind of attention, one better suited to complex nonlinear learning—and one that people thirty and younger are already highly accustomed to and often prefer. We expect this mode of presentation will become codominant with traditional linear and verbal instruction and training modes in the near future. We are utilizing this mode in a species of CFHs that we call *experience acceleration systems* (see Spiro, forthcoming).

The goal of all of this new work is to permit professionals in training to enter the messy world of practice better prepared to deal with the complexities they will face.

A Theory That Builds Bridges

Cognitive flexibility theory is not a competitor with other theories. It is, in a sense, a metatheory, a theory that builds bridges across theories and across curricular chasms that are too often left unreconciled.

CFT's principled pluralism bridges different paradigms and perspectives, allowing each to complement the others. CFT offers an organic *unity of diversity.* This is not an abstractive unity, which loses the particulars of the individual; rather it is a nonreductive unity in which a whole is formed that retains the diversity that was the basis for forming that unity. An apt analogy is the memory of a particular person's face, which we experience as a physiognomic whole (that is *that* person's face), but which still retains the cognitively recoverable diversity of features (and relationships among features) that comprise the incredible complexity of any face. CFT brings wholes and their complex conceptual aspects together, each contributing to our understanding of the other.

CFT bridges knowledge and practice by embedding each within the other, so the common problem of seeing the connection between the "basic science" and "clinical practice" parts of curricula (to use the analogy of medical education, equally applicable in any domain of professional training and most school subject areas) is mitigated.

CFT bridges cognitive and individualistic approaches, on the one hand, and collaborative, sociocultural, and situated views, on the other. CFT is inherently contextual in its method. And the kind of *open* knowledge structures it fosters are just the kind of noninsular understandings that best support and interact with collaborative and situated learning. A group is made up of individuals, and those individuals must possess the right habits of mind for the group to function at its best, habits of mind that CFT instills. And a goal of CFT is to make it possible for individuals to function alone, as sometimes we all must, with an internalization of the benefits of multiperspectival group dialogue—the group simulated within the individual mind.

Finally, CFT builds bridges between *standards-based* models and *constructivist* approaches. Too often teaching toward standards leaves students with memorized knowledge that is neither deep nor usable. Constructivist approaches too often leave the acquisition of some important aspects of knowledge to chance. With CFT, one can satisfy the goals of standards-based and constructivist approaches simultaneously while allowing the strengths of each to compensate for the weaknesses of the other. CFT marries standards with deep understanding and adaptive flexibility of knowledge application. Because CFT always ties constructive processes to a landscape of actual occurrences in the world (as best that objectivist ideal can be achieved or at least approximated—whether it is scientific data or the “data” of a literary text), it is a *realist* constructivism and thus in tune with the goals of standards advocates.

All of these things are necessary if we are to become a society of individuals who can master the complexity of the world around us, deal with the constant change we face, and perform the kinds of twenty-first-century jobs that will require independent, adaptive, and creative thought.

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See also

Cognitive Psychology; Constructivism; Hypertext; Learner-Centered Environment

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Cognitive Psychology

Cognitive psychology is the branch of psychology that attempts to understand how the mind works. More specifically, cognitive psychologists are interested in how the mind processes information, with a focus on underlying processes of attention, perception, learning, and memory. Cognitive psychology found strong roots as a reaction against behaviorism in the middle of the twentieth century, when behavioral scientists could not account for certain aspects of human behavior. Instead of seeing the mind as a collection of stimuli and corresponding responses, cognitive psychologists describe the mind as a processor with modules designed for various purposes. Cognitive psychology is closely related to educational technology because the computer has become the most recent metaphor for the way in which the mind processes information. Cognitive psychologists also use technology to try to simulate cognitive events. Finally, educational technologists draw on findings from cognitive psychology in the design, development, and implementation of technologies for teaching and learning.

In the early 1900s, John Watson began the behaviorism school of psychology. Arguing that the study of mental processes was unscientific, Watson and others (drawing on the experiments of Ivan Pavlov and Edward Thorndike) studied physiological responses to environmental stimuli. B. F. Skinner continued this line of research with a tremendous amount of experimental data, arguing that almost every aspect of human behavior is nothing more than a set of conditioned responses. Rewarding or punishing certain behaviors could program—or reprogram—these responses.

However, in the middle of the twentieth century, opponents of behaviorism provided evidence of various behaviors that could not be explained by simple conditioned responses. Among the most prominent of these opponents was the linguist Noam Chomsky. He wrote a review of Skinner's book *Verbal Behavior* in 1959 that argued behaviorism could not account for certain aspects of language. He specifically cited accounts where subjects would utter *original* statements that were completely grammatically correct. This innate language component could not be explained by external stimuli or conditioned responses; nor could behaviorism explain anomalies such as improvisation and creativity in music and art. Along with being unable to account for these phenomena, researchers became frustrated with the methodology of behaviorism that limited their studies to observable events and behaviors outside the body and mind. These circumstances paved the way for the so-called first cognitive revolution.

To suggest that cognitive psychology started in the 1950s would be incorrect. The first psychologists, such as Wilhelm Wundt, William James, and Hermann Ebbinghaus, as well as early philosophers such as Aristotle and Plato, were interested in cognitive processes long before behaviorism. However, it is generally argued that the cognitive revolution gave birth to cognitive psychology or the interest in cognition—an exploration of the processes by which knowledge is gained.

There are numerous lines of converging and diverging thought that originated from this revolution—all of which explore the ways in which knowledge is perceived, stored, retrieved, and communicated. Therefore, attempting to summarize, synthesize, and select major theorists and theoretical underpinnings in cognitive psychology is a difficult task. Cognitive psychology is often thought of as fitting hand-in-glove with information-processing theory, but the cognitive movement also gave birth to or aided in the development of such theories and areas of study as cognitive development, constructivism, schema theory, situated cognition, and cognitive science. George Miller and Ulric Neisser are credited for aiding the revolution with their important work, but theorists such as Jerome Bruner, John Dewey, and Jean Piaget were also pioneers in helping alter the zeitgeist. Some of these theories and their philosophers focused on the internal processes and rules we are born with. Others valued how knowledge is acquired. Most current psychologists agree that we need to draw on both arenas.

Needless to say, cognitive psychology has given rise to a number of novel approaches to learning and teaching, as well as a number of educators, psychologists, theorists, and philosophers who have pushed how we view cognition. The most recent event in the history of cognitive psychology is the advent of the second cognitive revolution. An interest in the individual and how the individual processes information is one tie that binds all of the earlier cognitive approaches. Philosophers and theorists, drawing on Russian psychology and psychologists such as Lev Vygotsky and Alexander Luria, are now beginning to value context and the cultural and social-cultural adaptations, semiotics, and tools that play a role in our cognition. This second cognitive revolution has given way to social-cultural, cultural-historical, social constructivist, distributed cognition, and situated cognition theories, as well as new psychologies such as cultural psychology, narrative psychology, and discursive psychology.

Due to the reciprocal and substantial relationship with neuroscience, philosophy, anthropology, education, psychology, sociology, and so on, understanding the role of cognitive psychology in educational technology is also a daunting task. However, there are three significant relationships we can identify. The first, and perhaps the most recognized, comes from viewing the computer as metaphor for the mind. In an information-processing approach to cognition, the mind is viewed as an information-processing machine—much like that of the computer. The body takes in information from the senses, processes it (decoding), and then produces output. Acceptance of this metaphor has prompted an interest in artificial intelligence, where humans try to get machines to perform human mental tasks.

A second relationship, drawing on the first, is the use of computers to try to explore and understand human mental processes. Computers, and other technologies, have been used to measure such things as attention, memory, and sensory perceptions. They have also been used in areas such as reading to study behaviors like eye movement.

Perhaps the most salient for our discussion of educational technology is the third significant relationship, which adopts a very broad definition of cognitive psychology. With the cognitive revolution, new theories of learning were devised and applied to new perspectives on teaching. For instance, theorists now recognize the importance of scaffolding and the need for feedback. Technology became a way to support the kind of pedagogical approaches that may not have been possible in traditional educational settings. For instance, certain cognitive approaches suggest that students need personalized and individualized feedback. Most teachers do not have enough time or enough assistance to complete such a task in class. However, certain technologies have been built to support immediate (just-in-time) and yet individualized feedback. Other pedagogical perspectives have suggested that discursive practices with students from outside the student's culture would enrich learning. Online technologies allow this type of learning to take place—learning that would have been *possible* but not *probable* otherwise.

This third relationship is double-sided. Educational technologies make it easier to apply findings from cognitive psychology and its related fields. However, educational technologists also draw on cognitive findings to design and develop new educational technologies. For instance, we know that information must be divided into chunks to be most easily appropriated. We also know that multimodal sensory inputs (text with graphics and video) can be more reinforcing than just text alone. Thus, the relationship between educational technology and cognitive psychology is beneficial, due in part to its recursive relationship.

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See also

Behaviorism; Bloom, Benjamin S.; Bloom's Taxonomy; Bruner, Jerome S.; Cognitive Apprenticeship; Constructivism; Gagné, Robert Mills; Instructional Design

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Collaboration and Negotiation Tool for Case-Based Instruction (CoNet-C)

The Collaboration and Negotiation Tool for Case-Based Instruction is an online discussion tool specifically designed to support case-oriented small-group discussion. The tremendous interest in group work and learning with computers has led many scholars to explore how networked technology can be used to create learning environments that promote discussion and collaboration. Many instructors and designers are familiar with generic Internet technologies for collaboration, such as bulletin-board systems, chat technologies, and e-mail. Yet few guidelines are available to help software designers and instructional designers develop online collaborative environments that support specific teaching and learning activities, such as problem-based learning or case-based instruction. The major goal of the CoNet-C project is to provide a feasible online discussion environment to support case-based instruction through the achievement of the following objectives: to facilitate students in participating in meaningful small-group peer interactions, thereby enhancing their online learning; to assist teachers in managing and guiding small-group online discussions efficiently, thereby enhancing their online teaching; and to allow researchers to conduct experimental study of online discussions efficiently, thereby enhancing their online research.

The Internet has become one of the most popular delivery methods for distance teaching and learning in contemporary society. Current models of instruction emphasize opportunities for students to articulate and reflect on their knowledge, interact with peers and teachers, and approach material from multiple perspectives. Educators and researchers have been trying to incorporate existing instructional theories and knowledge into online instructional environments in order to improve online learning and teaching. Among various instructional strategies, online discussion has been one of the most popular instructional methods. In non–face-to-face teaching environments like online instruction, online discussion provides an essential and unique way that teachers can interact with their students or have students interact with one another. Because of the importance of online discussion, most online course management systems widely used in colleges (e.g., WebCT®, Blackboard®) provide online discussion tools that allow teachers to create discussion forums for certain topics and assignments. In the discussion forums, students can exchange opinions with their peers.

Recently, with the emergence of blended or hybrid courses at the postsecondary level (i.e., courses that blend in-class and online learning experiences), even onsite instructors who teach their classes in regular classrooms often use online discussion as a supplementary instructional method. Many instructors believe that online discussion can be an effective instructional method to promote small-group interaction when they have larger-sized classes with limited time for in-class discussion. Therefore, online discussion can become an important instructional method in regular as well as online classrooms.

Despite the popularity and importance of online discussion, existing tools have limitations because of their inherent general-purpose functionality. Thus it may be difficult for teachers to create a certain discussion setting in which they can guide meaningful discussion in a way that corresponds with their specific instructional methods and goals. For example, an online discussion setting in which teachers want students to communicate with each other to complete group projects should be different from a discussion setting in which teachers want students to review various small cases or problems and discuss them as a small group. Therefore, it is important to develop discussion tools that provide customized online discussion capabilities that are compatible with a variety of instructional methods.

Goals of the Project

The overall goal of the CoNet-C project is to develop an online discussion tool aimed at supporting case-oriented discussion. In the design and development of the online discussion tool, at least three major groups of users were considered: learners, instructors, and researchers. CoNet-C is designed to be adaptive and tailored to these three different user roles. In terms of learners, CoNet-C helps learners focus on the given problems or cases for discussion and to participate in small-group discussions more effectively. The discussion tool is also designed for teachers to manage online discussions easily. For example, teachers can assign a certain problem or case to individual students in small groups for a particular period of time. Finally, CoNet-C includes features designed for researchers who are conducting experimental study in online discussion. Researchers can manipulate online treatment schedules and collect data through a special interface. CoNet-C is an extension of the Collaboration and Negotiation Tool (CoNet) project, which was originated by Susan M. Land at Pennsylvania State University in 1997. Since then, various versions of discussion tools have been developed for different orientations of online instruction, such as project-based instruction and case-based instruction at the college level.

A Prototype of the Discussion Method

CoNet-C was implemented in the context of an undergraduate course in turfgrass management taught by Alfred J. Turgeon at Penn State. In this online class, students studied a series of online lesson modules at the introductory level of turfgrass management. While completing the modules, they worked on five open-ended case problems related to turfgrass management.

Turgeon created and used a modified jigsaw discussion method for his turfgrass management class, which became a prototype for the interface design of CoNet-C. With this approach, each student is assigned to a small group of four to six members before the discussion begins. The instructor assigns different cases or problems to different members in a group. Each member generates her own solution to the given problem or case. Then, within a small group, each member shares the assigned problem and the solution with her peers. Each student should lead the discussion by replying to all questions from peers or by defending her position from group members' challenges. After finishing all discussion, all members within a group revise their initial solutions based on what they have learned from others in that group. After sharing final solutions with peers, they close the session of discussion.

The interface of CoNet-C has three main interfaces: learner, teacher, and researcher. These are designed to support discussion activities that are reflected in the jigsaw method described above.

Learner Interface

The main emphases in the design of the learner interface were to minimize navigation problems during discussion and to generate a customized interface. Thus, we tried to design an interface that could seamlessly integrate students' dual roles of both problem-solvers and peer-reviewers in discussion.

Once students log on to CoNet-C, they are led to a customized main page, where they can review the assigned problems and interact with their small group. Students can participate in a certain forum of discussion by navigating through the group members' names and discussion sessions. This navigation structure, based on members' names and discussion sessions, can reduce students' confusion in locating a particular forum and prevent interference among topics or forums.

Through the customized main page, students can find their own rectangular boxes at the top of the screen; the remaining boxes are their peers' areas. Within her own area, the student can review the assigned problems, create and revise her own solution to them, and lead discussions about her solutions with peers. By clicking on others' solution areas, she can review peers' solutions to the given problems and discuss them. For all interactions, CoNet-C identifies the learner's authority to either read or write in a certain area. For example, a student can revise her own solution; however, the same person cannot change her peers' solutions, only review them. Therefore, this interface helps students focus on discussion topics and to interact with peers efficiently.

To assist students in discussing their solutions and to provide constructive feedback to peers, a series of guiding questions was designed to serve as prompts. These guidelines were embedded into the discussion tool to facilitate learners' generation of critical questions and comments that might help improve peers' solutions. Some question prompts were generic (e.g., "Could you please give specific examples of that?") and others were more specific ("How would your answer change if all chemical application had to be made by licensed professionals?") in order to support a range of responses.

Instructor Interface

The main focus in the design of the instructor interface is to minimize the instructor's load in managing discussion activities, such as forming small groups, assigning problems to individual students, scheduling discussion sessions, monitoring discussions, and so on.

CoNet-C provides a comprehensive interface for supporting instructors to manage discussion; through this interface, instructors can easily form small groups, assign particular questions to individual students, open discussion sessions in a certain period of time according to their class schedules, and monitor all of the small groups' discussions. Most important, CoNet-C provides a database so instructors can create and revise discussion cases or problems and assign them to individual students. Once instructors create a problem or case database, the problems/cases can be utilized for discussion in classes.

Researcher Interface

Researchers share the identical interface with instructors; however, there are some advanced functions for research purposes. The main focus in the design of the researcher interface is to assist research activities such as treatment control and data collection. Besides forming small groups, researchers can assign individual students or groups into either experimental or control groups, and they can manipulate different interventions for different groups. Thus during certain discussion sessions, students can receive different treatments online. Also, all student interactions and their evolution processes in forming solutions are kept in a computer database. Thus researchers can retrieve all necessary information for their particular research purposes. For example, while students can see only the latest version of their solutions to given problems, researchers (and instructors) can retrieve all previous versions of their solutions and analyze how students' solutions have evolved throughout their peer discussions.

CoNet-C System Structure

There are three basic structures of the CoNet-C system. Three major databases hold students' information, discussion problems/cases, and peer interactions.

By incorporating these databases, instructors create particular discussion settings in which students participate in small-group peer discussions. While students participate in assigned discussions, CoNet-C refers to these databases continuously to provide customized discussion interfaces for particular users.

Design Experiment and Implementation

CoNet-C has been successively tested in college online classrooms and redesigned based on feedback from students, instructors, technical supporters, and other stakeholders. This broadened approach is based on the notion of a “design experiment” whereby technology innovations are studied within real contexts and where the innovations, students, and teachers can adapt themselves through iterative implementations to enhance learning and teaching. Through this approach, an online tool was developed to assist instructors in organizing effective discussion environments; practical ways were also found to help instructors incorporate new technology innovations into their daily classroom settings. For example, criteria for grading need to be tied directly to participation in discussion. Criteria should include points for responding in a timely manner and for providing the expected quantity and quality of postings. Cases or problems to be discussed must be open-ended enough to encourage diverse points of view. Providing case problems that were either too simple or focused (i.e., only one correct answer) led to limited interaction and discussion. Studies suggest that students infrequently referred to the supplemental guiding questions; therefore future implementations should make this feature more prominent, as some students reported difficulties in the process of generating constructive feedback. In addition, students who used the guidance perceived that it made asking questions easier, which in turn improved the quality of their feedback. Most students reported that they preferred the CoNet-C interface to a generic discussion tool because it was easier to write and revise solutions for each separate case discussion.

The instructor reported that the case/problem database saved time in assigning problems to students because it reduced the need to retype or repost cases/problems. He also perceived CoNet-C to be a tool that supports teaching and learning in addition to online discussions. Future research will be designed to extend the contexts in which CoNet-C is studied to support generalization and to collect additional data regarding how students learn from asynchronous discussions and the problems and processes they experience in this endeavor.

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See also

Collaborative Technologies; Computer-Mediated Communication (CMC); Distance Education; Online Learning Communities; Web-Based Instruction

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Collaborative Technologies

Collaborative technologies defines an area of research and development that examines the overlap between collaboration, a strategy for working together, and technology—the practical application of knowledge to extend human capabilities. Effective collaboration requires four key elements: (1) verbal and visual communication; (2) written communication; (3) coordination/management of the collaboration process; and (4) management of resources used or created throughout the collaboration. Collaborative technologies are designed to facilitate communication, coordination, and management in a variety of situations and to reduce constraints or compensate through technology for aspects of the collaborative process that are more difficult when participants are at a distance. Modern collaborative efforts in business, industry, education, medicine, or the military are used to cope with external competition that in many organizations is both local and global. Those organizations that utilize the capabilities provided by new collaborative technologies will increase their odds of survival.

Imagine a collaborative team working on a project in which all team members are in the same cluster of offices. There is a shared file cabinet where documents are stored, signed out, updated, and returned. Project questions can be answered by a quick walk down the hall to meet with a fellow team member. Team meetings are brief, focused, and effective. Project milestones are posted on the wall where everyone can see them daily.

Now imagine a collaborative team working on a project where team members never meet in the same physical space (e.g., a small company employing contract professionals, or a large company with team members from different parts of the organization—marketing, design, manufacturing, human resources, etc.—situated in different parts of the country, or a multinational company with team members scattered around the world in different time zones and speaking different languages). These teams will need to utilize robust collaborative technologies to engage in the project activities listed above.

There are many collaborative technology products and systems currently available with combinations of features and capabilities. In general, there are systems that use intranets (a private, secure network) and applications that use the capabilities of the Internet.

Team members using the same corporate network, even those in different buildings and different cities, could use a network-specific collaborative product. Several major companies offer products in the intranet area, and new products are constantly being introduced. Applications and systems that support collaboration over the Internet are particularly useful when the team does not have a shared corporate network. New systems and applications to facilitate Internet-based collaboration are also being introduced frequently. For intranet or Internet approaches to work it is critical that the communication and computer systems be compatible with each other and that all members of the collaborative team have the skills and knowledge necessary to utilize the technology as a full participant. The next section identifies selected technologies that contribute to an effective collaborative environment using the four key elements as a framework.

Verbal/Visual Communication

The most mature technology in this category is voice communication. This includes telephone conference calls, Internet telephony, and voice-messaging systems that provide integration with mobile devices such as cell phones and pagers. Although the technology for video telephones has been available for decades, problems with image quality and the need for high bandwidth have slowed adoption. The most common technology for visual communication is videoconferencing. This technology ranges from one-to-one conference calls using desktop video systems, one-to-many using a broadcast system, or many-to-many where all participants are visible to all other participants. In the latter situation, the system should provide the participants with the ability to electronically “raise a hand” to get the attention of the current speaker or individual in control of the collaborative session.

Document cameras are used to display a digital video image of a three-dimensional object for all participants as well as support for scanning and storing of two-dimensional images. The verbal/visual communication technology should also support the sharing of multimedia presentations (video clips, slide shows) using applications that are available to all participants. Visual communication between participants is enhanced through the use of a virtual whiteboard that allows participants to share information in real time.

Written Communication

Electronic correspondence (e-mail) is essential, although some correspondence may still be shared using postal or messenger services. Thus the system should be able to send and receive Internet e-mail as well as e-mail from a corporate network, manage messages (including the ability to recall or unsend a message), provide a history of messages received, display message status (received, opened, replied, forwarded), set up folders, search messages, and sort messages by various criteria. The system should support specific workgroup conferencing (small groups) with the same features as the general e-mail application, including the ability to attach specialized documents (spreadsheets, scanned documents, blueprints, etc.) and executable files (computer code) to an e-mail message. Members of the collaborative group should be able to use distribution lists to send the same message to all team members. Online (threaded) discussion forums can be used to share ideas and concerns on all aspects of the project, and when the written correspondence is a web document, the system should support hyperlinks within files and messages. Clicking hyperlinks should launch a web browser and take the reader to the linked content.

Coordination and Collaboration of the Cognitive Process

Documents developed using project-management applications need to be available on the network so that all participants can see the tasks to be performed, responsible individuals, overall timelines, and specific milestones or deliverables. The project-management system should be flexible enough to adjust project elements based on actual reports from participants, the shared version on the network should be the most current, and changes by one member to a specific task should be automatically communicated to all participants or subprojects linked to that task. The system should maintain a log of all activities related to the projects and provide a mechanism whereby team members can vote electronically on specific topics and/or questions. A shared scheduling system should be used by project members to arrange meetings and calendar events, (holidays, vacations, etc.). Information in the collaborative system should be open to authenticated members using as a minimum user ID and password. Biometric devices (thumbprints, retinal scans) and smart cards with embedded computer chips may replace this form of security. When data is moved between members of the collaborative system (i.e., over the Internet) some form of data encryption should be available.

Management of Resources Used or Created throughout the Collaboration

Participants should be able to view, create, modify, review, mark up, and revise documents. The system provides a document storage capability (a database with project documents) and automatic data backup and archiving that would allow multiple users to work on different versions of the same document at the same time, offer an “oops” capability (i.e., undo changes), as well as full restoration to an earlier version. There should be an audit trail of changes to identify who did what and when to the document.

Team members should be able to search the files, notes, and/or discussions stored in the collaborative environment using a variety of keyword identifiers. Computer applications used to produce documents or components of the project should be stored on the shared server and be available to team members. The system should support the use of electronic forms with drop-down selections to make data entry easier and less prone to errors. Some users may need to manipulate an application or system from the command line. Advances in graphical user interfaces have reduced the need for this functionality except in situations in which the participants have a high level of programming expertise.

A collaborative system with all of these features would require abundant bandwidth or a dedicated communications network, as well as high-end computer processing power. These systems are usually the most expensive.

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See also

Communities of Practice; Computer-Mediated Communication; Knowledge Management; Performance Support; Telecollaboration and Teleresearch

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Communication Theory

As a field of research, communication is relatively young. In the 1940s researchers departed from sociology, anthropology, and psychology to develop the first theory that focused on the *messages* exchanged between people. This theory (communication theory) was the formal beginning of the study of communication processes. Communication theory describes communication as a process in which individuals exchange messages and interpret the meaning of those messages. Today, communication theory is still used as the basis of how communication is viewed and researched.

In 1949 researchers Claude Shannon and Warren Weaver forwarded the first model of communication, making the field of communication distinct from other social sciences. The Shannon-Weaver model of communication has been slightly modified over the years; however, the basic components and appearance of the model remain the same. It is important to note that although the Shannon-Weaver model was initially intended to describe the media communication process, such as the use of the radio to transmit messages, the model is now used to describe virtually all forms of communication, including face-to-face communication.

Based on the Shannon-Weaver model, communication theorists today generally identify eight components of the communication process: source, receiver, encoder/decoder, message, channel, field of experience, noise, and environment. The *source* is the person who sends the message, and the *receiver* is the person who receives the message. Many researchers note that we rarely take turns sending and receiving messages; instead we are in the constant state of sending and receiving. The *messages*, often referred to more broadly as “symbols,” need to be sent through some sort of channel. Thus if a teacher (source) has a message for his students, the teacher must determine a channel, or method, to send the message. The message might be sent through talk, or a note, or an e-mail. Some messages are sent nonverbally, that is, without words. Examples of nonverbal messages include body language, pictures, facial expressions, and dress.

These symbols must be converted into meaning through the processes of *encoding* and *decoding.* As Shannon and Weaver first intended in their theorizing, encoders and decoders can be centered in the technology of the medium. For example, an operating system on a personal computer encodes and decodes the symbols of computer language into pictures and words that the typical user can understand. Today, we look at individuals as also having an encoding and decoding process in communication. Each message an individual sends and receives is interpreted, or decoded and encoded, for better understanding.

Every person has a *field of experience* that shapes the interpretation, or encoding and decoding, of messages. A person with technology experience might choose e-mail as a primary channel of communication. However, a person with little computer experience might feel frustration when trying to retrieve an e-mail. The frustration felt by the source of the message can influence how that person interprets the message. Culture is an important component when considering a person’s field of experience. For instance, in some cultures eye contact is an appropriate communication behavior, whereas in other cultures eye contact is a display of disrespect. Therefore, the norms and customs of differing cultures can influence how people perceive messages.

The *environment* in which the communication takes place can also influence the sending and receiving of messages. Although communication sometimes takes place face to face, with the source and the receiver sharing the same environment, sometimes communication takes place over time or space, and the participants have different environments. During a phone conversation, for example, one person can be in a noisy house, unable to attend to the messages, while the other person can be in a quiet environment ideal for holding a conversation. Environment influences the communication process.

Communication is not a precise science, and messages are not always received exactly as they are intended. Anytime there is interference in the communication process, *noise* occurs. Interference, or noise, can take place through any of the elements in the communication process. Noise can be within the source or the receiver. There is noise if a person's field of experience leads to a misinterpretation of a message. Noise can also occur in the channel. For example, a person's cell phone might cause noise if there is too much static to hear the messages clearly. Noise is the result of what we commonly know as miscommunication.

When considering the parts of the communication process, it is important to note the synergy between the elements. Each element has an impact on the other elements. When one chooses the channel to send the message, one must also consider the environment, the message, the receivers, and the receiver's field of experience. Advertisers are experts at considering the impact each component has on the other components. When advertisers need to market a product, they consider the audience they are targeting and find the appropriate channel in light of the audience's experiences and environment. Not one of these communication elements stands independent of the other elements.

In addition to the Shannon-Weaver model of communication, the middle of the twentieth century saw the rise of the *magic bullet* (or *hypodermic needle*) theory. The magic bullet theory describes the process of sending messages through a medium as similar to sending out a bullet to an audience, or injecting an audience with a message. Although the theory was first developed in the nineteenth century, the increased attention to propaganda during World War I and World War II brought the magic bullet to the forefront of communication theory. During this time, it was believed that sending out a message through a war poster, for example, would hit an audience and bring about a desired change. Thus in this early view communication was essentially thought of as being one-way: sender to receiver. Today, however, with Nielsen ratings, opinion polls, and interactive media technology, we view communication as a two-way process. The two-way process enables us to determine if a message brings about a desired response. Therefore, if a politician's campaign is not translating into support, the campaign committee can analyze the audience feedback, change the campaign, and resend the new message.

The *diffusion of innovation theory* further describes the process of changing a message that does not receive the desired response. The founder of diffusion of innovation theory, Everett Rogers, explained that diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system. An “innovation” can be any product, concept, or idea that is perceived as new. A college course taught at a distance via computer, for example, is an innovation that is being adopted by many institutions. Rogers (1995) developed a diffusion of innovation model composed of the following six main concepts:

1. Communication channels are the means by which a message is transmitted from one person to another.
2. When messages concerning a specific innovation are transmitted from a source to a target member, *the innovation-decision process is initiated.* This process is a sequence of decision points through which a target member passes. The sequence starts with *knowledge* or awareness of a potential innovation. The target member is then *persuaded* by information from a source and forms a favorable or unfavorable attitude toward the innovation. The next step is the *decision* to adopt or reject the innovation. If an adoption decision is made, the target member then *implements* the innovation. Finally, *confirmation* occurs when the individual seeks reinforcement for the innovation-decision that he or she has made.
3. *Homophily* refers to the extent to which people are similar.
4. Perceptual *innovation attributes* are relevant to the innovation-decision process: (a) relative advantage (i.e., the advantages of adopting the innovation versus the costs of adoption); (b) compatibility (is the innovation consistent with the values, past experiences, and needs of the target member?); (c) complexity; (d) trialability; and (e) observability (the degree to which the results of an innovation can be observed by target members).
5. *Adopter categories* describe the degree to which an adopter is relatively early or late in adopting relative to other members in a social system.
6. Opinion leaders are people within a given social system who are able to influence other individuals’ attitudes or behaviors in a desired way with relative frequency.

Given the diffusion of innovations framework, we can follow how an idea or product is initiated, adopted, or rejected.

The role of current communication theory, in general terms, helps us to answer the *how* and *why* questions about the communication experience.

More specifically, the goals of communication theory can be to *explain, understand, predict,* and *cause social change* (West and Turner 2000). For example, communication theory can *explain* our patterns of TV viewing or explain how people interpret visual images. Communication theory might also help one *understand* why we are persuaded by a politician's speech, or why people sometimes do not believe bad news. At times, we are able to *predict* something based on communication theory. Based on certain theories, we can somewhat predict if a couple will stay together, or if a particular student will have a favorable experience with a particular teaching style. Finally, communication theory can promote *social change,* as when it is used to guide principles of education entertainment. Some theories uncover problems and recommend methods to remedy those problems. For example, the government of a country struggling with an AIDS epidemic might include safe-sex story lines in a popular soap opera to educate the audience. In this case, communication theory provides a method to change the behavior of TV viewers and, in turn, promote social change.

Technology and communication theory are explicitly linked in numerous ways. As we use technology to replace face-to-face communication, we need to modify prior conceptions of the communication process and develop new theories to reflect the increasing adoption of technology in daily life. The prevalence of technology will also demand communication researchers to analyze which innovations are adopted by an audience and how those innovations will work as methods of diffusion. The adoption of communication technology is both an innovation and a method of diffusion that impacts all parts of the communication process, from sender to receiver.

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See also

Diffusion of Innovations; Entertainment-Education; Instructional Communications

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Communities of Practice

The term “community of practice,” although recently coined, refers to an age-old social structure that occupies a mediating position between the individual experience of learning and the reproduction of organizations and societies at an aggregate level. The term is used to refer to a perspective on learning, and to specific communities that are observable in many settings, including the online world. The perspective itself, and careful observation of specific communities, suggest important design considerations for online learning.

The term was first proposed by Jean Lave and Etienne Wenger in their 1990 book *Situated Learning: Legitimate Peripheral Participation.* It arose from an examination of apprenticeship systems and included five examples from different cultural and social settings: midwives in the Yucatan, tailors in West Africa, naval quartermasters, meatcutters, and sober alcoholics. The book has been influential as a theory that situates learning in everyday social processes and considers institutions of learning (e.g., schools) as a special case. Although it does not define the term “communities of practice,” the book makes the argument that a community of practice is the primary unit for the propagation of knowledge and the reproduction of culture.

In a subsequent book, Wenger (1998) extends the conceptual framework to argue that communities of practice are also the primary unit for the development of new knowledge. He argues that in the case of apprenticeship the competence of the community pulls the experience of the novice until the novice has the full experience of competence; and conversely, the new experience of community members (e.g., in other communities or other domains or with new technologies) can cause the community to reexamine its assumptions and grow its practice: to learn. The book also contains an ethnographic study of claims processors in a large insurance company that serves as a reference point for the development of the theory.

During the late 1980s and 1990s, work in many different settings developed the practice of cultivating and supporting intentional communities of practice as part of the efforts to improve quality of life at the job, to improve product quality (and worker performance), and, finally, as part of an emerging discipline of knowledge management. John Seely Brown and Paul Duguid (1991) give a conceptual perspective and describe some practical outcomes in the context of a copier-repair community. Others (Wenger, McDermott, and Snyder 2002) gather considerable experience of community development and describe how a community-of-practice perspective can be a unifying view that provides a design trajectory toward human-centered knowledge management.

The Well and other online communities—where the principal practice was to converse and belong—made the idea of online communities quite fashionable in the 1990s. As the Internet grew and as online communities proliferated, it is useful to look at some of them from a community-of-practice perspective. Large-scale development projects (collectively, the open source movement) brought hundreds of programmers together to develop large systems such as Linux and Perl. The social hierarchy, the distributed responsibility, the steady innovation, and the visibility of individual performance produced many successful design and development projects and large-scale systems. They also produced a larger community that served the apprenticeship needs of the less experienced and moved the competence of the communities as a whole to new levels. Eric S. Raymond ("The Cathedral and the Bazaar," available online) describes the process.

Extrapolating from early adopters to online communities of practice that would serve other populations is not simple. Among other things, the practice of code development can be visualized and observed with existing Internet technologies, whereas most other practices, such as claims processing or midwifery, cannot. Grafting Internet technologies onto the ongoing practices of a community is not a trivial task (Wenger, McDermott, and Snyder 2002).

Theorizing about and carefully observing face-to-face communities of practice suggest ideas that may be useful to the design, production, and use of information and communication technologies for learning. Consider the following issues:

The association between learning and the classroom is questioned: "The class is not the primary learning event. It is life itself that is the main learning event. Schools, classrooms, and training sessions still have a role to play in this vision, but they have to be in the service of the learning that happens in the world" Wenger (2001). The physical boundaries of the classroom do not exist on the Internet. How can the design of online resources for learning support focused inquiry without re-creating the sequestration of a physical classroom?

If we consider practice to be a lens that organizes knowledge and learning, being clear about what practice a learning activity is to support becomes very important. The fact that the Internet makes the communication of information cheap and fast does not necessarily make the visualization of practice any easier. How can the engagement between the practice and the practitioner be made permeable so that peripheral community members have real access to a community's real practice without disrupting the work of practitioners?

From the perspective of legitimate peripheral participation, a community's thick boundaries are themselves meaningful social spaces for a student to traverse. These boundaries are not the province of admissions officers and the registration process but rather of learners who are making sense of the practice as they interact with other learners. The design of information and communication technologies for teaching must therefore consider the importance of social contact between all of the participants in the process. Social contact around and outside the classroom must be explicitly supported and provided for.

Wenger (1998) argues that learning, meaning, and identity are inextricably linked. This implies that the development of competence (i.e., learning) is necessarily reflected in a person's sense of identity. Thus Wenger argues that communities of practice are the means of producing our sense of personhood. The design of online learning environments must therefore consider whether the expression of competence through the completion of a test at the end of an instructional episode is an adequate expression of a new identity.

Wenger's (1998) is a middle-out theory that sees communities of practice between the internal experience of a person and the objective institutions of society. A consequence of this argument is that "no community of practice is fully capable of designing its own learning; and no community of practice is fully capable of designing the learning of another." This conclusion suggests two things: the importance of transparency and historical context in the design of learning resources, and the importance of negotiability in the exchange between learner and teacher.

John D. Smith

See also

Computer-Mediated Communication; Knowledge Management; Learner-Centered Environment; Online Learning Communities; Performance Support; Situated Cognition

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Community Technology Centers (CTCs)

Community technology centers are organizations whose primary focus is providing technology access to underserved populations in rural and urban environments. CTCs across the country service a wide range of individuals, from young children to senior citizens. Some have organized curriculums, whereas others are open to the public for walk-in use.

As the CTC movement grows, so do the funding opportunities. One major source of funding is the government, which offers grants through multiple departments. The U.S. Department of Education’s CTC program (www.ed.gov/offices/OVAE/AdultEd/CTC/index.html), which appropriated $64.95 million for the 2001 fiscal year, is one such funding opportunity. Grants through this program are awarded to individuals or organizations interested in establishing or expanding CTCs in urban and rural communities. Another source of funding comes from private foundations. The Microsoft Giving Program (www.microsoft.com/giving/) provided $104 million in cash and software to nonprofit organizations that aim to increase access to technology in economically distressed communities. Similar funding opportunities are available from other sources.

As with any type of training, there is a wide range of philosophies concerning the best way to instruct users on the effective utilization of technology. Some focus on teaching specific technology skills that can easily translate into employment opportunities. Others are more concerned with developing general technology understanding that can be applied to any specific technology skill. Both of these philosophies are being implemented in two main categories: CTCs that exist within an established organization, and those that stand alone.

CTCs located within existing organizations offer community development services in addition to technology access and education. One place they can be found is within housing facilities such as the Neighborhood Networks program from the Department of Housing and Urban Development (www.hud.gov/nnw/nnwindex.html). Another common location for technology centers is within public libraries, such as the National City Public Library in California (its Community Computer Center offers open access as well as introductory computer courses to the public). A third location for community technology centers is within faith-based organizations. The Association of Christian Community Computer Centers (www.ac4.org) consists of more than 250 CTCs that are housed in Christian organizations.

CTCs located within an established organization offer services that may include, but are not limited to, preschool and family programs, after-school and summer activities, adult education, workshops, job preparation, and career development, as well as technology access. CTC staff may direct the services and programs independent of other departments within a single organization. However, a major goal is to integrate technology into other community services. For example, the East Side House Settlement (www.eastsidehouse.org/technology.htm) in the South Bronx of New York City serves as an example of an organization offering technology access and education as well as other services. East Side House provides computers, telecommunications, and technology training through early-childhood, after-school, vocational, senior, and teacher education programs. The technology center includes five computer labs that are well equipped with up-to-date software. Students are instructed in word processing, spreadsheets, and databases for academic and professional purposes. Project READ is a literacy training program offered by the Redwood City Public Library in California. It provides computer-aided literacy instruction to participants through a variety of software packages. Students can access the software in a modern computer lab.

CTCs may also function as stand-alone technology centers. Such centers may carry out other services offered by traditional community centers through the learning of technology skills. Many stand-alone CTCs use technology to enhance reading skills, self-esteem, and team-building through curriculum-based computer courses. For example, Playing2Win (www.playing2win.org), located in Harlem, New York, contains two computer labs. It offers a variety of courses to clients, from basic keyboarding skills to multimedia design. Playing2Win also provides walk-in access for a small fee. A small group of high school students within this CTC comprise what is called HarlemLive (www.harlemlive.org). This program teaches web design, video production, and business skills through the creation of an online magazine of the same name. Another stand-alone CTC is Street Level Youth Media (streetlevel.iit.edu) in Chicago. This CTC has multiple locations throughout the city that allow teenagers to create multimedia video projects. The main goal of this program is to provide disadvantaged youth safe and fun opportunities to learn with the hope of keeping them away from gang involvement.

Tamara R. Pearson
Aisha I. Wood

See also

Digital Divide

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Component Display Theory

Component display theory is an instructional design theory in that it is a method for designing and developing instruction (Reigeluth 1999). The key contribution of component display theory was to extend the model of computer algorithms and data into the instructional world by metaphor, where instructional strategies or teaching methods are treated as algorithms and domain content is modeled as data. This separation of content and strategy is frequently regarded as the theory’s key contribution.

Although its theoretical foundations are earlier research in concept learning (Merrill 1994), component display theory grew to maturity and was first implemented in the context of the Time-Shared Interactive Computer Controlled Information Television (TICCIT) project. In order to fully understand component display theory, one must turn first to TICCIT.

In 1972–1973 Victor Bunderson at the University of Texas was awarded a large grant to study learner control in the context of interactive television. Together with MITRE Corporation, Bunderson began work on the TICCIT project. Shortly after the grant award, David Merrill convinced Bunderson to bring TICCIT to Brigham Young University, where they would work together.

Building a principled mechanism that effectively allowed learners to control their path through instructional content proved more difficult than originally imagined. Eventually Merrill and a small committee of graduate students were tasked with solving the learner control subsystem problem. Because the team felt that the problem was one of systematically generating alternative strategy options, they worked from an algebra metaphor in which different types of instruction could be represented as variables to be added together, or concatenated, to effect specific learning outcomes. This meant devising a taxonomy of choices: Between what alternatives, or categories of strategy building blocks, would learners choose when exercising learner control? Merrill privately arrived at a two-by-two matrix that provided a separation of content and strategy and called a public meeting of all department faculty and students to announce his discovery. (This meeting was the first time any other members of the team heard the component display theory terminology.) TICCIT message authoring templates were created for each of the primary presentation forms, which made authoring content very quick. Later, several screen templates were also designed so that the screen layout and screen sequencing (in cases of multiple screens of messages) could be determined by formula through associations between authoring templates and screen templates. In this way content authored correctly would simply “run” in the screen templates.

In addition to the primary presentation forms, which are the core of component display theory, the TICCIT system also offered varying levels of difficulty for the learner to choose: easy, medium, and hard versions of the generality statement, and easy, medium, and hard (to understand) instances.

Learner control of the difficulty of instruction and other system features was enabled by a specialized keyboard, with keys labeled “Rule,” “Example,” “Easy,” “Hard,” and so on.

Merrill’s team produced a number of sequences, including what they called the all-American instructional strategy: a rule statement followed by an example statement followed by practice, with help available at any point along the way. TICCIT help was implemented as a huge state-based decision tree: If a learner missed a hard practice item, had he seen the hard rule and hard example? Had he successfully completed the medium-difficulty practice? Remediation was carried out by sending the learner back to the immediately previous uncompleted screen.

Initially, the project called for several such predetermined sequences of strategies (such as rules, examples, and practice opportunities) to be designed and implemented. Merrill’s breakthrough on the learner control problem came when he realized that the block sequence of strategies was too coarse a grain and that learners needed control over the individual strategies (e.g., choose an example now and a rule then) instead of the larger sequences of strategies. It was like deciding to deliver bricks on demand rather than walls on demand. This resulted in the system opening up and learners gaining control at the level of individual strategies.

Component display theory was an extremely significant contribution to the field of educational technology, as it represented one of the first successful attempts to separate instructional strategy from instructional content. CDT is also an intellectual parent of many other important instructional theories, including C. M. Reigeluth’s *Elaboration Theory* and Merrill’s later *Instructional Transaction Theory*. Instructional Transaction Theory further specifies the format in which the instructional content is to be expressed (knowledge objects) and the ways in which prespecified strategies (instructional transaction shells) should operate on knowledge objects. In this regard, Merrill, Bunderson, and other members of the TICCIT team foresaw the late 1990s learning objects movement.

David Wiley
Andy Gibbons

See also

Elaboration Theory of Instruction; Instructional Design; Learning Objects

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Computer-Assisted Instruction (CAI)

Computer-assisted instruction occurs when an instructional program is delivered to a learner using a computer. CAI is sometimes considered a type of computer-based instruction (CBI), which refers to any form of computer use in an educational setting, including instructional programs, tutorials, simulations, instructional management, supplementary exercises, programming, and productivity software applications such as word processing and spreadsheets. CAI and CBI are often synonymous, the former sometimes in a more restrictive sense to refer to drill-and-practice, tutorial, or simulation software used for stand-alone learning activities or as supplements to teacher-directed instruction. CAI may also describe the instructional program itself or the delivery of the instructional program by a computer. CAI is sometimes known as educational software and courseware when packaged as a comprehensive curriculum with management and assessment features. In a typical CAI session the student sits in front of a computer, which presents information on the screen. The student reacts to the information presented by working with the mouse and/or keyboard. The pace of instruction may be controlled by the student, who may have control over the sequence of instruction. At certain points in the program, the student responds to questions posed, and the program notifies the student whether the response was correct or incorrect. In more complex CAI settings, the program may also keep track of the number of correct and incorrect responses and adapt the sequence of instruction according to performance throughout the program.

The primary advantages of CAI are that it allows learners to work at their own pace, controls the flow or sequence of instruction, and provides immediate feedback. More sophisticated forms of CAI adapt instruction to individual learner needs by varying lesson content, instructional sequence, and level of difficulty for each lesson as well as revising the types of feedback. These revisions may be accomplished while the learner is completing a lesson. For example, the computer may select and present math problems at varying levels of difficulty in response to an initial diagnosis of each learner’s mathematics ability. Once an assessment is made, the control processes of the instructional program utilize feedback from the learner to continuously refine the estimate of the learner’s progress.

CAI had its beginnings in the 1950s when educational researchers attempted to solve learning problems by applying the techniques of behavioral analysis as theorized by B. F. Skinner through programmed instruction (PI). The concepts of PI were then applied to crude teaching machines that first appeared in the late 1950s and early 1960s. PI and teaching machines were used throughout the 1960s by colleges, public schools, and the military. PI never achieved a high degree of popularity in schools, possibly because it was monotonous and did not fit well with group-oriented, fixed-schedule school settings. Early efforts to use computers in instruction, however, emerged from the guiding principles of PI. In its early forms CAI was an integration of computer technology and the PI movement.

Among the original CAI models to emerge was a project under the direction of Patrick Suppes at Stanford University. The Stanford Project was begun in 1963 to develop a tutorial system for instruction in elementary mathematics, language arts, and reading. By the end of the second year of operation approximately 400 students received daily CAI in either reading or mathematics. As a direct consequence of the Stanford Project and the need for curriculum-relevant CAI, Suppes formed a company (Computer Curriculum Corporation), which marketed courseware for minicomputer systems. Suppes advocated the creation of many articulated programs instead of isolated topical lessons to effectively deliver instruction.

Another early CAI project originated at the University of Illinois in 1960. That project, Programmed Logic for Automatic Teaching Operations (PLATO), designed computer hardware and software specifically to deliver instruction in a variety of subjects to a large base of learners simultaneously. PLATO researchers pioneered the use of color graphics, touch-sensitive screens, delivery modes, a high level of interaction between computer and learner, and learner control. PLATO became a registered trademark of Control Data Corporation and served as a model for many courseware delivery systems. In 1967 the University of Illinois established a research laboratory for the PLATO project, and it expanded into a large-scale computer-based educational system (PLATO IV).

As the costs of computing technology declined, the use of CAI became more feasible for classroom applications; the use of microcomputers, as well as educational software, in schools began to expand in the early 1980s. With the emergence of microcomputers and local area networks that connected many microcomputers to one server computer, educational software companies (including CCC and PLATO) migrated their courseware to microcomputer-based platforms. These systems became known as integrated learning systems (ILSs) and consisted of computer hardware, software, and courseware configured as a local area network. ILSs generally included a comprehensive package of software (courseware) that provided CAI on a network. The courseware included a management system that tracked individual learner progress and adjusted instruction accordingly. ILSs experienced enormous popularity and sales when several book publishing companies purchased ILS companies and invested heavily in reshaping them for the future. During much of the 1980s and 1990s ILSs accounted for a large portion of the CAI systems used in public schools.

A great deal of research has been conducted on the effectiveness and efficiency of computer use and on the effects of CAI on academic achievement as well as specific academic areas, high-level thinking skills, learning rates, learning retention, locus of control, and motivation. The research indicated that the use of CAI as a supplement to teacher-directed in-class instruction produced superior achievement and retention effects for students of different ages and abilities in different curricular areas. These comparisons indicated that CAI was more effective with lower-achieving students than with higher-achieving ones. The research comparing the effectiveness of CAI to standard methods of instruction, however, provided inconclusive results. Meta-analytic methods were used to compare the results from a number of CAI studies and concluded that the use of CAI produced higher achievement (see Bangert-Drowns, Kulik, and Kulik 1985; Becker 1992; Kulik 1994; Kulik and Kulik 1987).

Research findings that examined the effectiveness of CAI in terms of learner achievement and time required to learn material to a mastery level indicated that student learning rates were faster with CAI. Much of the research also examined attitudes about CAI, and CAI often produced positive student and teacher attitudes. In many studies teachers and learners often perceived CAI as appealing and having a positive impact on learning. While cost considerations were not a main focus of CAI research, some studies indicated that CAI was more cost-effective than some instructional methods such as tutoring and at least as cost-effective as classroom instruction. A body of largely qualitative research on CAI indicated that computer technology was of more educational benefit when its use was incorporated into the classroom practices of teachers and integrated with, and essential to, the curriculum. The primary value of CAI may be found in its potential to motivate students, increase access, and reduce the time needed to accomplish a given set of objectives.

The instructional use of computer technology is now better distinguished as learning *from* computers and learning *with* computers (see Salomon, Perkins, and Globerson 1991; Jonassen and Reeves 2001). Learning *from* computers occurs when the computer is the medium for the delivery of content through an instructional program. The complexity of the instructional strategies and the volume of curriculum content embedded within the instructional program may vary from single-focus and sequential to comprehensive and adaptive. Learning *with* computers occurs when computer technologies are used as tools to support teaching and learning. Learning from computers is associated with CAI, whereas learning with computers is associated with the use of computer and software resources that are not necessarily instructional (i.e., e-mail, web browsers, word-processing software, presentation software, etc.) as cognitive tools to support learning activities in active learning environments. In contrast to learning with and learning from computers, learning *about* computers refers to the development of skills required to operate and utilize computer hardware and software and is not considered to be CAI.

Steven Mills

See also

Courseware; Intelligent Tutoring Systems; PLATO

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Computer-Assisted Language Learning (CALL)

Computer-assisted language learning is a rapidly evolving academic field that explores the role of computer technologies in language acquisition. The evolution of CALL mirrored developments in computer technology alongside the evolution of linguistic and instructional theories of language acquisition (Delcloque 2002; Warschauer 2002). Chronologically, CALL has evolved from a behavioristic model, to communicative and integrative models, to include finally a more collaborative approach. Implemented in the 1960s and 1970s, behavioristic CALL was informed by the behaviorist learning theories and used computers as tutors to engage learners in drill-and-practice activities with the intent of improving grammar and vocabulary. Emergent in the early 1980s, communicative CALL techniques were based on cognitive theories, which considered learning a process of exploration and discovery. These CALL programs encouraged learner interactions in

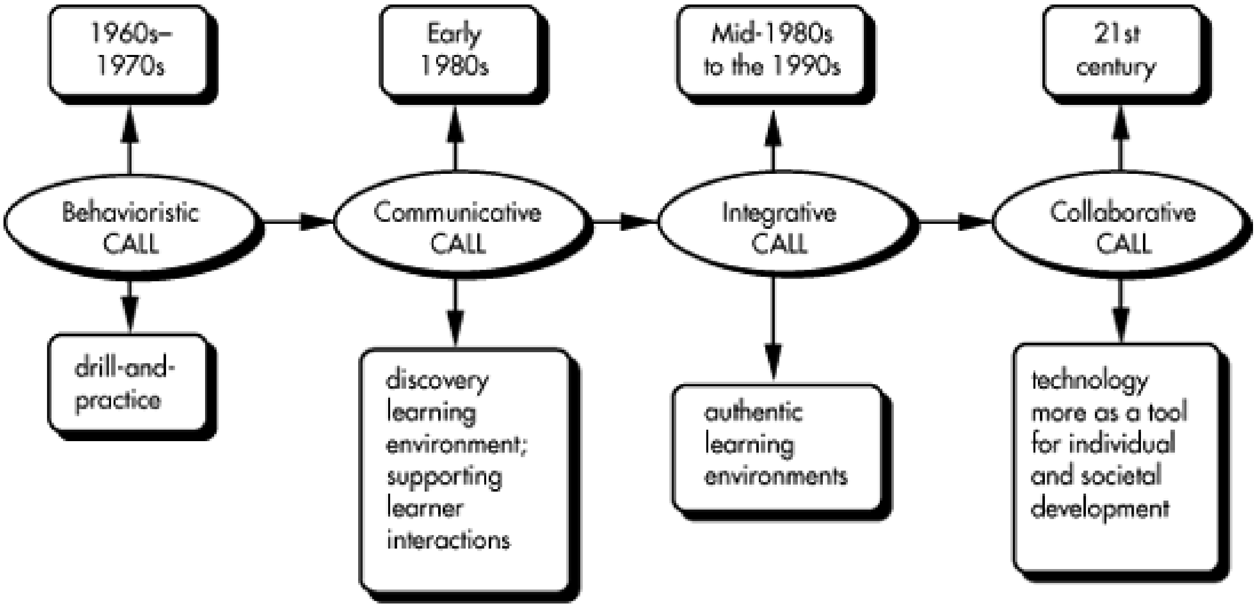

Figure 1:

The Evolution of CALL

Source: Created by the author.

processes that were to engage a broader schema of literacy, beyond mere grammatical forms and vocabulary. Supported by the socio-cognitive view of learning, integrative CALL referred to technology to create authentic learning environments, which *integrated* reading, listening, speaking, and writing skills in a target language. To this end, the current collaborative CALL identifies technology more as a tool for individual and societal development rather than just isolated language and literacy skills (Warschauer 2002). This approach is under the influence of sociocultural theories of education, where human learning and development are tied to collaborative purposeful activities mediated by tools and the social environment (Vygotsky 1978). Both integrative and developmental CALL support highly interactive and communicative language learning and include extensive use of the Internet. Figure 1 illustrates the evolution of CALL.

The development in CALL was influenced by technological development and the pedagogical shifts in language learning (Warschauer 2000). For instance, the evolution of CALL from being behavioristic to collaborative paralleled developments in computers from mainframe to personal computer, to the networked computer, to the World Wide Web. In particular, CALL has progressed in the context of the multifarious changes in language education such as the fostering of communicative ability, encouragement of creative self-expression, meaning negotiation, and the situation of language in authentic cultural contexts (Kern and Warschauer 2000). Although all forms of CALL are utilized, they now encompass more varied processes (from behavioristic to communicative models).

The Internet and the web had the greatest impact on language teaching and learning. Computer networks provide learners with opportunities to interact with speakers of the target language and share knowledge through multimedia authoring. The web also offers easy and immediate access to authentic language materials, including texts, audio, and video. It also supports the creation of virtual learning classrooms with various individuals and communication tools such as webcasts (i.e., live online streaming audio), audio and video conferencing, live chat, e-mail, listservs, discussion boards, and so on. A good example is the California State System's Virtual Language Learning (VLL) project, which aims at building virtual learning communities among instructors and learners in less commonly taught languages. The VLL engages instructors from four different campuses in collaborative course material development and refers to the "virtual language lab" software and other web communication tools for course delivery.

In addition, the wide collection of useful resources on the web can be easily used to support the short- and long-term production of the most current, creative, and engaging instructional activities (e.g., providing grammar and communicative exercises, developing students' online communication skills, and involving students in inquiry learning on current issues by using activities such as WebQuests). In particular, the web provides the possibility for teachers to engage students in creative language learning activities such as online journaling, collective editing, and creating animated grammar by using multimedia authoring tools such as Authorware, DHTML, and Flash. For assessment and evaluation, the web allows instructors to track learners' work and to measure their learning outcomes through interactive scenarios and tests, as well as authentic writing in the areas of formal writing (essays) and informal writing (discussion boards, e-mail). These activities, though powerful, need to be contextualized within pedagogical frameworks that function to both promote language acquisition and technology use and development in classrooms.

Pedagogical Advantages and Disadvantages

Research has evidenced the significant increase in student motivation when being engaged in real and meaningful learning activities. Motivation was found to be one of the best predictors of student achievement in language learning. The use of computer technology has the potential to increase language learners' self-esteem, develop vocational skills, and increase language proficiency and overall academic skills (Dunkel 1990). From a sociocultural perspective, CALL provides the tools and environment where students can engage in authentic language learning processes that can be communicative and collaborative. Stephen Krashen (1982) noted that individuals develop language more fully in comfortable environments where input of the target language is comprehensible (i.e., at the learners' proficiency level) and one level above the learners' proficiency level (i.e., the I+1 hypothesis). According to this model, in order to acquire language more holistically and naturally, there should be as many opportunities as possible for more natural and authentic learner interactions that are balanced with more direct instruction or language learning (i.e., overt teaching of grammar and rules).

CALL addresses theories of second language acquisition (SLA) and expands on them by taking into consideration comprehensible input of the target language as well as apperception, the students' ability to notice aspects of the input. For example, CALL activities and materials can provide input not only aurally but also textually and visually. As such, cues need to be included to ensure learners are focusing on the aspects important to comprehending the message. Carol Chapelle (1998) proposed a framework for developing relevant multimedia CALL, which has the following seven criteria that are drawn from the interactionist perspective of SLA:

- prominent significant linguistic characteristics
- modifications of linguistic input provided
- opportunities for both written and spoken comprehensible output
- opportunities for learners to notice errors in their own output
- opportunities for learners to correct their linguistic output
- modified interaction between the learner and the computer supported
- maximum opportunities for students to fully participate in second language learning tasks

The elements identified in this framework contribute to positive language acquisition. In this respect, the potential for CALL is positive when it is contextualized within SLA theory and a social learning environment that includes appropriate tools and support that facilitate language use and production.

In addition, CALL has the potential to create a space for dialogue where all participants have an opportunity to "speak" and the potential to provide input and be engaged in creative activities. These potentials are mostly achieved through computer-mediated communication (CMC), one element of CALL that refers to the use of e-mail and software programs such as the Daedalus Integrated Writing environment. CMC extends the use of technology beyond the classroom to virtual communities, which often cultivates new social relationships and supports "collaborative, meaningful, and cross-cultural human interactions" (Liu et al. 2003, 252). Through interactivity, collaboration, work-sharing, and real-time conferencing, online CALL can also support community-building among diverse groups of learners, which leads to new forms of socialization and acculturation (Warschauer 1997; Zhao 1996) and may foster the creation of “communities of inquiry capable of stimulating intellectual, moral, and educational growth among rich and poor alike” (Cummins and Sayers 1995, ix).

Yet CALL also brings negative effects that are common to many online learning environments, such as lack of human touch, isolated work, lack of equity in accessibility to technology (the so-called digital divide), and the possible growth of antisocial behavior from working in isolation (Pennington 1996). In CMC environments students may wander around and get lost in cyberspace. And as technology is not a sure and consistent tool, technical problems such as unreliable access to the web, support of oral production skills, and student resistance to working on computers are all areas that must be taken into consideration when weighing the positive and negative impacts of CALL (see www.history-of-call.org).

In addition, students’ use of computers and related classroom technologies can be constrained or inhibited by sociocultural variables of teachers, such as their views of schools as institutions of social control, one that is managed through the direct instruction of skills. In such instances students feel inhibited to express themselves since they fear they are not meeting requirements, or are overly concerned with learning the technology skill (i.e., keyboarding) and are not fully engaged in the CMC process (Warschauer 1998). The approach of the classroom teacher in introducing the technology, as well as the values and beliefs the teacher holds about how to convey information and skills, the expectations teachers have of students, and the experience of the students in computer and technology skills are all factors that may hinder the potential of the community (Bailey 1996). So even when teachers intend to implement CALL and CMC activities, they are doing so within societal institutions that hold varying expectations for students dependent on their language, ethnicity, and social class. As a result, technologies rarely achieve the transformational effects intended, especially when used with language and ethnic minority students (Warschauer 1997). This is a crucial area in CALL in that its beginnings focused on the accuracy of language use and moved toward fluency and further to communicative activities (Warschauer 2000).

Scholarly Activities in CALL

The Computer Assisted Language Instruction Consortium (CALICO) and the European Association for Computer Assisted Language Learning (EUROCALL) are two of the leading professional organizations in CALL. According to EUROCALL’s research policy statement (www.eurocall.org/research/research_policy.htm), scholarly work in CALL includes various activities and initiatives in research, development of materials, tools, and applications, and pedagogical practice.

It is noteworthy that under the influence of sociocultural theory (Vygotsky 1978, 1986), research in CALL has broadened from its earlier focus on the uses of hypermedia and multimedia in teaching a specific language to the uses of the web and virtual learning environments in supporting learner interaction. Online collaboration, communities of practice, and virtual learning communities are part of this, known as collaborative CALL.

Being inherently multidisciplinary, CALL research draws theories from SLA, cognitive science, linguistics, sociology, psychology, cultural studies, communication studies, and computer technology (CALICO 2002). Since the 1990s, research in CALL has begun to form its own theoretical and methodological paradigms. This is marked by CALL's standardized terminology, identified points of reference, and the inclusion of a significant number of scholarly activities (EUROCALL 1999). A well-recognized research method in CALL is to collect data from natural learning settings to test hypotheses generated by language acquisition theory (EUROCALL 1999). Another example is the newest socio-cognitive approaches in CALL research, which underscores the learners' meaningful interaction, negotiation, and knowledge construction in authentic learning environments. The overarching goal of CALL research is to address how technology supports the process of language teaching and learning, which will eventually lead to the development of CALL theory itself.

CALL research shares common methods as used in other educational and humanity research, including qualitative methods (e.g., case study, ethnography, grounded theory) and quantitative methods (e.g., descriptive, correlational, causal-comparative, and experimental). Qualitative methods have been used in studies that describe new learning environments and learner navigation patterns within these environments. Qualitative methods have also been used in studies that examine learner interaction with CALL programs and evaluate the program's instructional and technical design. By contrast, quantitative studies in CALL systematically investigate psycholinguistic and sociolinguistic variables on learning with technology and statistically analyze the effectiveness of instructional strategies (CALICO 1999).

At this juncture we need to consider users (specifically agency and identity) and broader conceptions of literacy beyond skills of SLA toward the ability of learners to be able to read, interpret information, and create knowledge from a variety of sources and to teach English to guide individuals in learning to write e-mail and use the Internet. In this environment "reading cannot be done without making critical decisions at every step of the way" (Warschauer 2000, 63). Thus, the future of CALL and

CMC requires educators to be able to teach from a critical literacy perspective that includes agency and identity as part of the language learning processes.

The Future of CALL

Some up-to-date topics in CALL are intriguing, such as language, identity, and the Internet, language in cyberspace, culturally appropriate interaction, and the Internet and minority language revitalization. The increasing reach of the Internet, which is considered one of the most democratic media recently developed, further complicates these issues. It not only enhances the powers of broadcasting and research but also promotes immediate dialogue between and among individuals and groups (Warschauer, forthcoming). The language used on the Internet, which is noteworthy since the number of non-English websites is growing rapidly, has exemplified this.

In *The Death of Cyberspace and the Rebirth of CALL,* Warschauer (2000, 61) states that “the significance of online communication lies not in its separation from the real world, but rather in how it is impacting nearly every single aspect of the real world.” Therefore, as research and experiences with online communications grow, so too will the impact and our perceptions of CALL and CMC. Such technologies further the skills of reading, writing, and communicating, since online technologies and their use will become more important in the twenty-first century. In an examination of the future of information and communication technology, Warschauer (2000) identifies ten areas where information and communication technology will progress in the twenty-first century. Of these ten, the following will have the greatest impact on CALL:

- The emergence of new computer and online devices such as RCFoC Radio! (a “radio” show in three web-based audio-on-demand flavors: RealAudio technology from RealNetworks, ToolVOX from VOXware, and MP3).
- The Internet, which will change from being exclusive to being inclusive as a mass form of communication.
- The movement from text-based to audiovisual communication, such as the growing popularity of home video production.
- Language of the Internet will expand from English to being multilingual.
- Technology use will move from “nonnative” to “native”—with individuals growing up with technology as a native skill.

These expanded uses will contribute to an increase in the use of English as the language for communication in media and commerce and further the expansion in the number of nonnative English speakers' use of technology around the world. It is likely that future developments in the area of technology will have a direct impact on English teaching pedagogy, research, and use. This will result in the creation of new contexts, new literacies, and new identities in the formulation of texts, ideas, and interactions within and outside classroom and school environments. To prepare for this future, we need to go beyond seeing computers and languages as ends in and of themselves. Instead, they can become tools for empowering individuals to look through the lens of critical literacy where reading and writing go beyond the written word, creating a conduit for rewriting the word and the world in order to transform it (Freire and Macedo 1997).

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See also

Computer-Mediated Communication; WebQuests

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Computer-Mediated Communication (CMC)

Computer-mediated communication refers to a range of functions in which computers are used to support human communication (Santoro 1995). G. Santoro describes three broad categories of CMC functions. These categories are distinguished by the nature of the human-computer interaction and by the role taken by the computer in mediating the human communication process. Although these categories are listed separately, it is most important to note that they are not mutually exclusive. Generally, these functions are combined to meet educational goals. The three categories are *computer-based conferencing, informatics,* and *computer-assisted instruction.* Computer-based conferencing refers to the computer as an interpersonal communications device and includes e-mail, interactive messaging (e.g., Internet chat, instant messaging), and conferencing systems (e.g., learning management systems such as WebCT®, Blackboard®, and FirstClass®) that may be web-accessed or not. It should be noted that it is becoming harder to distinguish what is web-based or web-accessible. Most conferencing systems, even those that are client-server applications, are becoming accessible via the web. While the primary function of computer conferencing is discussion, the discussion in online instruction is usually text-based and requires a lot of reading and writing on the part of student and instructor. Informatics is the use of the Internet as a giant library with a rapid growth of Internet-accessible resources, including online public-access library catalogs, interactive remote databases, and program/data archive sites. In computer-assisted instruction, the computer functions as a tutor or instructor and is programmed to take a more active role (i.e., it carries out commands, whereas in the two categories described above the computer passively executes human instructions).

In its broadest definition, CMC can mean virtually all instances when a computer is used as a communications device and can support a wide variety of educational formats that can range from simply providing students with e-mail in an otherwise traditional class to actually delivering instruction and supporting student-to-student and student-to-teacher interaction at a distance. For example, an entire course can be web-based, with almost all instructional activity involving the use of a computer. Or an instructor may use e-mail lists to support discussion groups to augment mainly in-person class instruction. Guest lecturers can join any class (online or not) from anywhere via video over the Internet. CMC can facilitate collaboration among students, individual pacing for self-directed learning, and student practice and reflection.

Functions of CMC

Computer conferencing is human communication enabled via the computer. A computer conference can be described as two or more people coming together to talk, using computers as the communications medium and software developed for computer communication. Computer conferencing can be as simple as one person talking to another via e-mail or as complex as people spread around the world communicating in real time. Although people may not be aware of computer conferencing, they may have used it without even being aware. America Online, CompuServe, and Prodigy were among the first commercial information services widely used to enable human contact via computer. In fact, a marketing strategy may include computer conferencing services so customers can meet new people from all over the world without leaving the safety and comfort of home. Talk and chat tools also enable people to interact with others online in real time.

Informatics means the computer as research tool. Informatics can save time and money because people can bring a world library into their homes or workplaces instead of driving to a physical building to conduct research book by book. In informatics the computer, through links to other computers and networks, serves as a virtual library with access to many databases. New additions to this library are continuously being added. A web browser allows one to search for materials throughout this worldwide library. Of course, one needs to be careful regarding quality control, given there are no librarians serving the sorting and authenticating functions on the web.

Besides using search and locator tools, information can also be found on electronic bulletin boards, usenet groups, and mailing lists. Usenet groups are discussion groups and each group is aimed at a particular topic, such as hobbies, cultural information, technical material, or specific interests. By subscribing to these discussion groups, people can read the posted messages, reply to previously discussed topics, and post a message for others to reply to.

Computer-assisted instruction and computer-based training (CAI and CBT) are growing fields rooted in a combination of other disciplines, such as education and computer science. The role of the computer as instructor is evident in the five basic elements common to CAI and CBT. First, the computer directly or indirectly orients the learner to the new insights that will be gained from the program and what is expected of the learner. Second, the computer then presents new information. Interaction is the next component as the student responds to the new information as it occurs throughout the program. Initially this interaction takes the form of prompting and cueing the learner and gradually moves to more complex questioning. Feedback, the fourth factor, is immediately provided to the learner for each response that she inputs. Finally, some form of assessment is incorporated into CAI/CBT programs to test the learner's level of mastery of the content presented. Just as a teacher in a traditional classroom instructs and evaluates students, CAI/CBT programs are developed to orient students to the program content, to present information, to provide ample opportunities for the learners to interact with the material, to acknowledge student input, and to ultimately test for comprehension and application (Zellhofer, Collins, and Berge 1998).

However, CAI and CBT differ from traditional classroom instruction because the learner is able to control her own pace through the material. If one topic is more difficult than another, the learner can take as much time as she needs to grasp the content before moving on to the next topic. CAI and CBT also vary from the traditional classroom because the learner is given the control of choosing the sequencing of the information. CAI and CBT programs can be linear, modular, or hypermedia. In the two latter cases, the learner is able to select the content of most interest to her, complete that segment of the program, then choose the next topic to be covered. Individual pacing and information sequencing are rarely choices offered to students in traditional classrooms, but they are the norm for CAI and CBT.

CAI/CBT, computer conferencing, and informatics are distinctive fields in their own right, but they all fall in the general domain of computer-mediated communication. The wide scope of CMC unifies online communication, information, and instruction. A person can communicate with another person, groups of people, or databases through the infrastructure of system networks designed to send and receive information and data that enable people to communicate online—the true purpose of computer-mediated communication.

Limitations of CMC

Of course, CMC is not the educational silver bullet we sometimes seek. Limitations include the suitability of some learning domains for CMC, technology accessibility issues, technophobia and novice users, a lack of writing skills by some persons, and lack of face-to-face contact.

Although CMC is an enabling medium for human interaction, research, and instruction, it is not practical for all purposes in education and training. First, because it is currently text-based, CMC is weak in addressing motor skills and tactile learners. CMC is a good instructional vehicle for dealing with writing, analysis, problem-solving, interests, and attitudes. Audio and video capabilities are quickly becoming economical for use in CMC and allow CMC to move beyond text-based modalities.

Another limitation of CMC is accessibility to hardware and software. To interact electronically, a computer, modem, telephone line or cable, and communications software are needed. However, if people do not have access to hardware and software at the workplace, home, educational institution, local library, or cyber café, CMC cannot take place. For those who do have the necessary hardware and software at home, there is the problem of constantly upgrading hardware and software and of ensuring that new add-ons and upgrades are compatible with existing hardware and software. And though the prices for new technologies are falling, add-ons and upgrades for better communication can still be expensive. Furthermore, significant bandwidth issues will arise as video and audio formats increasingly support CMC.

Some people are fearful of even touching a keyboard, much less trying to work through a software program. Such fears are a barrier to becoming proficient in using CMC and require individuals to confront their hesitancy to learn the minimum skills for computer use. Ideally, they will become comfortable with using the technology and become confident enough to learn more and develop their new skills. Novice computer users may also experience bewilderment and confusion when confronted with the vast realm of CMC. Fortunately, the hardware and software needed for CMC are becoming easier to use as new versions of software and new systems are developed for the mass consumer market.

Good typing skills are essential in CMC because it is currently a text-based medium. Novice users who have not acquired the necessary keyboarding and writing skills may become frustrated with not being able to communicate expressively with others. In everyday face-to-face contact, people rely on body language, facial expressions, and language inflection to send and interpret messages. These social communication cues are nonexistent in CMC, so writing ability becomes increasingly important.

CMC is a great medium for reaching out to others, but its aim is not to replace personal human contact. CMC will never, and should not, replace human interaction. Human contact is necessary and important, especially when people are confronted at practically every turn with a bombardment of information. In some cases, such as the resolution of conflict, face-to-face interaction is crucial. However, CMC is able to conveniently bring people together who, by any other means, would never have the chance to interact.

Advantages of Using CMC

Although there are limitations, CMC offers myriad benefits that can enhance, improve, and support education and training. As mentioned above, one advantage of CMC is the abundance of online information and instructional content. CMC makes it possible to access vast amounts of information and resources germane to the education and training sectors. Instructors can communicate with their colleagues about online instruction, download useful files for classes from remote databases, and post lessons and tutorials online. Similarly, students can form virtual study groups with classmates and research assignments utilizing Internet resources for class assignments. CMC is a great asset for classes that have a strong “read about, talk about, think about, or write about” component.

CMC in education and training makes the teacher’s physical presence and setting invisible and places the responsibility of learning on learners. CMC encourages the use of a variety of instructional methods where the instructor acts more as a facilitator rather than as a didactic authority figure. CMC provokes changes in the roles of instructor and students (see, e.g., Berge 2000).

The learner-centered approach is typical of CMC courses, prompting teachers to think about instructional design in innovative ways. Traditional lesson plans may not be suitable for online instruction. Besides choosing appropriate instructional activities that will cater to the different needs of the students, the instructor must also take into consideration staffing, class schedule, budget, varied learning styles, and the new frontier of the online environment (Berge and Collins 1995a, 1995b; Eastmond and Ziegahn 1995; Nalley 1995). Although some teachers may view this as more work, the benefit is that instructors are again asked to consciously examine a process that may have become habitual in order to ensure effective instruction. There are a variety of issues, such as suitable online content, varied ways of learning, instructional methods, and interactive activities that best address the content, the technology itself, and time, to be considered when designing online instruction.

Interactions in an in-person classroom environment may be limited due to distractions, fear of ridicule, insufficient time for all students to interact, or lack of encouragement. Students of classes delivered through CMC are more responsive to interacting with others because the pressures of the traditional classroom have been removed. Students can take the time to gather their thoughts to best reply to messages, and with this extra reflection time they can be confident of the remarks they submit. Interaction in online courses is often mandated; to be silent in a computer conference is to become invisible.

Online class discussions can be reviewed, or even printed out, to serve as notes and memory refreshers for students. Also, the instructor can use electronic text documents and archives for record-keeping purposes to track all class sessions, related problems, outcomes, and so on. This serves to make all parties more accountable and to avoid he said/she said scenarios. This is a valuable way of monitoring and pacing student progress and improving upon it in the future.

CMC overcomes geographic barriers. People do not have to be physically present at the same location in order to communicate. Whether at the workplace, home, or school, people are able to log on to networks to interact online with someone in the neighborhood or continents away. This is especially beneficial to people with physical disabilities or those in remote locations who would otherwise not have the chance for such interaction. CMC can bring people from around the world together to interact.

Besides eliminating geographic barriers, the dual temporal nature of CMC bridges time barriers. Interactions via CMC can either be synchronous or asynchronous. Synchronous communication is similar to in-person exchanges where all parties participating in the conversation are present (online) and provide immediate input and feedback to messages that appear on the computer screen in real-time. Asynchronous communication means leaving messages to be read by others later. Asynchronous communication (e.g., web-conferencing) allows participants to “go to class” when it is convenient. These synchronous and asynchronous aspects of CMC give communicators great flexibility.

No social group with computer access is excluded from taking part in communicating electronically with others because CMC is able to overcome space, time, and social boundaries that could not be bridged in the past. Social status is established by communication content and style, as well as the free sharing of information, thoughts, ideas and opinions—all physical attributes are rendered invisible.

Finally, CMC addresses demographics and lifestyle changes. Whereas computers were seen as complex technological tools in past years, they are now used by “average” people for entertainment and educational benefits. People’s expectations of technology have changed with the coming of the information age.

Implications for Education

The training and industry sectors are experiencing changes in how business is conducted, and these changes will continue to evolve as CMC expands (Berge 2001; Schreiber and Berge 1998). In order to stay competitive, reach a larger portion of the student population, and meet the widest variety of student needs, such as flexible scheduling and the demand for greater selection of course offerings, educational institutions are being pushed to implement CMC in their programs. Online teaching is part of the larger context of technology-mediated learning and an educational framework for transforming students into self-directed, lifelong learners. The main teaching styles used by online teachers are discussion, collaboration, authentic learning activities, and self-reflection/self-assessment. Teachers value these purposes and methods. The online classroom CMC, with its tripartite functions, can permit and promote efficient and effective learning and serve as a catalyst for improving education.

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See also

Collaboration and Negotiation Tool for Case-Based Instruction; Collaborative Technologies; Communities of Practice; Computer-Assisted Language Learning; Computer-Supported Collaborative Learning; Courseware; Web-Based Course-Management Systems

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Computer-Supported Collaborative Learning (CSCL)

Computer-supported collaborative learning means the use of computer-based networks to support students learning together in an effective and efficient manner. CSCL was developed based on the broader concept of computer-supported collaborative work (CSCW). CSCW provides support for group work via shared interfaces on a computer-based network. Both CSCW and CSCL are designed to supplement, rather than replace, face-to-face interactions, and both are designed to support groups working together for a common reason. CSCW and CSCL facilitate communication, information access, and collaborative problem-solving. The main distinction is that CSCW is primarily used in business and industry, whereas CSCL is used in educational settings.

Several major theories covered in other entries in this encyclopedia have contributed to the development of CSCL, including constructivism, sociocultural theory, problem-based learning, situated cognition, active learning, cognitive apprenticeships, and cognitive flexibility theory. All these theories share common themes, including the notion that learning should be active, purposeful, collaborative, and authentic. CSCL uses technology as a tool to support these notions and to function as a collaborator in the learning process by offloading some of the cognitive demands typically placed on learners. When technology is responsible for organizing, storing, and retrieving information and modeling various concepts and procedures, learners have more of an opportunity to focus on in-depth learning that requires higher-level thinking skills such as reflection and analysis.

Examples of CSCL

Collaborative Learning Environments Online (CLEO) supports inquiry and collaboration in science and mathematics via the web. Students use authentic data to solve research questions using real data. The online environment provides tools that enable students to share, analyze, and discuss results with geographically disparate peers and provides a clearinghouse of completed projects that can be used by others. Each project in CLEO supports authentic scientific investigations by highlighting a research question that drives the investigation, information about the procedures and tools used to gather data, authentic data shown in a variety of formats including graphs and charts, and a conclusion that leads to new areas of research.

The International Clean Air Project is one example of an authentic investigation supported by CLEO. In this project students from around the world explore issues related to what citizens can do to reduce air pollution in their community and what health issues related to air pollution should be brought to the attention of all citizens in the community. Through this project students are able to compare and contrast communities, share suggestions for dealing with air pollution, and become aware of issues that influence local and global economics and politics.

Computer Supported Intentional Learning Environments (CSILE) was developed by Marlene Scardamalia and Carl Bereiter at the Ontario Institute for Studies in Education. This collaborative learning environment has graphical, multimedia, and text-based capabilities that enable students to generate nodes with relevant information related to the topic being studied. These nodes then become avenues for other students to analyze, comment upon, and add to, thus building a community-based center of knowledge.

CSILE has been integrated into the K-12 curriculum across a variety of disciplines. One example of its use is the DIG Project in which two upper elementary classes studied ancient civilizations through interdisciplinary, project-based learning. Through the use of CSILE students created their own civilization based on cultural universals they studied in their classrooms such as housing, language, and government. CSILE enabled students to make complex connections among ideas and nodes and facilitated a deep level of collaboration among students working toward a similar goal. Students also had an opportunity to practice their writing skills in an authentic environment, to supplement this writing with graphics, and to respond to the writing of other students. Higher-level thinking skills were developed because students needed to ensure that the cultural universals created for this civilization fit with the group’s original goals and to collaboratively decide whether each node or idea was appropriate. Each student had an individual responsibility to the group’s final goal.

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See also

Collaborative Technologies; Computer-Mediated Communication; CSILE/Knowledge Forum®

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Cone of Experience

Introduced by Edgar Dale (1946) in his textbook on audiovisual methods in teaching, the Cone of Experience is a visual device meant to summarize Dale's classification system for the varied types of mediated learning experiences. The organizing principle of the Cone was a progression from most concrete experiences (at the bottom of the Cone) to most abstract (at the top). The original labels for Dale's ten categories are: Direct, Purposeful Experiences; Contrived Experiences; Dramatic Participation; Demonstrations; Field Trips; Exhibits; Motion Pictures; Radio—Recordings—Still Pictures; Visual Symbols; and Verbal Symbols. (See Figure 1.)

Dale made minor modifications of the visual in the second edition (1954), changing Dramatic Participation to Dramatized Experiences and adding Television. By the third edition of the textbook, Dale (1969) acknowledged the growing popularity of Jerome Bruner's (1966) cognitive psychology concepts by overlaying Bruner's classification system for modes of learning—enactive, iconic, and symbolic—on top of his own categories. This adaptation of his own schema may have been portentous, perhaps giving implied license to others to make other creative adaptations and interpretations, not always to the credit of Dale's original notion.

Application of the Construct

Dale's textbook in its three editions remained popular for over a quarter-century. Inasmuch as the Cone provided the organizing principle for the book, it became ingrained in the thinking of generations of educational technology students and professors who used the textbook. It stimulated many efforts to extend the original idea by developing its implications for elementary education, secondary education, adult education, corporate training, and even counseling.

As a visible leader in audiovisual education, Dale and his work had a great deal of authority within the field, and the Cone may be regarded as the earliest highly influential conceptual schema in the field. In his landmark work on visual learning, F. M. Dwyer (1978) credits Dale as one of the thinkers who inspired the visual education movement in the 1940s and 1950s

Dale's own claims for this classification system were modest and qualified. He advised against viewing the categories as rigid, inflexible divisions (1946). He insisted that the classifications should not be regarded as any sort of hierarchy or rank order (1946). This addresses one of the most

Figure 1:

Dale’s Cone of Experience (first edition)

Source: From Audio-Visual Methods in Teaching, 1d. by Dale. © 1969. Reprinted with permission of Wadsworth, a division of Thomson Learning: http://thomsonrights.com.

prevalent misconceptions of the Cone: that the progression from concrete to abstract represented a value judgment about concrete over abstract learning activities. Instead, Dale advocated the use of whatever methods or media were appropriate for the learner and the task, acknowledging that words can be a powerful and efficient means of conveying ideas even for the youngest children. If he had a bias regarding media it was toward rich combinations of concrete and abstract experiences: “Abstractions must be combined, if we are to have rich, full, deep, and broad experience and understanding. In brief, we ought to use all the ways of experiencing that we can” (Dale 1946, 48).

Because many of those who referred to the Cone were advocates for specific media or for audiovisual media in general, they had a tendency to selectively emphasize those parts of Dale’s work that supported their claims. Thus by the time of the third edition of *Audiovisual Methods in Teaching* Dale found it necessary to devote six pages of the chapter on the Cone to

“Some Possible Misconceptions” (1969, 128–134). At the core of the misconceptions are the notions that the value of an activity increases with its realism and that the learner’s understanding grows by beginning with direct experience and progressing to increasingly abstract activities.

One explanation for the prevalence of other interpretations of the Cone is that Dale did not explicitly draw the distinction between a descriptive construct and a prescriptive theory. He surely intended the Cone to be descriptive—a classification system—and not prescriptive—a road map for lesson planning. He came close to drawing this distinction when he stated in the summary of his chapter on the Cone: “The cone, of course, is merely an aid to understanding this subject . . . something to help explain the relationship of the various types of sensory materials” (1946, 52). The key words are “understand” and “explain,” which indicate a descriptive purpose, not a prescriptive one.

Yet Dale himself sometimes fell prey to the urge to extend the descriptive construct to prescriptions, as pointed out by D. P. Subramony (forthcoming). References to “uses” or “implications” of the Cone are scattered throughout the various editions of Dale’s textbook (Dale 1946, 1954, 1969). An example found in the third edition states, “When properly understood and used, however, the Cone can be a helpful and practical guide” (1969, 110). With this sort of ambiguity from the author, it is not surprising that many of his followers attempted to use the Cone as a prescriptive guide to lesson planning.

Origins of the Cone’s Concepts

Ideas parallel to those expressed by Dale in the Cone of Experience appeared in the literature of education prior to 1946. Paul Saettler (1990), a historian of the field of instructional technology, points to *Exposition and Illustration in Teaching,* published in 1910 by John Adams, “which included the following ‘order of merit’ concerning concreteness: ‘(1) the real object, for which anything else is a more or less inefficient substitute; (2) a model of the real object; (3) a diagram dealing with some of the aspects of the object; and (4) a mere verbal description of the object.’” However, a more direct ancestor of the Cone is probably another diagram developed by Hoban, Hoban, and Zisman (1937). They made the conceptual breakthrough of constructing a graph in which visual media are arranged along the *y* axis, while the learner’s level of development—from the concrete level of thinking to the abstract level of thinking—is arrayed along the *x* axis. In applying the graph to a particular case, one would locate the learner’s current level of conceptual development (concrete to abstract), then trace up to the slope line and then horizontally over to the visual medium that intersects at the same point. For example, an experienced learner with a highly developed (abstract) knowledge of jet propulsion would be expected to be able to learn more about jet propulsion effectively with diagrams and verbal texts.

The categories were: total situation, objects, models, films, stereographs, slides, flat pictures, maps, diagrams, and words. Dale's schema differs mainly in the addition of several classes of media and active learning experiences and the simplification of the schema by showing only the *y* axis—the media, indicating the other dimension (concrete-abstract) by the pyramidal shape of the cone. Although Dale's schema appears to be quite derivative of this, he does not explicitly acknowledge this source, although he makes several references to the work elsewhere in his textbook.

Misappropriation of the Cone

It is important to discuss what the Cone is *not* as well as what it is because of a widespread misrepresentation that has become ubiquitous in recent years. At some point someone conflated Dale's Cone of Experience with a spurious chart that purports to show what percentage of information people remember under different learning conditions. The original version of this chart has been traced to the Socony-Vacuum Oil Company in the 1960s, according to Dwyer (1978). Charles Cyrus, a training specialist at the University of Texas, indicates (letter to Michael H. Callahan, Department of the Navy, November 27, 1963) that the "people generally remember" data were disseminated by the Division of Extension, University of Texas, in the 1950s and may have reached oil company trainers during that period. Cyrus traces the chart back to Paul John Phillips, who brought the data with him after serving as head of the Training Methods branch of the U.S. Army's Ordnance School at the Aberdeen (Maryland) Proving Grounds. Phillips held this position and the rank of lieutenant colonel from 1940 to 1943. He later claimed that during this period his unit conducted research on training that supported these findings, although no documentation of that research is available.

As Dwyer points out, the reported percentages are impossible to interpret or verify without specifying at least the method of measurement, the age of the learners, the type of learning task, and the content being remembered. Despite the lack of credibility, this formulation is widely quoted, usually without attribution, and in recent years has become repeatedly conflated with Dale's Cone, with the percentage statements superimposed on the cone, replacing or supplementing Dale's original categories. The examples are too numerous to document here but are discussed in detail and with citations in Subramony (forthcoming).

The Cone of Experience is essentially a visual metaphor for the idea that learning activities can be placed in broad categories based on the extent to which they convey the concrete referents of real-life experiences. Although it has sometimes been interpreted as advocating the selection of certain media and methods over others, or as a prescriptive formula for selecting instructional media, such was not Dale’s stated intent. Dale’s own explanations are nebulous enough to support a wide variety of interpretations regarding its applications. Finally, there is the contemporary problem of the conflation of the Cone with the unverified “people generally remember” ordnance school percentages. Nevertheless, the fact that the Cone has been used in so many ways testifies to the robustness and attractiveness of Dale’s visual metaphor.

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See also

Bruner, Jerome S.; Instructional Technology; Research on Media and Learning; Visual Literacy

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Constructivism

Constructivism represents one set of assumptions about how people learn, that is, how they come to know. Many people think of constructivism as a teaching method, but it is not. Rather, it provides a lens through which we interpret any teaching-learning process. In the constructivist view, learning is not the receipt of information; teaching is not the transmission of information to the student. Rather, constructivism is based on the fundamental assumption that learning is in the activity of the learner. Learning is in the doing, and learning is a process of making sense of the world.

The importance of the constructivist view can perhaps best be appreciated through the contrast to more traditional views of learning. The traditional view that guides most teaching today is what is known as the information processing model, or more generally the “acquisition” view of learning. In this view, knowledge consists of symbols (concepts, procedures, etc.) and the ability to manipulate those symbols. Learning, then, is the acquisition of these symbols, whereas “instruction” involves finding the most efficient means of facilitating this acquisition. For example, it is common in algebra classes for the teacher to stand at the front of the room and provide students with formulas and numbers to plug into the formulas—often providing mnemonics and acronyms to help the student remember what to do next. While this leads to proficiency with calculation, it does not help the student understand the world of math.

The contrast is clear. In the constructivist view, as compared to the acquisition model:

- Knowing about is always contextualized or situated, not abstract.
- Knowing about is constructed through the individual interacting in a situation, not objectively defined.
- Knowing about is a “best interpretation” of a situation, not a truth.

Table 1 provides a further summary of the differences in views. Notice in the table that both views can discuss the teacher as coach—what is important is what it means to coach. In the acquisition model, the coach is transferring expertise with a goal of making the student like the coach. However, in the constructivist view, the coach is there to develop the student’s potential; thus the coach is successful when she can converse with the student and respect the student’s views (and the student’s ability to defend those views).

Also notice that “discovery” is listed under the acquisition model. Although the original notion of discovery learning was very much a constructive activity on the part of the learner, in the most typical use of discovery learning (and in the literal meaning of the term), the teacher guides the student to “discover” what is already known. It is much like turning over a rock and discovering something new. This is different from the constructive, inventive process in the constructivist view. Think, for instance, of the difference in learning that results when a student sits through a lecture on strip mining and its devastating effects on the land as compared to the learning that can come from a project in which students are asked by their state senator to advise him on what he should do about strip mining in the state. In the second activity, the students will be active researchers, learning the benefits and drawbacks of strip mining. They will likely look at environmental, economic, and social impacts and develop a deeper understanding of the systemic nature of real-world issues. They will be able to use the Internet to locate information and contact experts as well as

Table 1: Contrasting Views of Learning

Constructivism View	**Acquisition View**
Learning is: • organic • continual reorganization • invention	Learning is: • cumulative • discovery (finding what is known)
Knowledge is: • a construction	Knowledge is: • an acquisition
Coach-apprentice relation is: • mutual respect for views • ability to converse	Coach-apprentice relation is: • transfer of coach's expertise
Assessment is: • ability to use knowledge	Assessment is: • mastery of the content

Source: Created by the authors.

their school's local resources. However, in the information delivery model of the first example, they will memorize a few facts about strip mines and move on to the next topic. They will not learn that they can be independent learners, and they will not learn how to work with messy problems—a critical skill in the work world that is often not developed in school.

The role of the teacher is to support the learning process. Indeed, we talk about creating learning environments and scaffolding learning (providing supports that can later be removed, much like training wheels) because we see the efforts of teaching as being invested in supporting the student's construction of understanding. Of course this does not mean the student can study anything he wants. A central role of the teacher is to engage the student in particular issues, topics, and subject matter (i.e., engage the students with the curriculum). Furthermore, a student's constructed understanding is not acceptable simply because it is what he thinks or believes. Rather, the student must be able to test his understanding against known evidence and against the alternative perspectives. The constructed understanding must be rich and robust; it must be defensible.

Constructivists ascribe to three key principles about learning. First, *learning is situated.* What a student learns depends on the goals of the learner, the task set for the learner, the resources available, the expectations that are set, and so on. In essence, all aspects of the situation impact the nature of what the student learns. It is for this reason that we argue for authentic learning environments—environments that are consistent with the contexts we expect the student to be able to work in after the course is over. It is reasonable to think of learning as creating practice fields for the students.

Second, *learning is goal-driven.* Learning does not occur when an individual sees no benefit. Similarly, learning does not occur when the individual understands everything already. This seems obvious, but it is important. Learning is driven by an individual's need to understand and achieve some end. That goal—the learner's goal, not the goal specified by the teacher or text—determines what is learned. (The third principle, that learning is social, is discussed below.)

The implication, of course, is that it is essential for students to be engaged in the inquiry experience that is set for the class. There are three components to this engagement. The student must: (1) see the problem as important and personally relevant; (2) feel that her action is of value and not just an exercise; and (3) have decisionmaking responsibility.

What people do as "teachers" is seek to engage the student in establishing goals consistent with the outcomes we desire. Therefore, the learning problem must be presented in a context, with supporting discussion and documentation, that brings the student to see the value of working on the problem for its own sake—not simply because it is a course assignment. Without this engagement, even the richest problems offer no more learning potential than a textbook.

Once the student sees the value of the inquiry, the next hurdle is maintaining the student's interest by emphasizing that this is not just a classroom exercise. There must be some way for the student to demonstrate the understandings that have developed. Thus the outcomes must include a performance (a letter, presentation, report, video, product, etc.) that allows students to demonstrate their understanding outside the classroom. This could be for parents, but it could also involve a report delivered to Congress, the mayor, the principal, or some other community figure.

Finally, students must feel they have ownership of the inquiry process and the decisionmaking. The teacher plays the role of coach, but if the process is dictated and only particular outcomes are acceptable, students will reject the inquiry as an exercise. It is not the answer they come to but rather their ability to defend the answer (i.e., the critical thinking) that is important. An unacceptable answer or outcome should only be one that the student cannot defend in relation to alternative perspectives. Consider again the strip-mining example. In the science classroom where this problem was used, the teacher may have expected that students would develop an understanding that strip mines are destructive and should be closed down. What really happened, though, was that students saw the positive economic impact in the form of high-paying jobs for people in their town—perhaps even in their own family—in an area where good jobs were hard to find. Therefore, they concluded that the benefits of strip mining outweighed the consequences. This was sound logic based on well-researched facts; it was an acceptable answer.

The third principle is that *learning is social*. Interacting with others is one of the most efficient ways to test one's views. It provides an opportunity to articulate the views and to hear evidence from others that supports or contradicts your views as well as to hear alternative positions. It is the ability to reconcile these differences that is critical. The implication for this is that the constructivist learning environment emphasizes the collaborative aspect of learning. Collaboration can help to ensure that students share responsibility and seek to support each other. There is a considerable literature on the development of collaborative teams to guide this work. But in the end each individual must be able to defend the outcome of the work, providing rationale and answering questions. Thus while there is collaborative work, there also continues to be individual responsibility.

The constructivist framework has a long history. One researcher (von Glasersfeld 1989) attributes the first constructivist theory to Italian philosopher Giambattista Vico in the early eighteenth century: "One of Vico's basic ideas was that epistemic agents can know nothing but the cognitive structures they themselves have put together . . . 'to know' means *to know how to make*" (von Glasersfeld 1989, 123).

John Dewey was perhaps the greatest proponent of situated learning and learning by doing. Dewey reacted against the traditional educational framework of memorization and recitation and argued that "education is not preparation for life, it is life itself." Most important, learning was organized around the individual rather than around subject-matter topics and predetermined organizations of domains. Dewey emphasized perturbations of the individual's understanding as the stimulus for learning (Roschelle 1992). In essence, the learner's interest in an issue had to be aroused, and learning was then organized around the learner's active effort to resolve that issue.

Jerome Bruner brought the constructivist view back to the forefront in the mid-1960s. He popularized discovery learning, an approach in which teachers support students as they seek to understand issues that are personally and socially relevant. In Bruner's framework, the active struggling by the learner with issues *is* learning. In his best known curriculum effort, a study of anthropology for fifth-graders, Bruner began the curriculum with the unknown—the study of baboon communities and the Nestik Eskimos—as a means of stimulating the child's curiosity. Students were asked to relate the use of tools, language, social organization, and so on to their familiar culture (family, school, etc.).

Arguably, Lauren Resnick's (1987) presidential address to the American Educational Research Association was a primary stimulus for the current resurgence of interest in constructivism. In that address, she contrasted the way we learn out of school to the way we learn in school, emphasizing that outside of school learning is situated and serves as a tool and that it is collaborative.

Others (Brown, Collins, and Duguid 1989) expanded upon these ideas and argued that learning and doing are one and the same.

Constructivist Teaching Methods

The constructivist view argues that “teaching” methods should revolve around creating inquiry-based environments that will engage the students in using the concepts, principles, and procedures. All learning involves making sense of the world (i.e., it is inquiry-driven). Thus the course curriculum and the teacher’s efforts with the student must be geared toward engaging the students’ inquiry in such a way that they are involved in authentic uses of the relevant concepts, principles, and procedures. The students must come to own the problem and the inquiry.

There are many inquiry-based methods to choose from. Problem-based learning involves creating problems that will engage the students (and engage them with the relevant issues), then having students work as teams in cycles of collaborative analysis and self-directed learning. That is, the team is given a problem to solve such as “Should the United States change its immigration policy?” The team members consider the problem, brainstorm, analyze, and define learning issues. They then gather evidence and do analyses related to those learning issues. This cycle is repeated as they progress in their thinking—and their understanding of the issues. Project-based learning involves a similar process, though the cycles of collaboration and self-directed learning may not be so well defined.

Service learning and experiential learning are two alternative strategies that also involve inquiry environments where students are learning through doing. These are less structured than problem-based learning, and the problems are more emergent based on the particular situation. As such, students naturally take ownership of the problems. Here, part of the teacher’s role is somewhat different, focusing on helping to define a problem and then supporting the inquiry process.

The Jasper Woodbury series, focusing on mathematics, is perhaps one of the best-known sets of inquiry materials developed to support constructivist teaching strategies. A Jasper adventure is presented on videodisc. The adventure presents a lot of data situated in natural settings; then a problem is posed, and the student must use that data in working on the problem. For example, one problem had to do with developing a business plan for running a dunking machine at the fall festival. Students had to determine how many students would participate and each of several different ticket prices (using survey data) and then take into account the cost, including evaluating alternative strategies for acquiring needed resources (e.g., water).

One of the most effective strategies for supporting inquiry is to let the inquiry evolve from the students’ own interests in the subject matter. It has been demonstrated (Bereiter, Scardamalia, Cassells, and Hewitt 1997; Cohen and Scardamalia, 1998; Scardamalia et al., 1992; Scardamalia and Bereiter, 1991) that even young students have interesting questions that are relevant about subject areas. They have developed a distributed, computer-based discussion tool (in this case, CSILE) and methodology to support students' natural collaborative inquiry in the classroom.

In the constructivist view, the teacher plays a critical role in facilitating inquiry-based learning environments. First, the teacher engages the student in inquiry in the domain. There are many ways to do this, but all are built on two key foundations: thinking of linkages between the subject matter and the real world—ways in which the students can be authentically engaged in using the information; and engaging students in the issues so they take ownership. Second, the teacher serves as a coach. The expertise the coach uses is as an expert inquirer—not expertise as a subject-matter expert. The coach needs to: monitor the students' discussion so she understands their thinking; ask questions the students should be asking themselves given their current state of understanding and thinking (i.e., reflect expertise in inquiry); and promote reflection, which is a critical activity for students and one that the teacher generally must facilitate.

Reflection should occur regularly throughout the inquiry process. Summarizing or synthesizing the conversation or work thus far is one strategy for reflecting. It helps to highlight what we consider important. As the end of an inquiry it is important to pause and ask: What did I learn? Where do I need to improve my understanding? Where else does all of this apply? Without this reflective activity, we rapidly forget the key learning issues. Reflection serves as a mean for connecting experiences, tying the experiences to the students' lives outside the classroom and expanding student understanding. It enhances student metacognition and communication abilities; as an added bonus, reflection also provides the teacher with a way of gaining an understanding of where individual students are in their own development.

The Constructivist Learning Experience

Constructivist learning environments are collaborative: Students learn from each other through sharing different experiences, refining understandings, and questioning each other. These environments are also resource-rich. The learning activities that happen in constructivist environments require students to have access to a wide variety of materials, from books and magazines to experts. One key to a successful curriculum can be the use of technology as a resource.

Technology can support the constructivist environment not only as an informational resource but also as a communication and thinking resource. A classroom with an Internet connection can communicate with people worldwide, thus broadening the social context for learning. Furthermore, computers offer tools that help students collect and organize information in ways that are meaningful to them and that can prompt later reflection. Spreadsheets and databases allow students or teams to create sets of relevant information that can be easily accessed. Presentation software and word processors allow students to create professional-level output. Tools such as dynamic geometry software and three-dimensional modeling software allow students to visually see math and explore their evolving understanding of it or create their own version of the solar system that reacts to gravitational pull. Technology can also help students engage in rich problem-solving situations because of the availability of resources. These tools go far in the effort to create rich learning experiences for students by enabling simulations and modeling authentic learning environments (Jonassen 2000; Barab, Hay, and Duffy 1998).

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See also

Bruner, Jerome S.; Cognitive Psychology; Collaborative Technologies; Communities of Practice; CSILE/Knowledge Forum; Jasper Woodbury; Learner-Centered Environment; Mindtools; Problem-Based Learning; Situated Cognition; Vygotsky, Lev

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Copyright

Copyright provides legal protection for intellectual property by bestowing a bundle of rights on the copyright owner. New technologies seem to challenge copyright’s ability to apply to them, but the law, while retaining its basic tenets, has proven capable of accommodating the new challenges. Although Internet services like Napster (where users download music) challenged copyright’s boundaries, copyright law appears to be winning—at least in court.

As with patents, Congress’s power to legislate copyright laws derives from the U.S. Constitution, which gives Congress 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” (art. I, sec. 8, cl. 8). In other words, the Constitution tries to encourage the creation of new works by promising an economic reward to copyright owners. The Constitution sees the creation of new works as a means of advancing the public welfare.

The current Copyright Act, often called the Copyright Revision Act of 1976, actually took effect on January 1, 1978. It replaced the Copyright Act of 1909. However, the 1909 act still plays a role in some court cases. For example, in 1998 Martin Luther King Jr.’s 1963 “I Have a Dream” speech formed the basis of an infringement case brought by King’s estate against CBS. A CBS video of the speech had been used in an A&E video. The King estate claimed ownership of the speech; CBS claimed the speech had entered the public domain. To resolve the case, the court looked to the 1909 act, which was in effect at the time. The court found that the speech had been freely distributed with no copyright notice and published in a newsletter with no copyright. Thus, under the strict copyright notice requirements of the 1909 act, the court found the speech had entered the public domain.

What Can Be Copyrighted?

Five sections of the Copyright Act (secs. 102, 103, 104, 104A, and 105) address the question of what constitutes a copyrightable work. Section 102 provides the basic criteria for copyrightability. A work must be an original work of authorship fixed in a tangible medium of expression from which it can be communicated, either directly or with the aid of a machine or device. The eight categories into which such a work may fall are: literary works; musical works, including any accompanying words; dramatic works, including any accompanying music; pantomimes and choreographic works; pictorial, graphic, and sculptural works; motion pictures and other audiovisual works; sound recordings; and architectural works. It also clearly states that copyright does not "extend to any idea, procedures, process, system, method of operation, concept, principle, or discovery." This includes titles, names, short phrases, mere listings of ingredients, standard calendars, and rulers, as well as works such as improvisational speeches that have not been fixed in a tangible form such as a recording.

Section 103 includes compilations and derivative works. The catch here is that the compilation or derivative work's copyright "extends only to the material contributed by the author." It does not affect the copyright of the preexisting work.

Sections 104 and 104A address the national origin of the work. Section 104 sets forth the criteria for published works, such as one or more of the authors is a U.S. national or lives in the United States or is a national of a country with which the United States has a treaty. Section 104A restores copyright protection to certain foreign works that entered the public domain in the United States before 1996 for the remainder of the copyright term the work would have been granted if it had not entered the public domain.

Section 105 simply says works of the U.S. government are not copyrightable. This places many items in the public domain. However, government works created by an independent contractor may indeed be copyrightable by that contractor depending on the wording of the contract. Postage stamps, although created by the U.S. Postal Service, are indeed copyrightable.

Who's the Copyright Owner?

Sections 201 and 101 describe the copyright owner. As soon as a work is created in a fixed form, the copyright initially rests with the author, who may then decide to transfer some or all of the rights granted by copyright to others (see the discussion of section 106 below). In the case of a work made for hire, the employer is the copyright owner. Section 101 defines a work made for hire as one “prepared by an employee within the scope of his or her employment” or a work specially ordered or commissioned for use (e.g., a contribution to a collective work, a translation, a test, an atlas, answer materials for a test, bibliographies, an index, and a sound recording). The parties must have expressly agreed to the work-made-for-hire designation in a signed written instrument.

Section 106

Section 106 spells out the copyright owner’s bundle of rights. It grants a copyright owner the exclusive rights to do and to authorize any of the following: (1) to reproduce the work in copies or phonorecords; (2) to prepare derivative works based upon the copyright work; (3) to distribute copies or phonorecords of the work to the public by sale or other transfer of ownership, or by rental, lease, or lending; (4) to publicly perform literary, musical, dramatic, and choreographic works, pantomimes, and motion pictures and other audiovisual works; (5) to publicly display literary, musical, dramatic, and choreographic works, pantomimes, and pictorial, graphic, or sculptural works, including the individual images of a motion picture or other audiovisual work; and (6) to publicly perform sound recordings by means of a digital audio transmission. In addition, section 106A grants certain authors of visual-arts works the rights of attribution and integrity. However, all the rights granted by section 106 are limited by exemptions and compulsory licenses laid out in sections 107 through 121 (discussed below).

For How Long?

How long do the copyright owner’s exclusive rights last? Chapter 3 of the Copyright Act sets the duration of copyright. Section 302, amended in 1998 by the Sonny Bono Copyright Extension Act, establishes the basic copyright term for works created on or after January 1, 1978, as the life of the author plus seventy years. For joint works (i.e., two or more authors) the term is the life of the last surviving author plus seventy years. Anonymous and pseudonymous works and works made for hire receive copyright protection for ninety-five years from the year of first publication or 120 years from the year of its creation, whichever expires first.

Limitations on Section 106

Having granted copyright owners certain exclusive rights in sections 106 and 106A, Congress immediately added sections 107–122, placing “limitations on exclusive rights.” Section 107 restates the judicial doctrine of fair use, incorporating it for the first time into the copyright act itself. This section allows the reproduction of a copyrighted work in, for example, copies or phonorecords “for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research.” Section 107 identifies four criteria for determining if a particular use of a copyrighted work is indeed a fair use:

- *Purpose and character of the use:* Is this for a nonprofit educational purpose or commercial in nature?
- *Nature of the copyrighted work:* Is it factual or fictional?
- *Amount and substantiality:* Is it a small or large portion of the copyright work as whole?
- *Effect of the use upon the potential market for or value of the copyrighted work:* Is the original work’s market devalued by the reproduction?

Section 107 also clearly states that unpublished works may indeed fall under fair use based upon a consideration of the four criteria.

Section 108 turns to reproduction by libraries and archives, granting certain exemptions hedged about by detailed criteria. Thus the nine subsections in this section generate more subsections. The first subsection allows a library or archives, or any of its employees acting within the scope of their employment, to reproduce one copy or phonorecord of a work (except as noted in the following two subsections) or to distribute that copy or phonorecord if it is not intended for commercial use, the library is open to the public, and it includes a copyright notice. The second subsection allows up to three copies of an *unpublished* work solely for preservation and security purposes. If the copy is in digital format, it may not be made available in that format outside the library or archives’ premises. The third subsection allows three copies or phonorecords of a *published* work to replace a damaged, deteriorating, lost, or stolen copy or phonorecord or if the work’s existing format has become obsolete. But these copies may be made only if a reasonable effort has been made to find a replacement at a fair price and if any copy in digital format is not made publicly available outside the library or archives’ premises. In terms of this subsection, a format is considered obsolete if the machine or device necessary to render a work stored in that format is either no longer manufactured or is no longer reasonably commercially available. The next four subsections are concerned with patron copying and interlibrary loan copy-related issues such as a copy of an article or an entire work. Subsection 8 is an attempt to mitigate the effect of the life-plus-seventy-years duration of a copyright granted to an author (see discussion above):

> During the last 20 years of any term of copyright of a published work, a library or archives, including a nonprofit educational institution that

> functions as such, may reproduce, distribute, display, or perform in facsimile or digital form a copy or phonorecord of such work, or portions thereof, for purposes of preservation, scholarship, or research.

However, the library or archives may not reproduce, distribute, display, or perform a work if (1) the work is subject to normal commercial exploitation; (2) copies or phonorecords can be obtained at a reasonable price; or (3) the copyright owner posts a notice that either of the prior two conditions applies. The last subsection clearly states that Section 108 does not apply to a musical, pictorial, graphic, or sculptural work or a motion picture or other audiovisual work unless it is one dealing with news.

Section 109 deals with the transfer of a particular copy or phonorecord. It says if a person owns a phonorecord or computer program, she may not rent, lease, or lend that copy. But this does not apply to the rental, lease, or lending of a phonorecord for nonprofit purposes by a nonprofit library or education institution. "The transfer of possession of a lawfully made copy of a computer program by a nonprofit educational institution to another nonprofit educational institution or to faculty, staff, and students does not constitute rental, lease, or lending." It goes on to indicate that nonprofit libraries may lend computer programs if each copy has a copyright warning affixed to its packaging.

Section 110 identifies performances and displays that are not considered copyright infringements. The first subsection is referenced in discussions about the legality of showing videotapes marked "for home use only." Instructors or students of nonprofit educational institutions may perform or display a lawful copy of a work "in the court of face-to-face teaching activities . . . in a classroom or similar place devoted to instruction." The general consensus explains this subsection as allowing the showing of videotapes in class for instructional purposes only. "For home use only" videotapes may not be shown as rewards (e.g., for good attendance, or simply to baby-sit a class).

Section 117 allows the owner of a copy of a computer program to make a copy of that program for archival purposes. If the program is no longer owned by that person, the archival copy must be destroyed. This section also allows a copy to be made when it is "an essential step in the utilization of the computer program in conjunction with a machine and that it is used in no other manner."

Section 121, also known as the Chafee Amendment, after Senator John H. Chafee, who introduced the measure, was added to the Copyright Act on September 16, 1996. It addresses the reproduction of copyrighted works for blind or other disabled people. This refers to individuals who are eligible to receive books and other publications in specialized formats under the 1931 act to provide books for the adult blind. According to this section, "It is not an infringement of copyright for an authorized entity to reproduce or to distribute copies or phonorecords of a previously published, nondramatic literary work if such copies or phonorecords are reproduced or distributed in specialized formats exclusively for use by blind or other persons with disabilities." These copies or phonorecords may be reproduced or distributed only in a specialized format exclusively used by blind or other disabled people. These specialized formats are "Braille, audio, or digital text which is exclusively for use by blind or other persons with disabilities." They must include a notice stating that "further reproduction or distribution in a format other than a specialized format is an infringement" and include a copyright notice. However, the section does "not apply to standardized, secure, or norm-referenced tests and related testing materials, or to computer programs, except the portions . . . in conventional human language (including descriptions of pictorial works) and displayed to users in the ordinary course of using the computer programs."

Section 111 focuses on secondary transmissions, especially by cable systems; section 112, ephemeral recordings; section 113, pictorial, graphic, and sculptural works; section 114, transmission of sound recordings; section 115, compulsory licenses for making and distributing phonorecords; and section 116, public performances by means of coin-operated phonorecord players (e.g., jukeboxes). Section 118 centers on the use of certain works in connection with noncommercial broadcasting; section 119 on the secondary transmissions of superstations and network stations for private home viewing; and section 122 on secondary transmissions by satellite carriers within local markets. Section 120 turns to architectural works. These sections have limited impact on the average classroom.

Copyright Notice

Chapter 4 focuses on the details of copyright notice, deposit, and registration. Before March 1, 1989, failure to include the proper copyright on publicly distributed copies and phonorecords jeopardized the copyright in a work. What changed on that date? U.S. adherence to the Berne Convention Implementation Act of 1988 became effective. The Berne Convention does not require a notice, but use of the notice is strongly recommended because it clearly informs people that the work is copyrighted, by whom, and in what year. It also prevents a plea of innocent infringement (i.e., the infringer claims he or she did not realize the work was copyrighted).

The legal formality of copyright registration creates a public record of a particular copyright. Although registration is not required for protection, it establishes a public record; it *is* required before an infringement suit may be filed; it establishes evidence of the copyright's validity; it makes available statutory damages and attorney's fees in court actions; and it allows registration with the U.S. Customs Service to protect against the importation of infringing copies. Two copies of works published in the United States must be submitted for deposit in the Library of Congress.

Remedies

Chapter 5 enumerates the remedies for copyright infringement. It might also be called "crime and punishment." Remedies include injunctions; impounding and disposition of infringing articles; awards of damages and profits; and awards of costs and attorney's fees. Statutory damages can range from $750 to $30,000 for one work, although at the court's discretion it may range from $200 to $150,000. Section 504(c)(2) offers some protection for educators and librarians "in any case where an infringer believed and had reasonable grounds for believing that his or her use of the copyrighted work was a fair use under section 107" and was acting within the scope of his or her employment.

Esther Sinofsky

See also

Educational Fair Use

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Courseware

The origins of the term "courseware" are obscure, although it is obviously derived from the term "software." The latter has been attributed to John W. Tukey, a statistics professor at Princeton University, who in the January 1958 issue of *American Mathematical Monthly* wrote: "Today the 'software' comprising the carefully planned interpretive routines, compilers, and other aspects of automative programming are at least as important to the modern electronic calculator as its 'hardware' of tubes, transistors, wires, tapes and the like."

Credible claimants to the creation of the term “courseware” include programmers at IBM who in 1960 released the IBM 1500 computer complete with a courseware authoring system called Coursewriter, as well as Donald Bitzer and his colleagues at the University of Illinois who in the 1960s began developing a system (Programmed Logic for Automatic Teaching Operations, or PLATO) to automate instruction. Regardless of the origins, the term generally refers to any educational materials available in digital format.

Some people extend the term to refer to nonelectronic materials such as print-based textbooks, audiotapes, videotapes, and the like, but the more common usage is restricted to computer-based software formats that today are most widely distributed via CD-ROM or accessible through the World Wide Web or corporate intranets.

Although the word “course” in “courseware” may be interpreted to refer to educational software that is part of a formal course of study in the sense it is used in U.S. higher education, this is not a widespread distinction. Courseware comes in many forms, ranging from the *Sesame Street* CD-ROM a parent might buy a child to assist in early language development to sophisticated multimedia simulations that airlines utilize to train pilots.

In the early days of personal computers, there was a widespread belief that teachers should develop their own courseware, and a generation of teachers studied the BASIC (Beginner’s All-Purpose Symbolic Instruction Code) or primitive courseware authoring systems such as PILOT (Programmed Inquiry, Learning, or Teaching) so that they could do so. Another wave of teacher-produced courseware resulted from the introduction of HyperCard by Apple Computer in 1987. Today, teachers all over the globe are creating web-based courseware with hypertext markup language (HTML) editors and webpage production software such as DreamWeaver from Macromedia®.

Courseware encompasses both content and pedagogy. With respect to content, it would be difficult to find subject matter for which some form of interactive courseware has not been developed by someone somewhere, often an individual teacher, student, or programmer. Not surprisingly, most commercial courseware is focused on content related to information technology or some formal educational subject such as mathematics. Commercial courseware is typically developed by a team of specialists including subject-matter experts, instructional designers, graphic artists, and programmers.

With respect to pedagogy or instructional design, courseware exists in a variety of formats, including tutorials, drill-and-practice programs, simulations, and interactive learning environments. The earliest forms of courseware were heavily influenced by the behavioral psychology of B. F. Skinner (1968). These programs were essentially automated forms of programmed instruction. They presented information to the student in small segments, required the student to make overt responses to the information as stimulus, and provided feedback to the student along with differential branching to other segments of instruction or to drill-and-practice routines. Although this basic behavioral model continues to dominate commercial courseware such as integrated learning systems (Bailey 1993), the nature of the interactions between learners and computers in today’s most innovative courseware, such as constructivist learning environments (Wilson 1996), is based upon advances in cognitive psychology (Salomon, Perkins, and Globerson 1991) and constructivist pedagogy (Papert 1993). In these types of courseware environments, learners are less passive and may even contribute to the creation of interactive learning materials (Jonassen and Reeves 1996).

Courseware has recently become the focus of large investments from the U.S. Department of Defense, industry, and universities through the SCORM (Sharable Courseware/Content Object Reference Model) initiative of the Advanced Distributed Learning (ADL) organization (www.adlnet.org). The purpose of the ADL initiative is "to ensure access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required." Also referred to as "e-learning" and "online learning," distributed learning courseware is being "tagged" using extensible markup language (XML) to define all of the courseware elements, structure, and external references necessary to move courseware from one learning management system environment to another. As a result, courseware is supposed to become "accessible, interoperable, durable, reusable, adaptable and affordable." The ADL website claims that such sharable courseware will reduce the cost of instruction by 30–60 percent and the time of instruction by 20–40 percent as well as increase the effectiveness of instruction by 30 percent and student knowledge and performance by 10–30 percent. These findings are generally in agreement with other reviews of the literature (Kulik and Kulik 1991; Coley, Cradler, and Engel 1997).

Thomas C. Reeves

See also

Computer-Assisted Instruction; Instructional Design; LEGO/Logo; PLATO; Web-Based Course Management Systems; Web-Based Instruction

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Crossroads Project

The American Studies Crossroads Project (Crossroads) was one of the first websites and research projects devoted to technology and the humanities and one of the first to act as a comprehensive resource to an academic professional society, the American Studies Association (ASA). Founded in 1993 by Randy Bass, associate professor of English at Georgetown University, Crossroads's central research focus is the relationship between technology and pedagogy, highlighting the ways that the introduction of technology into classrooms leads to questions about teaching practices.

Crossroads serves the American studies community and a range of allied fields such as literature, history, art history, ethnic studies, and women's studies. The site provides a variety of web-based resources, including lists of links for national and international programs and centers in American studies, syllabi libraries, and a database of 5,000-plus links to American studies sites classified by subject and annotated for undergraduate users. In collaboration with the ASA executive director's office, the project publishes an online version of the ASA *Newsletter* and provides a listing of dissertations in American studies as well as a variety of information related to the annual meeting. In addition to these resources, the site also provides links and information for various constituent groups of the ASA and is beginning to provide these groups with online tools to represent themselves and their work online.

From the beginning, Crossroads sought to encourage faculty not only to integrate new technologies into their classrooms but also to ask tough questions about the implications of these new technologies for student learning. Crossroads engaged in a variety of research projects situated in faculty practice in classroom situations. Early project questions focused on, among other topics, the ways that electronic access to the cultural record created new ways of making knowledge, as well as how new technologies created opportunities for new forms of narrative. In asking these questions, faculty discovered that the introduction of new technologies brought forward questions about technology as well as questions fundamental to research and teaching practice in the disciplines.

These questions led to the design of the Visible Knowledge Project, a five-year project that seeks to deepen these inquiries through a focus on student learning. Using national networks of institutions and faculty involved in Crossroads and related projects, the Visible Knowledge Project provides for faculty to engage in course innovations involving technology, examine the evidence of student learning as a result of those innovations, and plan for further pedagogical change. Building off Crossroads, the Visible Knowledge Project site includes resources such as an online glossary, online project posters, and a set of tools to facilitate local discussions around technology and pedagogy. In addition to the Visible Knowledge Project, the Crossroads Online Institute continues the emphasis on helping faculty work through complex questions by providing an online faculty development seminar focused on the design of online or hybrid learning modules. The modules will be placed in a digital library along with faculty reflections and evidence of student learning.

Michael Coventry

See also

Who Built America?

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CSILE/Knowledge Forum®

The origins of CSILE (Computer Supported Intentional Learning Environments) are in research on knowledge-building, on the nature of expertise, and on the sociocultural dynamics of innovation. CSILE was designed to (1) make advanced knowledge processes accessible to all participants, including children; (2) foster the creation and continual improvement of public artifacts or *community knowledge* (Scardamalia

2002); and (3) provide a community space for carrying out this knowledge-building work collaboratively. It has evolved to the second-generation knowledge-building environment, known as Knowledge Forum.

The term “knowledge-building” (as a definable educational enterprise) originated with CSILE and accompanying scholarly works and represents an integrated framework for knowledge-building pedagogies, practices, and environments (Bereiter 2002; Bereiter and Scardamalia, 1989, 1993; Scardamalia et al. 1989; Scardamalia 2002). CSILE was first prototyped in a university course in 1983. By 1986 a fully functioning networked version was in daily use in an elementary school. In 1995 it was reengineered, with its affordances for knowledge building substantially enhanced, and published as Knowledge Forum (www.knowledgeforum.com) by Learning in Motion. Currently in version 4, with version 5 under development, Knowledge Forum continues to evolve in response to research findings and new opportunities. Thus, for example, while CSILE was built prior to the World Wide Web, Knowledge Forum now offers browser as well as client versions that can link Knowledge Forum classrooms to one another via the Internet. Current developments are taking advantage of the potential of wireless technologies to allow synchronization of online and offline knowledge-building. Knowledge Forum is used in education (grade 1 to graduate), health care, community, and business contexts in the Americas, Asia, Australia, Europe, and New Zealand. Knowledge Forum’s cross-sector, cross-age, cross-cultural framework reflects the theoretical idea that the socio-cognitive and cultural processes underlying knowledge acquisition and knowledge creation are fundamentally the same (cf. Piaget 1971; Popper and Eccles 1977) and so must apply to knowledge-builders of all sectors, ages, and cultures.

From the earliest days of educational computing, leadership was defined through model-school projects that demonstrate what classrooms enhanced with information and communication technology should look like. Typically, these classrooms exemplify discriminating consumership and creative use of off-the-shelf technology. Creating model-school projects was the idea behind the Apple Classrooms of Tomorrow program (Dwyer 1993). However, Apple’s first venture into advanced educational software (Bowen 1990) did not come out of their model classrooms. It came from CSILE, which Apple released in 1993 under the name Collaborative Learning Product. Apple’s press release announced:

Apple Introduces Ground-Breaking Product. . . .

> During a meeting of key education press at Apple headquarters today, the company introduced . . . Collaborative Learning Product, an integrated, research-based product and the first collaborative learning offering available for the K-12 education market.

Apple distinguished this product from bulletin-board services and e-mail, citing its affordances for inquiry-based work and knowledge construction, its basis in research, and its ability to address the skill requirements identified by a U.S. Department of Labor commission on achieving necessary skills for the workplace of the twenty-first century. It cited the following skills: “the ability to organize resources, to work with others, to learn a variety of technologies, as well as the ability to acquire, understand, and evaluate information.”

As the Apple press release claimed, CSILE represented a new generation of educational technology that specifically addressed the educational challenges of the twenty-first century. CSILE was not management, planning, or productivity software retooled for children; it was technology specifically designed to support knowledge creation. It was not a collection of tools; it was an environment to support the kinds of inquiry, information search, and creative work with ideas that go on in knowledge-building organizations of all kinds. There have since been a number of experimental efforts to construct knowledge-building tools and environments. However, Knowledge Forum is the only product continuously improved over the years based on research results arising from active and diverse user communities and reflecting knowledge-building theory, principles, and practices. Knowledge Forum development is not driven by technology but uses advances in technology to continually enhance and unfold the knowledge-building agenda.

The heart of CSILE/Knowledge Forum is a multimedia community knowledge space. In the form of notes, participants contribute theories, working models, plans, evidence, reference material, and so forth to this shared space. The software provides knowledge-building supports in the creation of these notes as well as in the ways they are displayed, linked, and made objects of further work. Revisions, elaborations, and reorganizations over time provide a record of group advances, like the accumulation of research advances in a scholarly discipline.

Multiple Perspectives, Multiple Literacies, and Teamwork

User-created graphical views constitute a higher level of organization and conceptually useful workspaces. A given note may appear in multiple views. As an example, four views provide different ways of conceptualizing the same group of notes.

The notes, represented by small icons, are produced by grade 1–3 students contributing information and graphics concerning their favorite dinosaurs. The notes appear on a blank white background, and show no particular organization. However, from the note titles children discovered classmates who had the same favorite dinosaur (triceratops, brontosaurus, etc.). Several students had produced graphic rather than text notes, and others wanted to link their notes to these graphics. So students added these graphics to the background of a new “dino types” view. Knowledge Forum’s keyword searches were used to collect all relevant notes (e.g., all notes with the keyword “triceratops”) and move them to the appropriate picture. The result was a new view. At about the same time, students in a university course were provided with access rights to this grade 1–3 dinosaur knowledge space. The university students noted, in reading these same notes, that they contained references to geological time. The university students created a new “geological time” view and entered a geological-timeline graphic from the Internet as a background. Student notes were searched again, now for periods of time (e.g., Jurassic), and the new collection was added at the appropriate point to the geological timeline. Students who had not yet identified the time when their dinosaur roamed the earth quickly extended their research so their note would appear in this new view. There was yet another sequence with these same notes. A biologist was invited to join the knowledge-building collaborative efforts. She signed in from afar and created the “food chain” view that referenced students’ dinosaurs as plant or meat eaters. The work illustrates the following knowledge-building affordances:

- Notes and views support teamwork and collaborative design. Notes are multimedia objects that can be coauthored. View backgrounds are not simply white backdrops or static bulletin boards (although they can be used that way); they are collaborative design environments with a built-in graphics program that makes it easy for users to design their own backgrounds.
- Views provide different perspectives on information. As the work of the biologist presented suggests, this networked technology is used to expand perspectives rather than to solidify roles in which students ask questions and experts answer them.
- Multimedia and other supports provide a way in for all participants to a common discourse. Notes and views support a range of multimedia objects, from text to video. As an example, some of these grade 1 students were not writers at the beginning of the year but did represent their ideas graphically. Easy assignment of keywords (touching a word in a note with a movable key icon is all it takes) made it possible for these young students to keyword their notes. These notes were then available, via keyword searches, for incorporation into new conceptual views.
- Notes and views can be individually or group authored. They can also be entered into private or public spaces; the default option is that they are contributed to a public forum. Accordingly,

the environment encourages openness in knowledge work while enhancing both individual and group processes.

- Emergent ideas and goals are supported. Knowledge Forum represents an open environment, without predetermined boundaries or structures around ideas or activities. Through collective responsibility for public knowledge spaces, with input from varied sources of expertise, the environment favors the emergence of big ideas and deep principles.

Creating Connections and Public Knowledge

Notes are situated in build-on structures that result in visible links to parent notes, with both notes and links modifiable.

- *Flexible build-ons:* The first five panes show the varied forms that a build-on structure can take. The note complex has been rearranged a number of times to give greater meaning to the concepts of frequency and amplitude. This flexibility can be contrasted with the downward branching of these same notes in threaded discourse. Threaded discourse now dominates the Internet, despite the fact that in many ways it defeats knowledge-building. Thus, for example, popular applications such as WebCT® and Blackboard® were built without supports for linking ideas across threads or for placing them in new and varied contexts. Linear discourse forms and isolated “conferences” entrap ideas. Knowledge Forum’s client version supports the full range of connections elaborated below; these more varied forms are being incorporated into the browser version (a process slowed by the limited interactivity allowed by current webpage technology).

Idea connectedness is further facilitated through the following means:

- *Annotation, citation, and reference links:* Annotations and reference links can be added to any note. References include pointers back to source notes, so ideas can be viewed in both original and new contexts. Links to views and subviews can be embedded within either notes or views. Deep embedding of ideas facilitates deep processing of information.
- *Interconnected views:* Views can be interlinked: Views reference other views, and different levels of access to views can be used to indicate the centrality or distance of particular views to the current work of the community.
-

- *Multifaceted indices:* Author-assigned indices (keywords, scaffolds, problem fields, titles) and automatically assigned indices (author, date, semantic field) make notes available through a variety of search parameters; a note-sorter allows the notes resulting from a search to be sorted for viewing or transported into another view. Citation, commentary, and notification enhance engagement by drawing all relevant authors back into the discourses that involve their ideas.

Advanced Knowledge Processes

Software typically includes palettes for text, graphics, and other productions. CSILE/Knowledge Forum introduced palettes for high-level knowledge processes.

Scaffolding knowledge processes. Scaffold supports are Knowledge Forum's most imitated feature. They were originally designed to provide procedural facilitation (Scardamalia and Bereiter 1983) for fostering expertise in writing and were titled "thinking types." Others refer to them as prompts and have used them to serve purposes similar to templates or fill-in-the-blanks forms. Knowledge Forum scaffolds can serve these purposes, but the following uses represent the real goals underlying their design:

- Scaffolds give ideas defined roles in such processes as theory refinement (e.g., "This theory cannot explain . . .") and constructive criticism. The opportunistic rather than mandated use of scaffold supports helps students embed these forms of discourse in their everyday work with ideas; "forms of discourse become forms of thinking" (Pontecorvo 1993, 191).
- The supports contained within any particular scaffold can be used opportunistically and flexibly in any order. Once selected, the term is entered into the main body of the text, at the point assigned by the author. The scaffold support then additionally serves as a searchable parameter. Scaffolds can be yoked to views, so different discourse forms can be encouraged in different views. It is also easy to toggle between scaffolds, so that multiple scaffolds can be used within any view or hidden when not wanted.
- Scaffolds are customizable. They can be easily added or modified to support the discourse needs of a particular community.

Reference and contribute. Knowledge Forum replaces the common "say it in your own words" norm with the more mature "contribute-and-reference" norm. Cited material is automatically quoted (made visually distinct), with automatic links back to original sources and automatic compilation of a bibliography. Users are especially drawn to this feature, because they see their work referenced rather than copied.

Problems of understanding. A problem field at the header of the note encourages a shift from topic- to problem-based inquiry. Knowledge Forum's "problem space" encourages the identification of problems of understanding to guide inquiry. "Problem" searches produce an overview of the problems that others are working on, so it is easy to contribute to those problem spaces or start a new field of inquiry.

Rise-Above and Improvable Ideas

"Rise-above" notes play a pivotal role in idea improvement. The idea, based on the philosophical concept of dialectic, is that the most constructive way of dealing with divergent or opposing ideas is not to decide on a winner or a compromise position but rather to create a new idea that preserves the value of the competing ideas while "rising above" their incompatibilities. In the simplest cases a rise-above may be simply a summary or distillation; in the most compelling cases, the rise-above presents a new idea that all the participants can recognize as an advance over their previous ideas.

A student's high-level summary of knowledge advances over a period of several months. This student packaged the set of notes that led to the discovery reported here; his older notes are now accessible only through this rise-above note. Rise-above notes are also used to synthesize ideas, create historical accounts and archives, reduce redundancy, and in other ways impose order on ideas.

The rise-above idea can be applied to views rather than notes. The linked views (e.g., eye, circulation) were created first, and this higher-order "human body" view then served to integrate these separate views and to support a new discourse on how different parts of the body work together. As this suggests, notes and views operate as a form of zoom in/zoom out, encouraging users to think in terms of relationships.

Endless improvability of ideas is further supported by the following:

- Ability to create increasingly high-order conceptual frameworks. It is always possible to reformulate problems at more complex levels, create a rise-above note that encompasses previous rise-above notes, or create a more inclusive view-of-views.
- Review and revision. Notes and views can be revised at any time, unlike most discussion environments that disallow changes after a note is posted.
-

- Published notes and views. Processes of peer review and new forms of publication engage students in group editorial processes. Published works appear in a different visual form, and searches can be restricted to the published layer of a database.

Individual and Group Portfolios: Evolution of Ideas

The entries in a database, taken collectively, provide process accounts of the contributions of each participant, as well as accounts of how those different inputs were combined to lead to the collective achievements of the group. Portfolios are simply new views created by an author, a group, or a class to highlight different aspects of this work. The evolution of ideas can be studied through searches and analytic tools. Thus, for example, the work that led to a new theory can be analyzed. Additionally, the process of constructing portfolios affords deeper student reflection about their own knowledge and puts self- and peer-assessment into evaluative accounts of student learning

Ideas and Artifacts as Objects of Discourse

Anything that can be represented digitally can be transformed into an object of discourse, with the full range of knowledge-building activities applicable. There are four different objects, along with transparent overlays, markup, and build-ons.

Embedded and Transformative Assessment

Knowledge-builders monitor their work and engage in self-assessment rather than being totally dependent on external evaluations. Individual and group portfolios help this process. Research tools work in the background of Knowledge Forum to automatically record activity patterns such as reading, building-on, referencing, and creating views. Results from these analytic tools can then be fed back into the work as it proceeds, rather than waiting until the end of a unit of work to provide feedback, when it is too late to make adjustments.

The Knowledge Society Network and the Virtual Suite of Possibilities

Through Knowledge Forum’s flexible database access and linking structures, knowledge-building discourse may be confined to a single classroom or distributed across the world. As this suggests, the work of local communities can be enhanced through the worldwide network of communities using Knowledge Forum. Sophisticated semantic analysis tools can be used for matchmaking (locating groups working in similar semantic fields) and common problems. Searches of the Knowledge Society Network access the published layers of all the Knowledge Forum databases linked to the worldwide network, with these published layers operating, in effect, as websites. Thus the work of a local community “rises up” to become an object of discourse within an extended discourse community. Adults frequently find that the work of even the youngest students helps them advance their own understanding—even if only their understanding of how students think.

There are virtual tours of a database that the Knowledge Society Network enables. This tour begins with an overview of the science work of a grade 1 class, September to June. By following links it is possible to get a more in-depth view of specific units (e.g., the unit on leaves). The tour is presented from multiple perspectives (e.g., links to the students’ and teacher’s perspectives). Other perspectives include the curriculum, research, assessment, parents’, and state-of-the-art perspectives. Access to all or parts of a database, with or without a guided tour, can be granted to visitors or telementors through the Internet. Participants can build on, comment, and in other ways create reference links to this work in the Knowledge Society Network. This network also supports virtual workshops, practica, seminars, and other events surrounding a knowledge base. Some of the most successful instances of collaborative knowledge-building have involved school students, teachers, researchers, graduate students, curriculum, and subject-matter experts coming together to tackle a problem of understanding.

Toward a Knowledge Society

From the start, the CSILE/Knowledge Forum initiative has aimed at revolutionary change: from a focus on carrying out tasks and activities to a focus on the continual improvement of ideas; from an emphasis on individual learning and achievement to the building of knowledge that has social value; from a predominantly teacher-directed discourse to distributed knowledge-building discourse. In line with the magnitude of the intended change there has developed, along with the CSILE/Knowledge Forum technology, knowledge-building pedagogy, practices, and principles (Scardamalia 2002; Scardamalia and Bereiter, forthcoming). Results indicate significant advances in textual, graphical, and computer literacy, as well as in depth of inquiry, collaboration, and a host of mature knowledge processes (Scardamalia, Bereiter, and Lamon 1994). More generally, use in grade 1 through tertiary education, in health care, in public organizations, and in workplaces suggest that Knowledge Forum not only enhances learning but also enables the creative work with ideas that set students on a course of knowledge creation—a course that helps to drive lifelong learning and innovation. A worldwide community of educational innovators—the Knowledge Society Network—has begun to take shape (Scardamalia and Bereiter 1996), supported by the Institute for Knowledge Innovation and Technology (www.ikit.org).

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See also

Active Learning; Computer Supported Collaborative Learning; Constructivism; Open-ended Learning Environments

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Curriculum Integration

At the beginning of the twenty-first century there is a national movement to change the way we teach students. Teachers in our nation’s schools are charged with teaching students who will spend all of their lives in a technology-driven society. The ability to use and, more important, integrate technology into the curriculum is a necessity in the teaching profession. This has given rise to the topic of curriculum integration.

Curriculum integration is difficult to define because of the many ways it can be accomplished. First, “curriculum” is defined as a set of courses constituting an area of specialization or a field of study; “integration” is defined as bringing together different parts to combine into a whole; “technology integration” refers to the combination of all technology parts, such as hardware and software, together with subject-related content to enhance student learning and accomplish curriculum goals. Thus the term “curriculum integration” includes the effective integration of technology throughout the curriculum to help students meet the standards and outcomes of each lesson, unit, or activity. Curriculum integration encompasses computer literacy, information literacy, and integration literacy.

A person must possess a certain level of computer literacy, which is the understanding of computers and technology and their uses. For many years, a majority of educators believed that if they used technology in the classroom, then they were integrating technology into their instruction. In other words, if a teacher uses any type of technology as a productivity tool or during instruction, then that was curriculum integration. These terms, “using” and “integrating,” are continuously interchanged. Yet clearly they do not mean the same thing. However, a person must know how to use technology prior to being able to appropriately integrate technology into classroom curriculum.

The second literacy one must possess is information literacy. Information literacy is knowing how to find, analyze, and use information. Information literacy is the ability to gather information from multiple sources, select relevant material, and organize the information into a form that will allow the user to make decisions or take specific actions.

Although computer and information literacy are very important for educators, today’s educators also must integrate technology as a tool to facilitate learning. Educators must be able to assess technology resources and plan classroom activities using any and all available technologies. These skills are part of integration literacy, which is the ability to use computers and other technologies combined with a variety of teaching and learning strategies to enhance students’ learning. Integration literacy means that teachers can determine how to match appropriate technology to learning goals, objectives, and outcomes (Shelly et al. 2002). Effective curriculum integration includes understanding how to integrate technology into the classroom curriculum successfully. This relies on a solid foundation of computer and information literacy.

To have effective curriculum integration, teachers must find methods and strategies that maximize the delivery and design of learning experiences. Educational technologists have become the advocates in integrating computers and other technologies into content areas. For years, schools have focused their efforts on getting technology or computer labs into the schools. Computer labs clearly provide solutions to some educational dilemmas and are an excellent addition to any school. Research shows that computers and related technologies, however, are more effective when integrated into subject content and placed in the classroom at the point of instruction (Web-Based Education Commission 2000). Point of instruction means having the technology in the classroom at the teachers' and students' fingertips.

In order to accomplish this, the role of the teacher must change to become that of a facilitator. The teacher's role changes from being the "sage on the stage" to being the "guide on the side." As teachers plan authentic learning experiences that incorporate a variety of tools and technologies, they need to be prepared to guide students through the learning experience. This requires a good foundation in computer literacy, information literacy, and integration literacy. Initially, teachers may be uncomfortable with the role of facilitator; however, as students adjust and learn to be more responsible for their learning, they will be more motivated and become better problem-solvers. When teachers are facilitators, they enable students to develop higher-order thinking and problem-solving skills. In addition, teachers help students develop the technology and social skills necessary to be successful in the workplace or in higher education.

Curriculum integration is evident when there is a seamless transition from one learning element to another using multiple technologies. An educator has always had the job of making teaching look easy. Integrating educational technology into the curriculum suggests determining which electronic tools and the appropriate methods for implementing them for any given classroom situations and learning condition. The definition of integrating technology in the curriculum means moving beyond trivial uses of instructional technology to uses that advance student learning of the technology in the curriculum that prepares students for the workforce of tomorrow. We can teach teachers to use and integrate technology, but until they experience hands-on authentic integration successes in their classrooms, we are just standing still. Standing still is not integrating, because integrating is like dancing: When you dance, the parties and equipment come together in perfect motion—that is curriculum integration.

Planning and Evaluation

To obtain effective curriculum integration, an educator must plan and think through the lessons. Lessons should be broken up into individual lesson plans, and those should be developed with an instructional planning tool or instructional model like the ASSURE model (Heinich et al. 2002). The ASSURE model, a six-step procedural guide for planning and delivering instruction that integrates technologies and media, can assist teachers with this process. The six-steps are: (1) analyze the learners; (2) state objectives; (3) select methods, media, and materials; (4) utilize media and materials; (5) require learner participation; and (6) evaluation and revise.

The tools used can be books, computers, multimedia, overhead projectors, televisions, videos, digital cameras, PDAs, photographs, or other tools used to accomplish learning goals. Technology is a tool, and if the tool is not appropriate for the instructional goals, then it should not be used. The instructional goals, the needs of the student, and the availability of the media for a specific set of objectives must be the driving force that causes a teacher to choose a particular media. The instructional goals should be the focus, not the technology. When integrating technology, it should always be viewed as a tool that assists the teacher in meeting the goals of the curriculum and the learning needs of the students. The teacher becomes a mentor and colearner, who is actively engaged in enabling students to access, analyze, apply, and create information electronically. When this happens, so does curriculum integration.

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See also

ADDIE; Analysis; Apple Classrooms of Tomorrow Project; Information Literacy; Instructional Design; Instructional Technology; Technology in K-12 Schools; Teachers: Preparation and Training

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Cyberculture and Related Studies

"Cyberculture" is a general, fluid, and contested term referring to the intersections among three relatively recent phenomena: digital technologies that make up cyberspace or new media; the social interactions and cultural manifestations that take place within or are made possible by new media; and the multiple contexts that surround new media. Often used interchangeably with the terms “Internet culture” or “digital culture,” cyberculture first surfaced in the early 1990s and gained popularity throughout the decade, directly coinciding with the widespread adoption and whirlwind popularization of the Internet. It is a term used by the popular press, academic scholars, and aficionados of the Internet.

Defined traditionally, the technologies that comprise cyberculture include the computers, servers, and wires that constitute the Internet, as well as the various applications that run on the Internet, including e-mail, mailing lists, listservs, bulletin boards, Internet relay chat, instant messaging, multiple-user domains, and, of course, the World Wide Web. Cyberculture technologies also include more recent developments like Webcams, blogs, networked games, chat rooms, and peer-to-peer networks. In more general terms, cyberculture technologies refer to digital technologies that are interactive and/or networked, including, for example, cell phones, PDAs, and stand-alone computer games, as well as DVDs, CD-ROMs, and software applications like word processors and spreadsheets.

In addition to the digital technologies that give it shape, cyberculture is defined by the ways in which humans use it. Cyberculture is found in the social interactions between users frequenting the same mailing list or chat room. Cyberculture is maintained by the collective behaviors and social norms agreed upon by users, enforced by list moderators, or stipulated in frequently asked questions. Cyberculture is apparent in the playful exercises and creative experiments found in Internet theater and cyberart, as well as in the wired attitude of writers of online sites like Salon, Suck, and Slashdot.

And finally, cyberculture includes the multiple and complex contexts from which the Internet emerges. For example, cyberculture can be ideological and geographical, as in the case of the ARPANET, developed by the U.S. military and firmly directed by Cold War politics, or in the case of Radio B92, the web-based radio station that delivered alternative news from a war-torn Belgrade in the late 1990s. Furthermore, cyberculture is both a product and a reflection of economic contexts, ranging from the free-market libertarianism popular in the early to mid-1990s to the dot-com daze of the late 1990s. Cyberculture also functions this way in relationship to political contexts, as witnessed, for instance, in the child-porn scare of the mid-1990s that led in part to the Communications Decency Act, as well as the most recent curbs on online privacy resulting from the post–September 11 climate and the emphasis on homeland security. Cyberculture includes and is given shape in the popular media via depictions of the Internet in film, television, and print, advertisements for the Internet, and rhetoric about cyberspace.

At the heart of cyberculture is an interest and concern with how the Internet and its related technologies are restructuring almost every aspect of lived experience among residents of developed and, increasingly, less developed countries. In a relatively short period, these technologies have affected the way we understand time, space, and the world in general. For example, national boundaries, previously self-contained, are quickly becoming eclipsed by the constant and instantaneous flow of information and capital. In addition, new media technologies have altered the ways we live our everyday lives. For many, a typical day now includes a succession of interactions with new media technologies, including everything from online banking to reading the newspaper on the Internet. The Internet has also offered us new possibilities and challenges, including the use of virtual learning environments and growing cases of Internet-aided plagiarism. In order to understand how these technologies have transformed our interactions within our changing society, it is imperative that we examine the role new media plays in the way our culture is being reorganized and understood.

Although the rapid integration of new media technologies into our society has confronted us with an expansive amount of questions and issues related to the various ways they have modified our lives, several key areas of concern have arisen. Among these, three specific discussions necessitate further consideration. The first is the so-called digital divide, which reflects concerns about the widening gap between those who have and do not have easy access to the Internet, as well as the ways in which such access is tied to education, ethnicity, and income, among other factors. The second includes the issues surrounding use of new media technologies as tools for communication and community-building. And finally, there are the questions involving the effects of new media technologies on our understanding of the body and identity.

The technologies associated with cyberculture have increasingly become essential tools for economics, politics, and education; questions of access, knowledge, and use surrounding new media technology are important in considering who will have power, and who will be powerless, in our increasingly technological society. Some studies, including “Falling through the Net,” a 1999 report commissioned by the U.S. Department of Commerce, argue that there is a digital divide forming in the United States and that ensuring all Americans have the skills and tools to participate in the emerging digital society is essential to guarantee the nation’s participatory democracy and economic success. Even though the number of Americans connected to the nation’s information infrastructure continues to rise, the digital divide still exists and, in many cases, is growing. The digital divide has created additional barriers for individuals and groups that have traditionally faced various boundaries in America; as the 1999 “Falling through the Net” report notes, minorities, low-income persons, the less educated, and children of single-parent households, particularly when they reside in rural areas or central cities, are among the groups that lack access to information resources.

The digital divide is of specific interest to educators. Educators are increasingly expected to assist in bridging the digital divide. In its study, the Department of Commerce suggests that a primary solution for making the technology available to those left behind by the information revolution is through public access points, referred to as community access centers (CACs), which include schools and libraries. The study intends the CACs to assist in providing public and free access to the Internet along with the training needed to survive in our emerging digital society. Although this recommendation has helped schools gain financial assistance for the procurement of new technologies, it has also created new demands for the educator, such as additional training in how to teach the essential skills needed for securing a job in the digital workplace.

Access to the Internet and its related new media technologies has become increasingly essential due to its accelerated use as a medium of communication and community-building. Communication has played a key role in both the development and initial popularization of the Internet. ARPANET, the Internet’s predecessor, was conceived of by the U.S. Department of Defense in 1969 in an attempt to create a communications network that would survive a nuclear attack. In the 1980s the use of the Internet spread beyond the military to academics and scientists, when they began using the technology for sharing research along with various collaborative projects. It was also during this time that many Internet users discovered its power for creating new ways of connecting with each other, engaging with applications such as e-mail, usenet groups, and MUDs. In the early 1990s the introduction of the World Wide Web brought the information superhighway to the masses; while surfing the web became the popular face of the Internet, new communication applications continue to flourish in the guise of e-mail, chat rooms, and instant messaging.

In addition to debate regarding access and the digital divide, the widespread use of the Internet for the purpose of communication has placed questions concerning the relationships between community and cyberspace in a central position among those interested in cyberculture. Within this discussion, the earliest arguments focused on the perceived decline of face-to-face community in contemporary culture. Several writers, including Howard Rheingold, contended that online communities were providing members with an arena for connecting with others in our modern society where the spaces traditionally associated with communities were disappearing. Conversely, others argued community could never exist in virtual space, and new media technologies were one of the major reasons, rather than a solution, for the failing sense of community in everyday life. While this debate lingers, more and more people are expressing either that they have found a true feeling of community online or that they have supplemented and strengthened real-life communities using new media technologies.

While virtual technologies have provided us with new opportunities for the creation of collective communities, the same technologies have also given us a set of tools for the expression of individual identities. One of the most popular uses of technology in this way is the creation of the personal webpage. People are employing text, images, and links in order to narrate their personality and interests to the web-viewing public. Whereas in real life we often are able to present only a limited view of ourselves to those we encounter—usually contingent on the situation we are in—the webpage allows people to explore and present as many aspects of their identity as desired. Several other technologies are being used in this way to varying degrees, including the inclusion of a tag line with a favorite quote attached to an electronic message, perhaps installing a webcam to one’s computer in order to broadcast aspects of one’s daily life over the web. While many value new media technologies as a novel way of expressing who they really are, others are interested in the anonymity afforded by the Internet. Many visitors of chat rooms, MUDs, and online gaming environments have explored the multiplicity of personas available to them as disembodied Internet users. This practice has been valorized by several writers as a way of deconstructing the limiting categories of gender, race, and class that surround and influence our offline lives. Others, however, fear that the naive passing that occurs in virtual environments works only to reinforce already existing prejudices and stereotypes.

With respect to the field of education in general and higher education in particular, the study of cyberculture, or cyberculture studies, has become a growth industry. Stretching back to the early and mid-1990s with the work of such thinkers as Julian Dibbell (1993), Howard Rheingold (1993), and Sherry Turkle (1995), and gaining steam during the mid- to late 1990s with the influential anthologies edited by Steve Jones (1995, 1997), the field of cyberculture studies (alternatively called Internet studies or new media studies) is currently undergoing institutionalization thanks in part to the publication of *New Media and Society,* the first conference of the Association of Internet Researchers in 2000, and select universities offering degree programs on the topic.

As witnessed in the countless monographs and anthologies published by academic and popular presses, and the increasing number of papers and panels presented at scholarly conferences from across the disciplines and around the world, the field of cyberculture studies is a diverse and growing field of inquiry. It is possible, however, to trace the major works of scholarship on cyberculture by establishing three stages or generations. The first stage, *popular cyberculture,* is marked by its journalistic origins and characterized by its descriptive nature, the tendency to divide the debate between utopian and dystopian arguments, and the use of the Internet-as-frontier metaphor. The second stage, *cyberculture studies,* focuses largely on virtual communities and online identities and benefits from an influx of academic scholars. The third stage, *critical cyberculture studies,* expands the notion of cyberculture to include four areas of study—online interactions, digital discourses, access and denial to the Internet, and interface design of cyberspace—and explores the intersections and interdependencies among any and all four domains.

Our disciplinary lineage begins with popular cyberculture, a collection of essays, columns, and books written by particularly wired journalists and early adopters. Starting in the early 1990s, these cultural critics began filing stories on the Internet, cyberspace, and the information superhighway for major U.S. newspapers and magazines. Significantly, what began as an occasional column in a newspaper's technology section soon became feature articles appearing on the front page, in the business section, and in lifestyle supplements, as well as within the new media/cyberspace beat of many mainstream magazines. Between 1993 and 1994, for example, *Time* magazine published two cover stories on the Internet, and *Newsweek* released the cover story "Men, Women, and Computers." Moreover, in 1994 the second editions of the popular how-to books *The Internet for Dummies* and *The Whole Internet* became best-sellers.

The popular cyberculture writings were generally descriptive. Usually required to follow the term "Internet" with the parenthetical phrase "the global computer network system," these journalists had the unenviable task of introducing nontechnical readers to the largely technical, pre–World Wide Web version of cyberspace. Accordingly, much of this work included lengthy descriptions, explanations, and applications of early Internet technologies such as file transfer protocol, gopher, lynx, UNIX configurations, telnet, and usenet.

In addition to being overly descriptive, early popular cyberculture often suffered from an unproductive dichotomy: Early popular cyberculture often took the form of dystopian rants or utopian raves. From one side, cultural critics blamed the Internet for deteriorating literacy, political and economic alienation, and social fragmentation. Often branded neo-Luddites, these critics feared a society based on mediation rather than face-to-face communication and wondered aloud whether our children would find themselves more at home in front of a computer screen rather than at school, on the playground, and around the dinner table. From the other side, a vocal group of writers, investors, and politicians loosely referred to as technofuturists declared cyberspace a new frontier of civilization, a digital domain that could and would bring down big business, foster democratic participation, and end economic and social inequities. Although finding friendly platforms within major U.S. newspapers and popular magazines, their primary pulpit was a new line of technozines—glossy, visually impairing magazines with names like *Mondo 2000, bOing bOing,* and *Wired.*

Finally, in addition to its descriptive nature and rhetorical dualisms, early popular cyberculturalists employed the frontier as the reigning metaphor. For example, in the now canonical 1990 essay “Across the Electronic Frontier,” Mitchell Kapor and John Perry Barlow (1990) described the Internet in the following terms: “In its present condition, cyberspace is a frontier region, populated by the few hardy technologists who can tolerate the austerity of its savage computer interfaces, incompatible communication protocols, proprietary barricades, cultural and legal ambiguities, and general lack of useful maps or metaphors.”

If early cyberculture scholarship can be characterized by its descriptive nature, binary dualism, and frontier metaphors, the second stage, cyberculture studies, rests upon the twin pillars of virtual communities and online identities. One of the earliest and certainly the most referenced articulators of virtual communities is Howard Rheingold (1993), who defines a virtual community as: “A group of people who may or may not meet one another face-to-face, and who exchange words and ideas through the mediation of computer bulletin boards and networks. . . . We do everything people do when people get together, but we do it with words on computer screens, leaving our bodies behind” (58).

If Rheingold’s *The Virtual Community* is the first pillar of cyberculture studies, the second is Sherry Turkle’s *Life on the Screen: Identity in the Age of the Internet* (1995). Turkle addresses the idea of online identities by exploring ethnographically a number of virtual environments, including multiuser domains, or MUDs. She finds that while some people use cyberspace to repress an otherwise less-than-functional “real” or offline life, most use the digital domain to exercise a more true identity or a multiplicity of identities. According to Turkle (1995, 263), “Virtuality need not be a prison. It can be the raft, the ladder, the transitional space, the moratorium, that is discarded after reaching greater freedom. We don’t have to reject life on the screen, but we don’t have to treat it as an alternate life either.”

By the mid-1990s, cyberculture studies was well under way, focused primarily on virtual communities and online identities. Furthermore, as a result of the enthusiasm found in the work of Rheingold and Turkle, cyberculture was often articulated as a site of empowerment, an online space reserved for construction, creativity, and community. Fortunately, however, this simplification was matched by the richness found in the nascent field’s welcoming of interdisciplinarity. With the growing popularity of user-friendly Internet service providers such as AOL and CompuServe and the widespread adoption of Netscape, the great Internet rush was on. Significantly, the introduction of the web was not only a *technological* breakthrough but also a *user* breakthrough. Replacing tricky file transfer protocol and burdensome gopher with a simple, point-and-click graphical interface, the web helped to foster a less technical, more mainstream Internet populace. Coupled with these technological breakthroughs were academic considerations. In addition to a concerted effort on the part of university administrators to get faculty wired, scholarly conferences, papers, archives, and discussions came online, leading all but the most technophobic academics to the Internet.

As expected, new scholars brought new methods and theories. For example, while some sociologists approach virtual communities as “social networks,” others employ the sociological traditions of interactionism and collective action dilemma theory. Within anthropology, scholars began formulating a new subfield, cyborg anthropology, devoted to exploring the intersections between individuals, society, and networked computers. Researchers from a related field, ethnography, took their cue from Turkle and began to study what users do within diverse online environments, ranging from online lesbian bars and usenet newsgroups to web-based “telegardens” and online cities.

At the same time, linguists began to study the writing styles, netiquettes, and (inter)textual codes used within online environments. Similarly, feminist and women’s studies researchers have used textual analysis and feminist theory to locate, construct, and deconstruct gender within cyberspace. Furthermore, a collection of community activists and scholars began to explore the intersection of real and virtual communities in the form of community networks, including the Public Electronic Network in Santa Monica, California, the Blacksburg Electronic Village in Blacksburg, Virginia, and the Seattle Community Network in Seattle, Washington.

Although cyberculture studies strays in many directions, a product in part of the massive influx of scholars from across the disciplines, an increasingly well-traveled path is taking shape and represents a third stage of work: critical cyberculture studies. Influenced heavily by recent scholarship in critical theory and cultural studies, critical cyberculture studies deals primarily with the social construction of cyberspace and focuses especially on issues of cultural difference, consumerism, and power. Whereas early proponents proclaimed the Internet as a virtual space free of gender, race, and class, critical cyberculture studies scholars place issues of cultural difference in the center and explore the ways in which policy, code, and rhetoric reveal and reflect cultural differences. Similarly, wary of discussions of the digital divide framed by corporate computer interests suggesting that the appearance of hardware will ensure access, contemporary scholars locate the debate within a matrix of political, cultural, and economic considerations.

In some ways, critical cyberculture studies represents an intervention into the dot-com daze that practically overcame the Internet in the late

1990s. While acknowledging the contribution of companies like AOL to broaden the spectrum and diversity of the Internet's population, critical cyberculture studies encourages us to think about the differences between communication and consumption, e-mail and e-commerce, and active participation and passive reception.

Perhaps more than anything, critical cyberculture studies seeks to position cyberspace and its attendant technologies in as large and broad a context as possible. For example, contemporary scholars are beginning to look at the Internet within a historical context, comparing its social, technological, and economic developments to those found in the history of other once-new communication technologies like film, radio, and television. In this light, new media's "newness" becomes less important in favor of a more holistic sequence of media history, one that encourages critical perspectives and affords a broader understanding of media convergence.

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See also

Communities of Practice; Community Technology Centers; Digital Divide; MOOs and MUDs; Netiquette; Virtual Reality; Weblog

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D

Diffusion of Innovations

"*Diffusion* is the processes by which an innovation (a new idea) is communicated through certain channels over time among the members of a social system" (Rogers 1995, 5). There are four factors that interact to influence the diffusion of an innovation: (1) the innovation (e.g., educational technology); (2) the communication channel (e.g., media, word of mouth); (3) time; and (4) the social system (e.g., school, university). Everett M. Rogers has done the most to synthesize all of the significant findings and theories related to diffusion. His book *Diffusion of Innovations*, first published in 1960 and now in its fourth edition (1995), has become the standard reference in this area. It provides a theoretical framework for models of diffusion and offers a critical examination of the research evidence.

Diffusion theory is valuable to the field of educational technology for several reasons (Surry 1997). First, the causes of educational technology's diffusion problems remain unclear; some blame the teacher while others blame the institutions. Second, educational technology is an innovation-based field in which the various products and methods used represent innovations in the form, organization, and delivery of instruction. Third, by studying diffusion theory, it is possible to come up with a model for adoption and diffusion of educational technology. Diffusion theory provides important guidance for those interested in seeing educational technology adopted within all levels of the educational system. There are five concepts that are central to diffusion of innovations theory: (1) the innovation-decision process; (2) attributes of successful innovations; (3) adopter categories;

(4) characteristics of successful change agents; and (5) consequences of innovations.

Innovation-Decision Process

The innovation-decision process may be considered from the perspective of an individual or an organization. Potential adopters have to first know about an innovation, be persuaded as to the merits of such an innovation, decide to adopt or reject the innovation, implement the new idea, and finally confirm their decision whether or not to continue with the original decision.

This process is predictable regardless of the innovation and provides a framework for those working toward diffusing educational technology in the classroom. The type of innovation-decision has an important influence on the rate of adoption of an innovation. Organizational adoption of innovations (e.g., school or university adoption) tends to fall into one of three categories:

1. *Optional* innovation-decisions are choices to adopt or reject an innovation that are made by an individual or an organization. A school or a university may choose to use a certain educational technology idea or teaching method. Teachers may as well have their own initiatives to teach using certain educational technology techniques or methods.
2. *Collective* innovation-decisions are choices to adopt or reject an innovation that are made by consensus among members of an organization. A school board or a university committee may collectively decide to standardize certain educational technology tools and methods. Such a decision is normally made through agreement by the majority members of the organization.
3. *Authority* innovation-decisions are choices to adopt or reject an innovation that are made by one or more individuals in an organization who possess power, status, or technical expertise. An educational policy may require all employees to adopt and use certain educational technology innovations regardless of the opinion of the teachers.

Attributes of Successful Innovations

For an innovation to be readily and easily adopted, it is usually evaluated with respect to five attributes. First, an innovation must have relative advantage to the potential adopter. For example, an educator should clearly see the benefits of educational technology in enhancing the teaching process over traditional teaching methods. Second, the innovation must fit and be *compatible* with existing working patterns and experiences. Adopting an innovation should be consistent with an organization's existing values, past experiences, and needs. Third, a new innovation such as educational technology should allow for experimentation (trialability) by potential adopters before they make their decision to adopt or reject the idea. Fourth, the positive results of an innovation should be visible to others. Teachers need to see the results of educational technology use by their colleagues and examine its effect on others' classes in order to decide whether or not to use it in their own classes. Fifth, an innovation that is perceived as difficult to use and complicated will be adopted more slowly than others. These attributes and many others have been found to play an important role in several technology-related adoption studies.

Adopter Categories

Adopters of an innovation are usually categorized based on the degree to which an individual is relatively earlier in adopting new ideas than the others (innovativeness). Typically, there are five main adopter categories:

1. *Innovators:* individuals who are obsessed with new ideas and believe that there is always a better way to do things. For example, innovators in the field of educational technology may invent new ideas, but most of the time they improve the methods by which already invented tools are used. Innovators find ways of overcoming obstacles to their plans, love challenges, and usually never stop until they achieve their goals.
2. *Early Adopters:* people who are the first to adopt an innovation in an organization. They tend to have a higher level of formal education and a higher social status. They are the individuals who are considered by many as "the individuals to check with" before using a new idea. Such people serve as a role model for speeding the diffusion of an innovation since they are not too far ahead of the average individual in innovativeness.
3. *Early Majority:* individuals whose innovation-decision period is relatively longer than that of the innovator and the early adopter. They follow with the intention and willingness to adopt an innovation, but they seldom lead.
4. *Late Majority:* those who adopt new ideas just after the average member in an organization. The adoption for the late majority is mostly due to increasing network pressure from peers. For example, as more teachers adopt educational technology for their teaching and learning activities, people in the late majority feel that they are left behind and realize the increasing pressure

from their students and from the organization to catch up with the rest.

5. *Laggards:* the last people in an organization to adopt an innovation. Their decisions are often made based on what was practiced in the past, and their interaction is normally with those who have relatively traditional values. An example of this category would be traditional teachers who have served for a very long time and don't see a compelling reason to adopt new educational technologies. From their perspective, what they have been doing traditionally works just fine, and there is no need to learn new technologies and methods to change the teaching and learning processes.

Individuals falling into these adopter categories for any given innovation tend to follow the normal curve with a few innovators (2.5 percent), early majority (13.5 percent), and laggards (16 percent), and many early and late majority categories (68 percent to 34 percent each).

Characteristics of Successful Change Agents

A *change agent* is an individual who influences the innovation-decision of others. Change agents play a key role in the innovation-decision process and can be opinion leaders or peers of the potential adopter. Typically, change agents desire to secure the adoption of the innovation. However, change agents may assert their power of persuasion to slow or stop the diffusion of innovations they perceive as harmful to potential adopters (Rogers 1995). Teachers, students, and institutions are all seen to be effective change agents in the diffusion process of educational technology. Successful change agents have a strong client orientation as opposed to an orientation toward the innovation. They tend to understand their clients and have credibility, possibly because of similarities to the client. Teachers are ideal change agents because of their homophily with other teachers.

Near-peer influence, institutional support, and colearning with students are methods that can provide the channels for change agents to diffuse educational technology use in schools and universities. Students with technology skills have a powerful influence to assist and persuade teachers to adopt technology in their instruction. Finally, institutional support is essential to creating an environment conducive to the adoption of educational technology use among teachers and students alike.

Consequences of Innovations

The adoption or rejection of an innovation leads to certain consequences that may affect an individual or an organization. There are desirable or undesirable consequences, direct or indirect, and anticipated or unanticipated.

It is usually hoped that an innovation will lead to desirable, direct, and anticipated consequences. However, consequences do not always occur as intended, leading to undesirable, indirect, and unanticipated consequences. Although it is possible to describe and establish categories for consequences of innovations, it is difficult to generalize or predict when and how consequences will happen.

Diffusion Theory

Educational technology is an innovation-based field that follows an unpredictable path guided by highly dedicated and motivated individuals. These individuals share a common vision and work to bring that vision into reality. Motivated teachers, students, and administrators usually work hard to make educational technology better understood, successful, and diffused faster in an institution. Rogers’s 1995 work mostly analyzed distinct innovations whose characteristics were not changed by the adopters during the diffusion process. However, educational technology cannot be described as static or unchangeable innovation. Adopters of educational technology tend to reinvent and mold the innovation in accordance with their needs and perceptions. This may cause the innovation to be unmanageable unless a centralized organizational structure is developed and implemented to maintain stability and ensure continuous growth of the innovation.

Possible Strategies for Diffusion

For educational technology to be widely adopted as a tool for teaching and learning, several strategies should be considered. As mentioned earlier, most members in a social system or organization fall in the early and late majority categories. This category of potential adopters should be targeted the most. They should be recognized as a distinct group within the institution and made a part of the planning and policymaking process. Attempts to “convert” them to a point of view are likely to be fruitless, and imposing the new technology on them would be disastrous. Diffusion of the innovation to the late majority and laggards is more likely to occur through this early majority involvement since the vertical lines of communication between the three groups are more direct than with the innovators and early adopters.

The problems of diffusing educational technology may vary widely from one institution or social setting to another. Technical and pedagogical support such as infrastructure, expertise, and training are some of the problems normally cited by educators. Training programs will help introduce educational technology to teachers and students and teach them how technology can assist them in teaching and learning tasks. The changing nature of technology makes the case that change is making technology simpler and easier to use. This will encourage educators to explore emerging technologies and to integrate technology into their teaching.

Additional barriers to the effective diffusion of educational technology are related to insufficient support by institutions. There is a big role to be played by technical personnel in institutions to provide support for teachers and students alike. Institutions should develop a scheme for appropriate recognition or acknowledgment of the extra effort invested in developing new approaches to teaching. Teachers may complain about the time-consuming nature of developing technology-based materials and approaches given the scarcity of time available to commit to such tasks.

As for students, educational technology can be used as a way to add excitement to the learning process. Methods can be used to produce education-entertainment programs such as educational CD-ROMs and games that combine teaching with entertainment. Today, students in schools and universities are highly skilled in using computers, the Internet, and other related technologies. Students have been acting as change agents among themselves, and there is a need to extend their skills to reach the educators in order to encourage the adoption of educational technology and its integration into the curriculum.

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See also

Communication Theory; Entertainment-Education; Instructional Communications; School Reform

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Digital Divide

The fundamental premise of the so-called digital divide is that factors such as income, race, gender, age, location, and education affect access to technology and the equity of technology experiences overall. It is a multifaceted problem and involves unequal opportunities regarding information technologies, in the United States and globally. Put simply, the digital divide describes the differences between the technology/information "haves" and "have-nots." Yet the daily use of technology in society expands, so an individual's fluency with technology and his ability to use technology as a functional tool in daily life will need to be considered. The many obstacles include educational experiences, workplace opportunities, access to information, and communications opportunities.

Some may argue that the digital divide is closing (e.g., the number of computers in classrooms has mushroomed in recent years). But mere numbers do not always translate into access and learning opportunities for all students. Learning activities and experiences need to be evaluated.

Much of the early research on the digital divide focused on the number of computers in schools. In 1992, results showed that schools with a high percentage of poor and minority students had fewer computers available to students, with the average ratio being 19.2 students to one computer. Strides have been made in giving poor and minority students more access to technology. In one report (Coley, Cradler, and Engel 1998), the penetration of computers in U.S. schools was examined using data from a 1997 survey. The report stated that 98 percent of all schools own a computer, with the typical number of computers per school being between twenty-one and fifty. The average ratio was 5.7 students to one computer. However, schools with a high percentage of minority and Title I students have an above-average student-to-computer ratio. Schools containing 90 percent or more minority students have an average ratio of 17.4 students to one computer, and as the percentage of Title I students increase, so does the ratio of students to computers.

Students in K-12 and higher education school systems who are impacted by the digital divide may be at a disadvantage without the equivalent learning experiences. This could occur in a variety of ways. These students might not have the exposure to much of the technology that the workplace uses. They also might not have the opportunities to learn how to acquire, organize, and evaluate instructional resources. Finally, these students often engage in different learning activities than students not affected by the digital divide. Underserved students are frequently asked to complete drill-and-practice tasks rather than research-oriented learning exercises.

The digital divide also influences an individual’s ability to have access to information and opportunities in the workplace. Research has shown that there is a disparity among various ethnic groups with respect to computer ownership. A Department of Commerce (1999) report found that African Americans and Hispanics are far behind Asian Pacific Islanders and whites when it comes to owning a computer. The gaps could partly be explained by income disparities.

One can examine the digital divide from another perspective by looking at the use of technology to function in society. In a Department of Labor (1991) report, industry leaders stated that it was important for employees of the future to be fluent in the use of technology. With information technology evolving at such a rapid pace, individuals without opportunities for ongoing training will quickly fall behind better prepared individuals. Mere access to technology will not help these individuals; training will. An examination of how to work effectively within various communities must occur in our society. The training of various minority groups, the poor, the elderly, rural residents, and others is fundamental to providing the skills necessary to function in an increasingly technologically advanced society. Some organizations and agencies are working to improve technology access and fluency for individuals affected by the digital divide. For example, community technology centers are working with many rural and urban populations to provide additional access and training. As technology continues to penetrate all aspects of society, all individuals will need to be fluent in the use of technology.

Finally, opportunities to communicate with computer technology is another issue deserving attention. The ability to use communications tools available on the Internet is another place that training is needed. However, there are other avenues to investigate. The content of the Internet is considered to be a stumbling block for many individuals affected by the digital divide. A Children's Partnership (2000) study reported that much of the material on the Internet does not provide a service for many Americans. The study findings show there are barriers such as literacy levels, language, lack of cultural diversity, and lack of local information. Appropriate content could certainly be a reason more poor and minority households are not using the Internet. All organizations, institutions, industries, and educators that use the Internet need to be aware of this problem with online content and encourage the creation of projects and groups that can work to alleviate obstacles for all individuals using the Internet.

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See also

Community Technology Centers; Cyberculture and Related Studies

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Digital Video

Digital video is a technology used to record and display moving images as binary data. Because video in digital format is transmitted using binary code (a system that communicates information in a series of discrete signals represented as 1's or 0's), it offers several advantages over analog video, a format that transmits information in a continuous range of electromagnetic waves. Producers and consumers of this technology benefit from its efficient use of transmission and storage space, its high-quality, robust signal, its compatibility with other information in digital format, and its user-friendly viewing and editing interfaces. These advantages contribute to making digital video an increasingly popular means for delivering education and training content via CD-ROM and the World Wide Web. The recent technological advances involving the production of digital video equipment, compression schemes, and network communication modes suggest it will remain the standard for some time to come.

Analog versus Digital Video Formats

Analog, the signal format most common before the rise of the digital signal format, is used with various technologies, including telephone communications, broadcast radio, and television. Analog appliances record or transmit information as a continuous electrical signal composed of electromagnetic waves. In analog video cameras, waves are created by a charged coupled device. This device captures visual information and transforms it into an electrical signal that can be broadcast directly or recorded on magnetic tape. When analog video is sent from its source through the air, wire, or other network conduit, the electromagnetic signals weaken. During transmission, signals run the risk of picking up vibrations from other sources that can result in errors or noise. To compensate for the weakened strength of signals at a distance, amplification is performed at various points during transit. The amplification of a weakened and sometimes error-filled signal often results in reduced signal quality and distortion.

By contrast, digital data travels as a series of discrete, high- and low-voltage pulses representing binary data. In digital video cameras, the charged couple device transmits high-voltage pulses that represent a 1 and low-voltage pulses that represent a 0. Simple and discrete in form, these pulses can travel great distances with little deterioration in signal quality. When signal boosting is necessary, pulses can be replicated identically through signal regeneration. Digital signals do not pick up noise or vibrations in the way that analog signals do.

Advantages of Digital Video

The basic differences between the analog and digital data formats account for several advantages of video recorded and transmitted in digital format.

Transmission and Storage Space

First, digital video makes more efficient use of storage and transmission space because it is composed of discrete pulses rather than continuous waves. In its natural, uncompressed state digital video requires less recording and transmission space. When it is compressed (a process that uses mathematical algorithms to eliminate extraneous data) it requires even less. As a result, digital video requires less network bandwidth for transmission and less storage space for recording data. Extra space in the network conduit is made available for multiple signals. Interactivity, or two-way communications, often results from using extra space. When storing digital video, increased efficiency results in better use of storage units such as cassettes, disks, and hard-drive space. Efficiency also results in products (digital videocassettes, cameras, and other equipment) that are much smaller.

Superior Quality

Because digital data can be stored efficiently, large amounts of data can be captured in less space. This results in the second advantage of digital video: superior quality. Digital video reproduces images that have greater accuracy to their original source. Betacam, an expensive professional analog video, is the only analog standard that rivals the quality of digital video. Higher-quality reproduction of moving images results from increased resolution, greater color rendition (the ability to produce accurate colors), and increased frame rate (the number of still images captured per second). For example, the mini-DV format captures 500 lines of horizontal resolution, a nearly 25 percent improvement over pictures recorded in the S-VHS or Hi–8 analog formats.

Robust Signal

Another advantage of digital video is its robust signal. This signal is free of problems encountered by an analog signal when it is transmitted over distances or copied. As a result, it is possible to dub multiple generations, or additional copies from other copies of the original source information, without signal loss. Reproduction of digital video is less expensive because the process does not require as much time or as many resources.

Random Access

One more significant advantage of digital video is its support for random access of stored or transmitted information. This means that information recorded in digital format can be and usually is edited in a nonlinear format. Unlike linear editing, where moving forward and backward through the medium is required before editing can occur, nonlinear editing allows instant access anywhere in the data. This instant access saves time and allows greater creative control over material. For example, changing or switching one shot with another in nonlinear editing is a difficult proposition; reediting of the entire piece is required to change even one frame. But editing video in nonlinear format is easy and takes little time. Nonlinear editing also makes it easy to link portions or clips of video together with transitions like dissolves and fades. It also makes it easier to modify the data and add special effects such as picture-in-picture and colored filters. Although it is possible to digitize analog video and edit it using nonlinear editing, this process requires special equipment and results in the degradation of video quality. Nonlinear editing systems work easily and fluidly with digital video, requiring no special equipment and preserving video quality.

The Production Process

Content

The creation of digital video content involves several steps. First, content is recorded in a digital or analog video signal. This signal is stored on a tape. Popular analog tape formats include VHS, S-VHS, Hi–8, and Betacam. Popular digital video formats include Sony’s DVCAM, HDCAM, and DigiBeta and Panasonic’s DVCPRO. The method of storing data on the tape is the main difference among the different tape formats. The source and the quality of the initial video content that is recorded will vary considerably. Source content may range from previously edited, broadcast-quality data to raw, unedited images. Source content might be recorded directly through the camera to the tape or prerecorded. The techniques for shooting video vary depending on the purpose and use for the footage. Video that will be viewed in conventional ways (e.g., on a television or monitor) will likely be filmed in different ways.

Capturing

Second, video content is “captured” using a video capture card—an internal device within a computer that allows individuals to input video as binary data. Video capture cards range in quality based on cost. Cards that support high video resolution, color rendition, and frame rates are more expensive than those with less resolution, no color rendition, and smaller frame rates.

Users have many options when selecting nonlinear editing systems because they vary in sophistication, quality, and cost. Low-end systems, the type commonly used by amateurs or hobbyists, can be constructed from integrating several basic computer components. These include a personal computer with a fast processor, video capture card, sound card, and SCSI (small computer systems interface) controller. In order to control this hardware and edit the video, a simple video editing software program must be installed and configured. Apple’s iMac computer, marketed as a preconfigured, low-end, easy-to-use system, represents one popular option.

Middle-range systems, the kind commonly used by low-budget production companies and schools, consist of the basic hardware and other equipment such as video decks, mixing boards, disk arrays, and recording equipment. More powerful software programs such as Premiere and Dazzle and Final Cut Pro are the most commonly used software options.

High-end, commercial, nonlinear editing systems, the kind used by large-scale production houses producing movies and TV programs, consist of basic hardware components modified to work specifically with proprietary nonlinear editing software. Such systems are available from major multimedia companies, including Media 100 and Avid.

Editing

Third, video content is edited and saved as an uncompressed file. This step in the production process marks the greatest advantage of digital over analog video. Digital editing software programs allow nonlinear interaction with digital content. Editing video using a digital editing software program allows instant access to specific images that may be located anywhere in the content. This process enables greater creative control over the editing process. Transitions, titles, and special effects can be easily inserted, and audio can be mixed seamlessly and simultaneously. Although the output of digital video is a linear sequence (e.g., a series of images edited together to tell a story), constructing it in a nonlinear process facilitates creativity and spontaneous decisionmaking about content. Once edited, the video image is saved as an uncompressed file. Several standard file formats are commonly used for uncompressed files. These include Apple’s Quicktime (.MOV, .MOOV) and Video for Windows (.AVI).

Compression and Distribution

Because uncompressed files are often incredibly large (often exceeding two gigabytes for four-minute video clips), the content is compressed for distribution and then delivered to the viewer. Data compression transforms a data into a code that is smaller than the original code. Methods of coding data vary significantly and are evolving. Perhaps the most significant difference in data-compression processes exists between the lossy compression and the lossless compression schemes. Lossy compression, the kind used in video and audio compression, discards some information during the compression process. Because video and audio are not an exact medium (meaning they can still communicate their message with some loss of information), the human ear and eye do not notice the loss of some data provided it is the right type of data. Lossless compression, the kind used when exact information is required (like when sending text information), does not discard data. Compression performance is measured by the size of the output stream compared to the size of the input stream.

Regardless of the compression process used for coding, a compressed file must be decoded before it can be viewed. Decompression is performed by software installed on the output computer. This software is referred to as a player or plug-in. This software may be preinstalled on a user’s computer operating system or web browser. If not, it must be packaged with digital video content.

The standard compressions for coding and decoding video content are called codecs. The codec selected for distribution of digital video will vary based on the distribution medium and file format determined to be appropriate. Each codec is created for specific purposes. Professional video developers make decisions about appropriate codecs based on their knowledge of these codecs and the technological limitations of their intended audience.

The delivery of digital video is undergoing an even more dramatic evolution than other aspects of digital video production. The most important development in the delivery of digital video content has been the development of streaming media. Streaming media is prerecorded or live content transferred to users on demand. Formats created by RealNetworks, Windows, Apple, and nonprofit groups such as the Moving Pictures Expert Group are competing to become the standard in streaming media formats. Streaming media resides on a server or web server and can be accessed through links on. HTML files situated throughout the Internet or through direct addressing. Streaming media turns digital video into fluid content that resembles other conventional media technologies such as broadcast and cable TV.

Technological Advances

Continual technological advances resulting in improved compression rates, network bandwidth, software usability, and equipment costs have contributed to the growing preference for digital video. These advances influence every aspect of digital video production, from the recording of video content to its capture, production, and output on disk, tape, CD, or the web. As a result, users at every skill level, from beginners to professionals, are experiencing increased accessibility to the medium and the advantages it offers in the way of quality, usability, and compatibility.

Progress in the hardware industry is steadily improving the performance of video capture cards, computer ports, processors, and other devices associated with digital video. The improvement of the information transfer rates (the speed of sending information from a user to a device that controls it) in cameras, microprocessors, and media drives (special hard disks used to store video data) continually speed up the amount of time required to produce video. In large commercial video production houses, where time is money, speed increases have shortened production times, resulting in increased profitability. Amateurs have also appreciated the ability to create small video clips without large investments of time. It is becoming more common for individuals to create and edit their own home videos on personal computers, an activity previously limited to professionals with expensive equipment.

This progress has been accompanied by the creation of more efficient codecs. By using various codecs to compress digital video, large, high-quality files can be reduced for storage and transmission. The development of more sophisticated compression algorithms has led to both a decrease in the file space required for storing digital video and the power of hardware for playing it. Software programs have made it easier to determine appropriate codecs for video depending on the method by which they will be stored and transferred.

The popularity of digital video is also related to the physical expansion of global and local network infrastructures. The network expansion that promises the most dramatic impact on the use of digital video by the masses (specifically for entertainment purposes) is the placement of broadband networks in residential neighborhoods. Here, narrowband access through telephone lines is being replaced by broadband access enabled by cable and digital subscriber lines. These expansions could help to overcome bottlenecks (caused when information travels from the broadband Internet to narrowband residences) and thereby enable video use. Networks of all sizes have had difficulty keeping up with growing demands for bandwidth. If network bandwidth fails to meet the growing need for digital video, its increasing popularity as a medium for education and training on the Internet will likely wane.

Groups working to support the increasing use of digital video have begun to install dedicated wide area networks. One such network (Internet2) has been in use by colleges and universities since February 1999. This network boasts huge transfer rates and is becoming more and more common for businesses and corporations to install on their own internal dedicated high-speed networks (intranets). Corporate intranets are already providing education and training materials, including videos, for employees. In fact, many of the best examples of digital video training materials are being developed on intranets. Although the growth of these networks means support is provided for the applications of digital video, it is unfortunate that these resources are not accessible to the public. The removal of private resources from the Internet and access promise to be issues in the future for digital video.

Software for recording and editing and playing digital video is also improving dramatically. The increased usability of nonlinear digital editing software programs with graphical user interfaces has made complex editing processes simple and enabled greater creative control over the medium. Nonlinear editing programs have lowered the technical skill required to create digital video. As a result, more individuals have begun using these programs, resulting in greater sales and declining product costs. Plug-ins/players are also becoming easier to use and more affordable (free, in most cases). As a result, access to digital video on the Internet or CD-ROM is easier and faster and becoming more affordable for the general population.

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See also

Interactive Television

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Distance Education

Distance education has gained increasing attention from the public and would appear to be a modern-day phenomenon. It has, however, been around a long time but has only recently become known as distance education and distance learning. As the terminology has evolved, so have the components that define this type of instruction.

The most obvious is the physical distance that separates teachers and learners. Beyond that, practitioners in the field would include the use of mechanical or electronic means for delivery of content; interaction between teachers and learners (with a requirement that any participant can initiate interaction with the others); and the influence of a formal educational organization such as a training department or a university (sometimes referred to as a “contract”) that delineates the roles of the participants, the expectations, and the anticipated outcomes. (This final component is what distinguishes distance education from informal self-study or information dissemination in the form of a radio news program, for example.)

Examples of distance education are as varied as the technologies that provide content and as divergent as the needs of the student population. Low-tech options for learning at a distance include print-based correspondence study, videotaped classes that are distributed through the mail or private delivery services, and live audioconferences during which students call in to a telephone bridging service to engage in a real-time discussion with the instructor and other students. The familiarity of broadcast TV has long played a role in distance education, with lavishly produced telecourses (often featuring nationally recognized experts in the field acting as commentators, speakers, or hosts) aired on public stations with faculty support and college credit provided by individual postsecondary institutions. Online and computer-based instruction has garnered the greatest attention in the distance learning field, with course management software systems providing easy-to-use templates for the development of web-based coursework. Instructionally, many of these options closely resemble their historical antecedent of correspondence study, albeit with greater flexibility for participant interaction and the potential to integrate a variety of instructional media.

Overall, the purposes of distance education eventually boil down to three guiding principles. The first is the decision to provide educational opportunities for unserved or underserved populations. This would include those students for whom traditional coursework is unrealistic due to geographic factors or to competing priorities of family or employment, as well as individuals who may be homebound or otherwise unable to travel. In some instances, distance delivery of instruction can break through cultural barriers to educational opportunity, as in the case of religious strictures limiting face-to-face interactions among men and women, for example.

The second purpose for distance delivery of instruction is to save money. This is particularly true in the corporate/industrial training sector, where students may have previously been flown to a central location for classes. By providing courses directly to the student's workplace, the company not only saves travel costs but also does not lose the productivity of that employee during this period. Even though many delivery systems are relatively expensive compared to traditional in-person courses, the savings over time have proven to be a desirable incentive for its implementation. Few, if any, traditional K-12 or postsecondary schools have undertaken distance education programs as a way to cut costs, however, and instead find such endeavors to be significantly more expensive than continuing to offer courses in a face-to-face configuration.

Finally, distance education can help traditional schools offer a much wider variety of courses to students. In a rural school district in South Dakota, employing a teacher of Japanese (if one could even be found in the area) for the few students interested in studying this language would be cost-prohibitive. However, by utilizing the economies of scale possible when students across a large geographic area take Japanese classes together, these kinds of curricular options become highly desirable in remote locations. When one considers the vast distances separating Alaskan villages or ranches in the Australian outback, utilizing all of the available technologies to provide a well-rounded education is not a luxury.

History of Distance Education

Although distance education may appear to be a recent phenomenon, it has a long history in the United States and abroad. Correspondence instruction was already popular in Europe when it began in this country in the early 1870s, although it was considered “informal” education intended for the working class and those unable to attend traditional “formal” classes. Interest in correspondence study was fueled, in part, by the industrial revolution that created a need for trained workers. In 1881, William Rainey Harper, a teacher of Hebrew, began teaching courses for Sunday school teachers via correspondence and shortly thereafter, as the president of the University of Chicago, developed the first distance education program within a university.

When radio gained popularity early in the twentieth century and was available in the typical American home, it was only natural that universities and trade schools would utilize this new medium to deliver instruction. By 1919, thirty-six universities had begun to incorporate radio programming into their correspondence courses. Unfortunately, postsecondary institutions failed, at that time, to recognize the potential of distance learning and relegated it to a lower status within their organizations, essentially opening the door to a wide variety of entrepreneurial efforts that were often fly-by-night scams or barely disguised diploma mills. In this mood, distance education programs at accredited institutions languished in a state of limbo until the 1950s.

The next upswing for distance education was generated by a heightened interest in the sciences and technology and can be traced to two significant events, both occurring in 1958: the launching of the first geostationary satellite, and the National Defense Education Act, which was in direct response to the Soviet Union’s launch of *Sputnik.* Federal funds poured into TV-studio construction projects, and universities were once again interested in distance education (albeit primarily in its high-tech incarnation as educational television). By 1960 there were more than fifty educational television stations in the United States. One of the most fascinating and imaginative projects was the Midwest Program on Airborne Television Instruction, in which coursework was transmitted from one of several DC-6 aircraft that flew over a six-state area. This initiative began in 1961 and lasted an amazing six years. However, the cost of maintaining all of these projects took its toll, and as the novelty began to wear off viewership declined, partly because the quality of the courses was questionable at best.

Throughout the 1980s and early 1990s, televised distance learning programs adopting satellite delivery began a slow but steady rise as costs dropped and more schools and businesses could realistically consider utilizing these technologies. Two major initiatives helped to revitalize interest in distance learning. The first was the founding of the Annenberg/Corporation for Public Broadcasting grants program to fund the development and production of high-quality courses that incorporated video programs, texts, study guides, test banks, and related teaching materials. Examples of these courses included well-respected series like *Eyes on the Prize* and *The Mechanical Universe.* The second initiative, aimed primarily at the K-12 environment, was the Federal Star Schools Program Assistance Act, a project started in 1988 and designed to encourage statewide partnerships for distance education programming. By 1994 students who had participated in coursework funded by this program numbered in the millions. However, even with these exemplary programs, resistance to distance education lingered in sometimes subtle ways. Universities restricted the number of credits earned “at a distance” that could be applied to a degree, for example, and the stigma of these courses as supposedly less rigorous and of lower quality remained.

The most recent renaissance of distance education activity in the United States has, once again, been sparked by advances in technology. The widespread availability of the Internet, coupled with decreasing costs for increasing computing power, ignited the creativity of trainers and educators who are recognizing the enormous potential of distance instruction. While private-sector corporations explore computer networking and online learning as a solution to expensive face-to-face training, traditional colleges and universities are suddenly competing with institutions that offer complete degree programs online, wooing students who might prefer the convenience of taking classes from home.

In 1995 there were approximately 16 million Internet users worldwide; by June 2000, that number had climbed to well more than 332 million (Sly 2000). In the United States alone, close to 1 million students enroll in distance-delivered courses through postsecondary institutions each year.

Delivery Systems

One component of the definition of distance education refers to the use of a delivery system, some kind of “mediating interface” that ties the participants together and provides opportunities for interaction. In the traditional classroom, delivery systems may consist of the human voice, gestures, images projected within the room, and other sensory stimuli. If learners are separated geographically, however, some kind of device or technology is required to enable ideas to be exchanged, and the variety of delivery systems grows richer every year. If something can be considered as a method of transporting video, audio, or data, it has probably been used for distance education. Although there are many different ways of providing these connections, they are typically categorized using one of three structures: tangible/virtual, synchronous/asynchronous, or distributed/centralized.

Tangible/virtual delivery systems refer to the actual medium of distribution; like the artist who expresses herself with clay or watercolor, these systems provide a method not only for fixing content in a permanent form but also for disseminating that content beyond the immediate surroundings. Tangible delivery systems are those in which a physical element is used to contain ideas (e.g., text materials printed on paper or moving images on videotape) or to allow for human interaction (copper telephone lines or fiber-optic data connections). What makes a delivery system tangible is its physical presence.

Virtual delivery systems are those in which ideas are distributed through a medium that is volatile and impermanent. Satellite TV signals travel through the air and may be converted to video images, but their delivery medium remains ethereal. Other virtual delivery systems might include radio programming, microwave TV distribution, and wireless data networking.

Whether tangible or virtual, delivery systems are subject to constraints in bandwidth (a way to measure the complexity or richness of a given signal). More robust signals are those that carry large amounts of information, such as broadcast-quality video with its wide color palette and audio accompaniment. Bandwidth is often compared to a garden hose: The larger the hose, the greater its capacity and distribution capability, and large bandwidth delivery systems are those that can carry a rich array of sensory stimulation. Unfortunately, the larger the bandwidth, the more expensive it becomes. Inexpensive delivery systems, like standard telephone lines, carry a limited amount of information, whereas large bandwidth systems, such as fiber-optic cable or microwave TV signals, can transport a heavy load of video, audio, and data signals concurrently but are significantly more expensive as a result.

One of the more frequently used methods for categorizing delivery systems depends on time. Synchronous systems are those in which instruction is delivered and received in real time, whereas asynchronous systems are those in which there is a noticeable time delay between the sending of a signal and its receipt by the learner.

Synchronous delivery of instruction, such as live satellite TV programming or an online chat system, requires all learners to participate at the same time. They may be geographically separated, but instruction occurs according to a predetermined schedule during which they may simply receive programming (e.g., by watching a televised lecture/demonstration) and/or interact with the instructor and possibly other learners in a real-time format. Although some students prefer to engage in coursework on their own schedule rather than according to a preset timetable, for others the opportunity to interact in a live conversation adds an element of personal involvement that may otherwise be limited and can provide a sense of connectedness not found in many time-delayed delivery systems. In addition, coursework delivered as a synchronous module can often be captured for use later as an asynchronous review of material (e.g., taping a satellite-delivered program).

Asynchronous delivery systems—those in which instruction is received significantly later than it was sent—offer distant learners the opportunity to study at times that are convenient for them. Such systems might utilize e-mail, pretaped video programs, online discussion boards, or something as familiar as printed modular texts that are designed to be self-paced. Many traditional face-to-face courses also utilize these elements as a supplement to the live in-class activities as a way of extending the classroom beyond the constraints of real-time schedules. The major disadvantage to such delivery systems appears to be the potentially isolating effects of such coursework if not carefully planned to incorporate activities that require interaction among students and instructors.

Delivery systems are also categorized by whether the interactions are centralized or distributed, that is, whether communication is one-to-one, one-to-many, or many-to-many. One-to-one interactions occur in most correspondence courses, whether utilizing postal delivery of materials or the online environment. Although instructors might interact with many students, they will communicate with each student privately, and students will not interact with (or probably even be aware of) other students taking the same course. This is especially true in self-paced programs in which each learner is at a different point in her work.

A satellite video broadcast is considered a one-to-many delivery system, with the instructor at an “originating location” (typically a television studio/classroom) where the video program is sent up to a satellite that then amplifies and distributes the signal across the earth’s surface in a pattern known as the satellite’s “footprint.” A good analogy for this type of delivery system is a showerhead. A narrow stream of water (the television signal) travels to a device that sprays the water (signal) over a large surface. The program can then be received by anyone inside the footprint who has the appropriate antenna or dish. Because a satellite’s footprint typically covers almost one-third of the earth’s surface, the potential audience for satellite-delivered instruction is enormous and would be limited only by instructional or administrative constraints. Microwave delivery of instruction using the frequency range designated for educational use (Instructional Television Fixed Service) works in a similar one-to-many way. Signals are sent out from a tower to a radius of twenty to thirty miles and can be picked up with specialized antennae anywhere within range of the signal.

A configuration in which any participant has the option of initiating interactions with one or more other participants would be classified as a many-to-many delivery system. The use of online chats is a good example, where no one individual is the “originator” based on their location or available technologies, and anyone who chooses to participate can initiate discussion with others. Although communications organized in this way

Table 1: Characteristics of Example Delivery Configurations

	Tangible	Virtual	Central	Distrib.	Synch.	Asynch.
Print-Based Correspondence	x		x			x
Prerecorded Media (e.g., tapes)	x		x			x
1-Way Audio (e.g., radio)		x	x		x	
2-Way Audio	x	x		x	x	
1-Way Video	x	x	x		x	
2-Way Audio, 1-Way Video	x	x		x	x	
2-Way Audio & Video	x	x		x	x	
Online Discussion	x	x		x	**x**	**x**

Source: Created by the authors.

have been utilized successfully for many years in telephone audioconferences, its popularity is a relatively recent phenomenon in education as instructional paradigms began moving away from primarily teacher-centered models while advances in technology were enabling nonlinear communication structures. (See Table 1.)

There are countless other means for categorizing and describing delivery systems, but the critical point is that these categories can be helpful when determining how best to distribute instruction to learners at a distance. For example, a needs assessment of a potential student clientele reveals that most of them work full-time and would be unable to attend classes regularly, so a model that utilizes asynchronous components (e.g., printed materials and videotaped lecture/demonstrations) would likely be successful. Or if coursework will require a high degree of discussion and student participation, a system utilizing both synchronous and asynchronous elements in a many-to-many configuration (e.g., audioconferencing and online discussion) would be desirable. Also no successful distance education program utilizes only one type of delivery system, and most programs incorporate at least three types of interaction and content delivery. For those systems that are completely or predominantly organized around messages going from teacher to student, additional technologies must be integrated to accommodate the need for student-to-teacher and student-to-student interactions. The more options for learning that are presented, the more likely it is that the students’ various learning needs will be met and their obstacles to education hurdled.

Theories

Many of the earliest distance education programs, especially those originating in Europe, developed out of a theoretical perspective that emphasized the industrialization of education. These programs (described by the German educational theorist Otto Peters) included components such as mass production of standardized course materials that required a high level of quality control, long-term planning that focused on careful decisionmaking, organization of programs based on their overall purposes and goals, and centralization of course administration. This theoretical model exhibits characteristics that most educators would find admirable, but it has never found strong acceptance in the United States. This is probably due to the decentralized nature of the U.S. school systems and structures that emphasize the autonomy of the individual teacher.

A more accepted theory (at least in the United States) that has guided many distance education programs focuses on the independence of the learner and a separation of teaching from the end result of learning. Charles Wedemeyer, a proponent of independent study and the freedom of individuals to pursue learning at times and places of their own choosing, wrote extensively of the need for students to take on responsibility for their own learning. This theoretical approach emphasizes the need for educational programs to encourage students to engage in learning at their own pace, stopping and starting as they choose, and to incorporate whatever media are available to provide a wide array of options. Wedemeyer recognized distance education as a less restrictive form of education that was more likely to accommodate these tenets of individualism, and many of his ideas are gaining acceptance in traditional learning environments as the roles of learner and teacher shift to accommodate constructivist thought.

Börje Holmberg posited a theory of distance education with an emphasis on interaction and communication. His idea of learning as a “guided didactic conversation” was intended as an explanatory framework for how distance education can support student motivation and facilitate a sense of connectedness to the learning group, something not easily accomplished when learners are physically removed from one another. To critics of distance education who charge that it can be an isolating experience devoid of human contact, this theory responds that the interactions incorporated into such teaching are purposeful and considered critical to the student’s success. Unlike many face-to-face courses, distance education course design includes planned interactions, never assuming that meaningful communication will occur simply because the opportunity exists. This theory has been embraced in many distance education programs worldwide, leading many new distance teachers to marvel at how well they get to know their students, even though they may never meet in person.

These three theories (industrialization, learner autonomy, and interaction) represent a sampling of theoretical bases upon which planning, decisionmaking, and research have been based. Other theories that have been used to guide distance education practice include the adoption of innovations, instructional equivalency, communications, and systems theory; as an interdisciplinary field that incorporates aspects of many domains, one of the strengths of distance education remains its diversity of thought.

Implementation

The perspective of distance education as belonging to a somewhat marginalized category of instructional activity has a long history, and this has reinforced the idea that, by definition, such teaching is somehow less rigorous, less scholarly, and certainly less respectable than traditional, face-to-face models. Fortunately, the overwhelming majority of programs delivered at a distance prove this to be a patently false assumption, although a silver lining has emerged from such biases. Calls for the careful evaluation of distance education programs require a clear delineation of what constitutes a rigorous course, how the courses under consideration are to be evaluated against these criteria, and ultimately how the results compare to our familiar models of teaching and learning. It comes as no surprise to practitioners in this field that nearly every well-controlled comparison of distance education courses with their classroom-based counterparts has returned the verdict of “no significant difference” in learning gains. The long-term benefit of these evaluative activities, however, rests in the furthering of our understanding of how best to design instruction for any type of environment or delivery system and apply these standards to all of our teaching efforts.

Issues of copyright and intellectual property rights are of particular concern to teachers who are developing instructional materials for distance delivery. Copyright law and the accompanying fair use guidelines are sometimes difficult to interpret for specific cases, and many institutions are justifiably worried about inadvertent infringements. With current technologies, reproducing, altering, and distributing someone else’s work has become nearly effortless, and it has never been easier to break the law as a result of ignorance. Those working in distance education recognize the need to provide access to educational resources but must also strive to observe the property rights of those whose works they (and their students) rely upon, and when in doubt they should obtain written permission to utilize these materials. Ideally, the terminology utilized in legal decisions of copyright compliance may eventually reflect current practice (e.g., if a class is conducted in a real-time format with all participants able to see and hear one another, can it be considered face-to-face?), but until then educators must temper demands for access with respect for the law and the rights of creative individuals.

Intellectual property rights are being renegotiated at many postsecondary institutions as a direct result of distance education. When an instructor designs and develops an online course, the question of who that course belongs to can become a delicate matter, especially if the instructor chooses to take a teaching position elsewhere and hopes to reuse those materials. In programs that utilize satellite delivery of lecture/demonstration sessions, the question of videotape ownership can prove controversial. Instructors may be uncomfortable with the idea that students (or anyone) could purchase an entire set of such tapes, potentially devaluing the marketability of that instructor's writings or consulting opportunities. Additionally, the possibility that an institution might choose to simply replay the tapes during later semesters, rather than hiring the live instructor, is a significant disincentive to teaching in such programs, and it is in the best interests of the institution and its faculty to clarify policies regarding such arrangements.

This represents only a small fraction of the issues that must be resolved before distance education becomes an unremarkable and everyday option for learning. Other topics currently of concern to professionals in the field include technology access for underprivileged students; assisting faculty and trainers with appropriate professional development and technical support; ensuring that distance-delivered materials are accessible to all students (including those with disabilities); reconciling accreditation guidelines that require minimum amounts of "seat time" with asynchronous learning initiatives; guiding students as they take on greater responsibility for their learning; and designing research on distance education practices to help guide planning and decisionmaking. Efforts to improve instruction at a distance will ideally be applied in many learning environments and lead to the eventual integration of these practices into the broader categories of exemplary teaching and training.

Susan M. Zvacek

See also

Adult Learners; Copyright; Courseware; Instructional Communications; Interactive Television; Open University; Television and Learning; Virtual Universities; Web-Based Course Management Systems; Western Governors University

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Educational Fair Use

The term “educational fair use” refers to a set of negotiated guidelines explaining the application of fair use in educational situations. Despite the common myth in education circles, educational use and fair use are nowhere near synonymous. Just because a teacher or student wants to reproduce or show a copyrighted work for classroom use does not mean that the teacher or student may actually do so. Section 106 of the Copyright Revision Act of 1976, which took effect on January 1, 1978, confers upon copyright owners the exclusive right to reproduce, prepare derivative works of, distribute, perform, and display their copyrighted works. Section 107 immediately creates a limitation on the exclusive rights granted in Section 106: fair use.

> Section 107. Limitations on exclusive rights: Fair use
>
> Notwithstanding the provisions of sections 106 and 106A, the fair use of a copyrighted work, including such use by reproduction in copies or phonorecords or by any other means specified by that section, for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research, is not an infringement of copyright. In determining whether the use made of a work in any particular case is a fair use the factors to be considered shall include—
>
> 1. The purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes;
> 2.

The nature of the copyrighted work;

3. The amount and substantiality of the portion used in relation to the copyrighted work as a whole; and
4. The effect of the use upon the potential market for or value of the copyrighted work.

> The fact that a work is unpublished shall not itself bar a finding of fair use if such finding is made upon consideration of all the above factors.

Section 107 is the congressional restatement of a judicial doctrine first introduced in 1802 by Lord Ellenborough in *Cary v. Kearsley:* "A man may fairly adopt part of the work of another: he may so make use of another's labours for the promotion of science, and the benefit of the public: but having done so, the question will be, Was the matter so taken *used fairly*" (emphasis added). In *Wilkins v. Aiken* (1810), Lord Eldon referred to fair quotation and legitimate use. The phrase "fair use" seems to have first appeared in *Lewis v. Fullarton* (1839). In 1869 it first gained recognition as a legal doctrine in *Lawrence v. Dana.* Until incorporated into section 107, it remained a judicial equitable rule of reason. Although never actually mentioning fair use, Justice Joseph Story's 1841 decision in *Folsom v. Marsh* laid out the basic criteria for fair use.

It was only through intensive lobbying efforts that teaching, scholarship, and research was included as possible fair-use purposes in section 107. Even then, no one was quite sure how to apply it to those situations. Committees formed to further explicate fair use apropos print, music, and off-air recording. In March 1976, the committee focusing on print sent its agreed-upon guidelines to Congress. (See Appendix Figure 1.)

The music guidelines followed a month later in April (see Appendix Figure 2). The off-air recording guidelines were announced in 1981 (see Appendix Figure 3). The educational multimedia guidelines are a product of the late 1990s (see Appendix Figure 4). Unlike the original three guidelines, this last set of guidelines has not as yet gained the same widespread acceptance.

Two points to keep in mind about all the guidelines: First, although they have been read into the *Congressional Record,* this does not give them the status of law. It does, however, supply the courts with legislative intent. Second, the intent that the guidelines be considered the minimum and not the maximum standards of educational fair use seems to be endangered. The various standards are increasingly cited as if set in stone.

Esther Sinofsky

See also

Copyright

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Wilkins v. Aiken, 17 Ves. 422, 34 Eng. Rep. 163 (Ch. 1810).

Appendix

Figure 1: Agreement on Guidelines for Classroom Copying in Not-for-Profit Educational Institutions with Respect to Books and Periodicals

The purpose of the following guidelines is to state the minimum and not the maximum standards of educational fair use under Section 107 of H.R. 2223. The parties agree that the conditions determining the extent of permissible copying for educational purposes may change in the future; that certain types of copying permitted under these guidelines may not be permissible in the future; and conversely that in the future other types of copying not permitted under these guidelines may be permissible under revised guidelines.

Moreover, the following statement of guidelines is not intended to limit the types of copying permitted under the standards of fair use under judicial decision and which are stated in Section 107 of the Copyright Revision Bill. There may be instances in which copying which does not fall within the guidelines stated below may nonetheless be permitted under the criteria of fair use.

Single copying for Teachers	* For personal scholarly research; use in teaching or preparation to teach * Covers a chapter, article, short story, short essay, short poem, chart, cartoon, or diagram
Multiple Copies for Classroom Use	* Limited to one copy per pupil * Must meet tests of brevity, spontaneity, and cumulative effect * Must include copyright notice * Poetry: not to exceed 250 words * Prose: complete article or story of 2,500 words or less; excerpt of not more than 1,000 words or 10% or work * Illustration: one per book or periodical issue * Excludes "special" works such as picture books which are limited to two published pages

* Must be requested by the teacher

* Limited to 9 instances during class term

* Cannot replace or substitute for anthologies and the like

* Does not apply to consumables such as workbooks, answer sheets, and test booklets

* Cannot replace purchase of items

Figure 2: Guidelines for Educational Uses of Music*

The purpose of the following guidelines is to state the minimum and not the maximum standards of educational fair use under Section 107 of HR 2223. The parties agree that the conditions determining the extent of permissible copying for educational purposes may change in the future; that certain types of copying permitted under these guidelines may not be permissible in the future; and conversely that in the future other types of copying not permitted under these guidelines may be permissible under revised guidelines.

Moreover, the following statement of guidelines is not intended to limit the types of copying permitted under the standards of fair use under judicial decision and which are stated in Section 107 of the Copyright Revision Bill. There may be instances in which copying which does not fall within the guidelines stated below may nonetheless be permitted under the criteria of fair use.

Guidelines for Educational Uses of Music

Permissible	***Prohibited***
* Emergency replacement for imminent performance provided replacement copies purchased soon after	* Replacement or substitution for anthologies and the like
* For academic uses other than performance, not more than 10% of whole work as long as not performable unit and only one copy per pupil	* Excludes consumables such as workbooks and answer sheets
* Editing or simplifying as long as fundamental character of work not distorted	* Substitution for actual purchase of sheet music
* Single copy of a student’s performance for evaluation or rehearsal purposes	* Copying for performance except in emergency as noted
* Single copy for constructing aural exercises or examinations	

*Please see complete version for more information.

Figure 3: Guidelines for Off-Air Recording of Broadcast Programming for Educational Purposes*

In March 1979, Congressman Robert Kastenmeier, Chairman of the House Subcommittee on Courts, Civil Liberties and Administration of Justice, appointed a Negotiating Committee consisting of representatives of education organizations, copyright proprietors, and creative guilds and unions. The following guidelines reflect the Negotiating Committee's consensus as to the application of "fair use" to the recording, retention, and use of television broadcast programs for educational purposes. They specify periods of retention and use of such off-air recordings in classrooms and similar places devoted to instruction and for homebound instruction. The purpose of establishing these guidelines is to provide standards for both owners and users of copyrighted television programs.

**Guidelines for Off-Air Recording of
Broadcast Programming for Educational Purposes**

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* Applies to nonprofit educational institutions only

* Applies to programs broadcast for general reception

* May only be retained for 45 consecutive calendar days

* May be used once in teaching during first 10 consecutive school days within the 45 calendar day period

* Must be requested and used by individual teachers; cannot tape in anticipation of requests

* Teacher may only request off-air taping of a program once, not each time it is broadcast

* After first 10 consecutive school days, may use only for evaluation purpose until end of 45-day period

* May show only a part, but may not alter original content or create anthologies

* Must include copyright notice

* Educational institutions must implement appropriate control procedures for monitoring compliance with the guidelines

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* Please see complete version for more information.

Figure 4: Fair Use Guidelines For Educational Multimedia

Table of Contents:

1. Introduction

1.1 Preamble

Fair use is a legal principle that provides certain limitations on the exclusive rights of copyright holders. The purpose of these guidelines is to provide guidance on the application of fair use principles by educators, scholars and students who develop multimedia projects using portions of copyrighted works under fair use rather than by seeking authorization for non-commercial educational uses. These guidelines apply only to fair use in the context of copyright and to no other rights.

There is no simple test to determine what is fair use. Section 107 of the Copyright Act sets forth the four fair use factors which should be considered in each instance, based on particular facts of a given case, to determine whether a use is a “fair use”: (1) the purpose and character of use, including whether such use is of a commercial nature or is for nonprofit educational purposes, (2) the nature of the copyrighted work, (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole, and (4) the effect of the use upon the potential market for or value of the copyrighted work.

While only the courts can authoritatively determine whether a particular use is fair use, these guidelines represent the endorsers’ consensus of conditions under which fair use should generally apply and examples of when permission is required. Uses that exceed these guidelines may or may not be fair use. The endorsers also agree that the more one exceeds these guidelines, the greater the risk that fair use does not apply.

The limitations and conditions set forth in these guidelines do not apply to works in the public domain — such as U.S. Government works or works on which copyright has expired for which there are no copyright restrictions — or to works for which the individual or institution has obtained permission for the particular use. Also, license agreements may govern the uses of some works and users should refer to the applicable license terms for guidance.

The participants who developed these guidelines met for an extended period of time and the result represents their collective understanding in this complex area. Because digital technology is in a dynamic phase, there may come a time when it is necessary to review the guidelines. Nothing in these guidelines shall be construed to apply to the fair use privilege in any context outside of educational and scholarly uses of educational multimedia projects. These guidelines do not cover noneducational or commercial digitization or use at any time, even by non-profit educational institutions. These guidelines are not intended to cover fair use of copyrighted works in other educational contexts such as digital images or archives, distance education, or electronic reserves, which may be addressed in other fair use guidelines.

This Preamble is an integral part of these guidelines and should be included whenever the guidelines are reprinted or adopted by organizations and educational institutions. Users are encouraged to reproduce and distribute these guidelines freely without permission; no copyright protection of these guidelines is claimed by any person or entity.

1.2 Background

These guidelines clarify the application of fair use of copyrighted works as teaching methods are adapted to new learning environments. Educators have traditionally brought copyrighted books, videos, slides, sound recordings and other media into the classroom, along with accompanying projection and playback equipment. Multimedia creators integrated these individual instructional resources with their own original works in a meaningful way, providing compact educational tools that allow great flexibility in teaching and learning. Material is stored so that it may be retrieved in a nonlinear fashion, depending on the needs or interests of learners. Educators can use multimedia projects to respond spontaneously to students' questions by referring quickly to relevant portions. In addition, students can use multimedia projects to pursue independent study according to their needs or at a pace appropriate to their capabilities. Educators and students want guidance about the application of fair use principles when creating their own multimedia projects to meet specific instructional objectives.

1.3 Applicability of These Guidelines (Certain basic terms are identified in bold and defined in this section.)

These guidelines apply to the use, without permission, of portions of lawfully acquired copyrighted works in educational multimedia projects which are created by educators or students as part of a systematic learning activity by nonprofit educational institutions. Educational multimedia projects created under these guidelines incorporate students' or educators' original material, such as course notes or commentary, together with various copyrighted media formats including but not limited to, motion media, music, text material, graphics, illustrations, photographs and digital software which are combined into an integrated presentation. Educational institutions are defined as nonprofit organizations whose primary focus is supporting research and instructional activities of educators and students for noncommercial purposes.

For the purposes of these guidelines, educators include faculty, teachers, instructors and others who engage in scholarly, research and instructional activities for educational institutions. The copyrighted works used under these guidelines are lawfully acquired if obtained by the institution or individual through lawful means such as purchase, gift or license agreement but not pirated copies. Educational multimedia projects which incorporate portions of copyrighted works under these guidelines may be used only for educational purposes in systematic learning activities including use in connection with non-commercial curriculum-based learning and teaching activities by educators to students enrolled in courses at nonprofit educational institutions or otherwise permitted under Section 3. While these guidelines refer to the creation and use of educational multimedia projects, readers are advised that in some instances other fair use guidelines such as those for off-air taping may be relevant.

Overview of Educational Fair Use for Multimedia*

Preparation of Educational Multimedia Projects under These Guidelines

- Must include proper attribution and citation
- Students may use portions of lawfully acquired copyrighted works for multimedia projects
- Teachers may use portions of lawfully acquired copyrighted works to create multimedia teaching tools

Permitted Educational Uses for Multimedia Projects Under These Guidelines

- Students may perform and display in class for which created or keep as examples in personal portfolio
- Teachers may perform and display in face-to-face instruction, assign for directed self-study, use in distance education in certain circumstances
- Teachers may perform and display own projects at workshops and conferences
- Teachers may keep in personal portfolios

Limitations

- Teachers may use creations in class up to 2 years after created
- May use up to 10% or 3 minutes, whichever is less, of motion media work
- May use up to 10% or 1,000 words, whichever is less, of text material
- May use up to 10% but no more than 30 seconds of music and lyrics from a musical work
- May use no more than 5 images by an artist or photographer or not more than 10% or 15 images, whichever is less, from a published collective work
- May use up to 10% or 2,500 fields or cell entries, whichever is less, from a copyrighted database or data table
- Teachers may make a second copy to be placed on reserve or for preservation purposes

Examples of When Permission Is Required

- For non-educational or commercial purposes
- For replicating or duplicating beyond limitations

- For electronic networking

Important Reminders

- Need to be cautious when downloading material from the Internet since many works are copyrighted
- Credit the sources and display their copyright notice and ownership information
- Include acknowledgment that multimedia project prepared according to the guidelines
- Does not apply to computer programs
- Guidelines do not preempt or supersede licenses or contractual obligations

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* Please see complete version for more information.

Educational Systems Design (ESD)

Educational technology is a broad field that encompasses both “hard” and “soft” technologies. Educational systems design is a “soft” educational technology that is grounded in systems philosophy, systems theory, and design theory and enhances the success of efforts to change our education systems. ESD provides a knowledge base that improves the chances of successful implementation of a change in education, improves the chances of long-term survival of the changes, and, most important, improves the chances that the changes will meet the needs of the social systems and individuals they serve.

Technology can be used to help educators do better what they are already doing, or it can be used to help them do things very differently—and potentially much better—than without it. ESD is an important soft technology for helping educators succeed at the latter.

Because most readers are familiar with instructional systems design (ISD), and because there are many similarities between ESD and ISD, it may be helpful to understand ESD by comparing and contrasting it to ISD. ESD is broader in scope than ISD, for ISD is a subset of ESD, but both encompass knowledge bases for “process” and “product” (means and ends). Furthermore, ESD has a foundation in systems thinking and design thinking, and it focuses on holistic transformation rather than piecemeal change. These four issues are discussed below.

The Scope of ESD

The major difference is that ESD is concerned with the entire education system, whereas ISD is only concerned with one part of it: the instructional subsystem. There are four subsystems in any educational or training system (Banathy 1991):

1. The learning experience subsystem, in which the learner processes information from his environment to produce new or modified cognitive structures;

2.

The instructional subsystem, in which instructional designers and teachers use information about learning needs (gained through analysis activities), as well as administrative and governance input, to produce environments or opportunities for learners to learn;

3. The administrative subsystem, in which administrators use information about instructional needs, as well as governance input, to make decisions about resource allocation, including use of leadership; and
4. The governance subsystem, in which “owners” use their goals and values to produce policies and in other ways provide direction and resources for the educational enterprise in order to meet their needs (which usually include those of learners, teachers, and administrators).

ISD provides the knowledge base about designing the instructional subsystem, whereas ESD provides the knowledge base about designing the complete education system.

Process and Product Knowledge in ESD

Knowledge about the *process* of ISD is generally referred to as ISD models (such as those reviewed in Gustafson and Branch 1997), which focus on the activities in which people should engage in order to design a new instructional system. By contrast, knowledge about the *products* of ISD is generally referred to as instructional theories (such as those compiled by Reigeluth 1983, 1999), which focus on what the new instructional system should be like—what instructional methods it should use.

In a similar way, knowledge about the process of ESD is generally referred to as ESD models, or systemic change models, and focuses on the activities in which people should engage in order to design a fundamentally different educational or training enterprise or to fundamentally transform an existing one (see, e.g., Duffy, Rogerson, and Blick 1999; Jenlink et al. 1996, 1998). Knowledge about the products of ESD is generally referred to as comprehensive design and focuses on what features a fundamentally different kind of educational or training system should have in order to meet fundamentally different learning needs of the system it serves (see the vision offered by Reigeluth and Garfinkle 1994).

Foundations of ESD

A critical feature of ESD is its foundation in systems thinking and design thinking (design philosophy and design theory) (see, e.g., Banathy 1996, 155–171). Systems thinking, which includes systems philosophy, systems theory, and systems methodology (see, e.g., Ackoff 1981; Checkland 1981;

Churchman 1979; Hutchins 1996), is the centerpiece of the new sciences, which also include chaos theory, nonlinear science, and the science of complexity (Bohm 1983; Davis 1989; Wheatley 1992). Systems thinking focuses on understanding the mutually interdependent relationships (1) between a system and the larger systems of which they are a part (suprasystems); (2) between a system and its peer systems (other systems that are parts of the same suprasystem); and (3) among the many functions and components that comprise the new system. It also focuses on understanding the complex dynamics that govern the behavior of systems and strongly influence the effects of any changes made to a system (Senge 1990). Particularly relevant to ESD are the systems concepts of holism, self-organization, emergence, coevolution, and dynamical systems (Capra 1988; Michaels 1994).

Design thinking (Ackoff 1981; Checkland 1981; Cross 1984; Nadler 1981; Warfield 1990) informs process knowledge about how to design education systems. The fundamental activities of analysis, synthesis, and evaluation occur continuously throughout the design process. Simultaneity, recursion, and transcendence are important concepts, as are idealized design, values-based design, holistic design, continuous design, and ethical principles of design (e.g., stakeholders or users should design their own systems).

Piecemeal versus Systemic Change

To further understand the nature of ESD, it is helpful to think in terms of two basic kinds of change: piecemeal and systemic. Piecemeal change leaves the structure of a system unchanged. It often involves finding better ways to meet the same needs. In contrast, systemic change entails transforming the structure of a system, usually in response to new needs. For example, one may find that students' characteristics (such as their entering knowledge, learning styles, interests, and motivations) are more diverse than they used to be and that they have very different goals (such as college, vocational school, or immediate employment). To respond to these changed needs, an educator may decide to use customized, team-based, problem-based learning with continuous progress and to use advanced technology in new ways. Piecemeal change usually changes one part of a system in a way that is still compatible with the rest of the system, whereas systemic change entails such a fundamental change that it requires fundamental changes throughout the system, because the other parts of the system would not be compatible with the change.

Thus ESD is concerned with creating a new paradigm of education or training, as opposed to making changes within the existing paradigm. It recognizes that fundamental change in one aspect of a system requires fundamental changes in other aspects for it to be successful. In public education, it must eventually pervade all levels of the system: classroom, building, district, community, state government, and federal government. Similarly, in corporate training, it must eventually pervade all levels of the corporation. In this way, it can encompass not only the nature of the learning experiences and the instructional system but also the administrative and governance systems.

Such an approach to improvement is radical, not to mention difficult and risky. Thus it is important to address the rationale for such a radical change.

When and Why Is ESD Needed?

Systems thinkers know that when a human-activity system (or societal system) changes in fundamental ways its subsystems must change in equally fundamental ways to survive. This is because each subsystem must meet one or more needs of its suprasystem in order for the suprasystem to continue to support it (Hutchins 1996). So if the suprasystems for education systems are undergoing systemic changes, only then do education systems need to undergo systemic change or risk becoming obsolete.

So are education's suprasystems changing dramatically? In the industrial age we needed minimally educated people (dropouts) who would be willing and able to endure the tedium of work on assembly lines. However, those line jobs have been rapidly disappearing. Just as the percentage of the workforce in agriculture dropped dramatically in the early stages of the industrial age, so the percentage in manufacturing has been declining dramatically over the past few decades. Even in manufacturing companies, a majority of the jobs today entail manipulating information rather than materials (Reich 1991). Just as the industrial age represented a predominance of manual labor with machinery, so the information age represents a predominance of "knowledge work" with information technology. This means that more people must be educated to higher levels, with a greater emphasis on preparing students to think, solve problems, assume responsibility and initiative, and work well in teams. These are dramatically different educational needs from those that our industrial age schools were designed to meet. While preparation for work is but one mission of schools, the civic and character-building missions have seen similarly dramatic changes in this age of terrorism, global conflict, drugs and violence, and corporate malfeasance. Thus it is evident that education's suprasystems are indeed changing dramatically.

The Knowledge Base of ESD

Given the need for ESD, what is its knowledge base like? It was mentioned earlier that it includes both process and product knowledge. Product knowledge is concerned with what a new system of education should be like. This part of the knowledge base investigates the changing educational needs of the suprasystem (the community or organization to be served) and individual “clients” and explores the educational implications of those changes in needs. Process knowledge is concerned with how to design a new education system or how to help an existing one transform itself. This part of the knowledge base investigates the obstacles to systemic change and the activities that are most likely to lead to a successful change effort. These are discussed below.

Product Knowledge

Product knowledge is composed of (1) visions of different kinds of education systems and (2) linkages between each kind of education system and the characteristics and needs of the larger systems it serves. Consider, for example, the following analysis.

One thing educators know for certain is that different people learn at different rates. Yet our industrial age education systems present a fixed amount of content to a group of learners in a fixed amount of time, making it like a race to see who receives the A’s and who flunks out. By holding time constant, we force attainment of standards to vary. Our current systems are not designed for learning; they are designed for sorting, which was appropriate for industrial age needs. However, our information age society, with a predominance of knowledge work, requires all students to learn—that no child be left behind. If we are ever to meet this new educational need, we must stop holding time constant and instead hold attainments constant by allowing every student as much time as needed to master them.

However, switching from a time-based system to an attainment-based system means that we must switch from group-based progress to personalized progress. This in turn requires changing the role of the teacher to that of a coach or manager, rather than that of dispenser of knowledge to groups of learners who rotate from one teacher to another at the ring of a bell like so many little widgets on an assembly line. This requires that learning occur primarily from sources other than the teacher. Thus technology and other resources (including peers) must be used in dramatically different ways. Rather than focusing on technology integration—using technology to enhance what is currently being done in classrooms—we should focus on technology transformation—using technology to do things that were not possible before (Reigeluth and Joseph 2002). Furthermore, our assessment systems need to change from norm-referenced (comparing students with each other) to criterion-referenced (comparing student performance to a standard). One might envision an “inventory of attainments” replacing our current report cards and transcripts.

Table 1: Key Markers That Distinguish Industrial Age and Information Age Organizations

Industrial Age	**Information Age**
Standardization	Customization
Bureaucratic organization	Team-based organization
Centralized control	Autonomy with accountability
Adversarial relationships	Cooperative relationships
Autocratic decisionmaking	Shared decisionmaking
Compliance	Initiative
Conformity	Diversity
One-way communications	Networking
Compartmentalization	Synthesis and holism
Parts oriented	Process oriented
Planned obsolescence	Total quality
CEO or boss as "king"	Customer as "king"

Source: Charles M. Reigeluth, ed. (1999), *Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory* (Mahwah, NJ: Lawrence Erlbaum Associates).

To build product knowledge by investigating broader societal changes and exploring their educational implications, it is also helpful to look at the work of people like Daniel Bell (1973), Alvin Toffler (1980), and Robert Reich (1991), who have identified several massive changes that our society has undergone, from the agrarian age to the industrial age and now into what some call the information age. According to these and other scholars, there are "key markers" that characterize the emerging differences between information age organizations and their industrial age counterparts (see Table 1).

These key markers may provide insights as to core ideas that should guide the design of our new education systems (Banathy 1991). For example, changing from a system in which a group of thirty students must learn the same thing at the same time and rate, to a system in which each student takes as long as necessary to master a standard of attainment, clearly entails customization. Similarly, our current systems of education are also based on conformity and compliance. Students are typically expected to sit down, be quiet, and do what they are told. Their learning is directed by the teacher. But employers now want people who will take initiative to solve problems and who will bring diversity—especially diverse perspectives—to the workplace. Both of these enhance the ability of a team to solve problems and keep ahead of the competition. Communities and families also need people who will take initiative and honor diversity. The systems that education serves need diversity and initiative to be fostered by our education systems in the information age. Understanding these key markers can play a valuable role in building a sound product knowledge base in ESD.

So what product knowledge do we currently have? The New American Schools Development Corporation assumed as its mission to foster the development of “break the mold schools” as called for by President George H. W. Bush in 1990. This resulted in the development and implementation of seven comprehensive school designs, such as ATLAS, Co-NET, Modern Red Schoolhouse, and Roots and Wings. However, these designs have largely not arisen through a careful examination of the changing educational needs of society and a fundamental rethinking of teaching and learning processes to meet those new needs and thus have largely not “broken the mold” of the current school system. Furthermore, they have often not been implemented as intended and have not produced the desired improvements in student learning (Berends, Bodilly, and Kirby 2002). Nevertheless, these designs do represent “product” knowledge—guidance about what school systems should be like. Other more promising, though less thoroughly worked out, guidance can be found in a vision of brain-based learning systems (Caine and Caine 1997) and the vision of an information age education system (Reigeluth and Garfinkle 1994).

Process Knowledge

Process knowledge can focus on either how to design a new education system or how to help an existing one transform itself. This part of the knowledge base investigates the obstacles to systemic change and the activities that are most likely to lead to a successful change effort. The result is a set of principles and methods for systemic change (see Caine and Caine 1997; Duffy, Rogerson, and Blick 1999; and Jenlink et al. 1996).

There are many approaches to systemic change, none of which have been well-developed, researched, and validated. One approach is for “experts” to develop a comprehensive new system (product) and to have the leadership in a school district purchase the design, complete with implementation plans and assistance (process). This “invented elsewhere” approach has not been very successful for many reasons. One is that people don’t like to be changed. They are much more receptive to change when they are in control of it. Another is that systemic change requires people in a system to adopt different mental models about the system’s activities and structure for the change to be successful (Senge 1990, 2000). This approach overlooks this important principle of systemic change.

A second approach is for a school system to design and implement (process) its own new system (product). One variation of this approach is a process in which all stakeholders (as opposed to a small group of leaders) are involved in, and are given ownership over, the change process and the nature of the new system. Another variation of this “invented here” approach is a process that entails just a few schools, rather than all the schools, in a district changing. A third variation is to create several autonomous schools within a building and initially change only one of those schools-within-a-school, as opposed to changing the whole school building. This approach has only recently begun to be tested but appears to be promising.

Regardless of such variation, some principles appear to have empirical support for the “invented here” approach. The following is a small sample of such principles (see Caine and Caine 1997; Duffy, Rogerson, and Blick 1999; Jenlink et al. 1996):

- Systemic change should not be undertaken unless the district is at a sufficient level of readiness for systemic change. Time can be spent helping to build such readiness.
- The school district’s organizational design must be changed from a bureaucratic one to a participative and collaborative one early in the change process. This entails using principles of transformational leadership.
- A facilitator experienced in the process of systemic change should be used.
- Effort should be focused primarily on helping stakeholders (particularly those most responsible for implementing the new system) to evolve their thinking or mental models about education.
- The school district (including the community) must be the unit of change.
- Learning must be at the center of the change effort.
- Change must occur simultaneously in the core work process, internal social structure, and community relationships.
- Efforts should be made early to build political support for systemic change.
- The superintendent and teachers’ association president must provide early advocacy for the change effort.
- A leadership team should be created to provide political support for the change effort.
- A school design team should be formed to lead the design work. It should be comprised of seven to nine people from all groups who will be affected by the change (teachers, parents, students).
- No one should be forced to change.
-

- All who are going to change should be given training to prepare them for the change (students, parents, teachers, and administrators).

Both the product and process knowledge bases in ESD are in the relatively early stages of development.

Charles M. Reigeluth

See also

Diffusion of Innovations; School Reform

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Elaboration Theory of Instruction

The elaboration theory of instruction offers a holistic approach to sequencing instruction that helps make learning more meaningful and is more motivating for learners (Reigeluth 1999b; abstracted here with permission of the publisher). It also can allow learners to have more control over some scope and sequence decisions during the learning process. This stands in sharp contrast to the parts-to-whole sequencing, superficial coverage of content, and teacher control over scope and sequence decisions that have been typical of education and training since 1900. (The term “content” is used here to refer to everything that comes under “what to teach.” It therefore includes whatever tasks you might teach, as well as whatever knowledge; the term “content analysis” includes “task analysis.”)

The elaboration theory recognizes that different kinds of sequences are needed for different instructional situations. Thus it synthesizes recent work on scope and sequence into a single coherent framework, extending that work where holes were found. It currently deals only with the cognitive and psychomotor domains and not the affective domain. (However, there are strong indications that it can be, and indeed is already intuitively being, applied in the affective domain; see, e.g., Greenberg and Kusché 1993; Goleman 1995.)

To understand the elaboration theory, it is helpful to begin with some general issues about the form of the elaboration theory and the nature of instructional sequencing. Then the kinds of situations that call for different kinds of elaboration sequences are discussed. Finally, the three major kinds of sequences offered by the elaboration theory are described.

General Issues about Elaboration Sequencing

One general issue is that elaboration theory is a design theory rather than a descriptive theory (Simon 1969); this means that it is oriented toward achieving goals and making decisions rather than making descriptions and conclusions (Cronbach and Suppes 1969). Its purpose is to offer guidance on the best means for accomplishing a given goal, where "best" is determined by a set of criteria appropriate to the situation at hand. Therefore, the major parts of elaboration theory are (1) methods and (2) the situations under which each method is likely to be best.

Also, elaboration theory is an instructional theory, which means that its purpose is to offer guidance on what methods of instruction are likely to be best for different situations. The elaboration theory deals only with macro-level (broad) methods: guidance for making scope and sequence decisions—decisions about what to teach and what order to teach it.

Sequencing is Based on Relationships

The second general issue is that each method of sequencing is based upon a single type of relationship among parts of the content. For instance, a historical sequence is based upon the chronological relationship—the actual sequence of events. A procedural sequence, the most common kind of sequencing in training, is based upon the relationship of "order of performance" of the steps in the procedure. A hierarchical sequence is based upon the relationship of learning prerequisites among the various skills and subskills that comprise a task. And the "simplifying conditions" sequence (described later) is based upon the relationship of the degree of complexity of different versions of a complex task.

Topical and Spiral Sequencing

A third general issue is that two basic patterns of sequencing can be used that are fundamentally different: topical and spiral (see Figure 1). In topical sequencing, a topic (or task) is taught to whatever depth of understanding (or competence) is desired before moving to the next one. In spiral sequencing (Bruner 1960), the learners master a topic (or task) gradually in several passes. They learn the basics of one topic (or task), then another, and another, and so on, before they return to learn more about each topic. This pattern continues until the desired depth and breadth are reached for all of them.

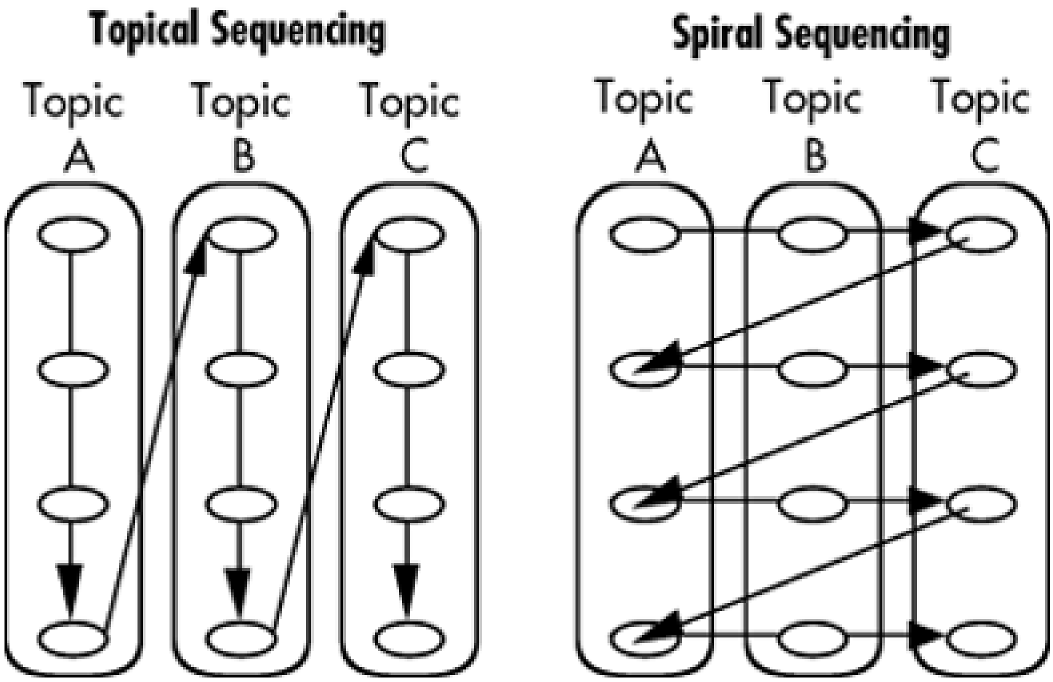


Figure 1:

Topical and Spiral Sequencing

Source: Created by the author.

Rather than thinking of spiral and topical sequencing as two separate categories, it is useful to think of them as the two endpoints along a continuum. The instructional designer’s (or the learner’s) decision, then, is where on the continuum to be for any given training program or curriculum and for any given group or individual learner—or when to be at any given point on the continuum.

Different Sequences for Domain Expertise and Task Expertise

The elaboration theory is founded on the notion that different sequences are best for different situations, because different sequencing methods are based on different kinds of relationships within the content, and different relationships are important for different kinds of expertise. So the kind of sequence that will most facilitate learning depends on the kind of expertise one wants to develop.

Elaboration theory distinguishes between task expertise and subject-domain expertise (Reigeluth 1999a). With task expertise the learner becomes an expert in a task, such as managing a project, selling a product, or writing an annual plan. With domain expertise the learner becomes an expert in a subject area not tied to any specific task, such as economics, electronics, or physics (but often relevant to many tasks). This is different from the distinction between procedural and declarative knowledge (J. R. Anderson 1983).

Task Expertise

Tasks range from simple to complex. The elaboration theory is intended only for more complex tasks. It is based on the observation that complex cognitive and psychomotor tasks are done differently under different conditions, that each set of conditions defines a different version of the task, and that some of those versions are much more complex than others. Thus, the elaboration theory offers the simplifying conditions method (SCM) to design a holistic, simple-to-complex sequence by starting with the simplest real-world version of the task and gradually progressing to ever-more complex versions as each is mastered. Problems or projects that learners tackle should be ones that are within the so-called zone of proximal development (Vygotsky 1978)—close enough to the learner's present competence for the learner to be able to deal with successfully—and the problems or projects should gradually increase in complexity.

Domain Expertise

Domain expertise ranges from simple to complex, but also from general to detailed. The general-to-detailed nature of domain expertise allows the design of a holistic sequence that goes from simple to complex. (The elaboration theory's sequencing guidance for domain expertise was derived primarily from Bruner's 1960 spiral curriculum and Ausubel's 1968 advance organizers and progressive differentiation. But it differs in several important ways from each, and it also provides greater guidance on how to design such a sequence.) An elaboration sequence starts with the broadest, most inclusive, most general ideas (which are also the simplest and generally among the first to have been discovered). Examples include the law of supply and demand in economics and Ohm's law in electricity. The sequence gradually progresses to more complex, precise ideas. Examples include ideas related to maximizing profits on the supply side (marginal revenues and marginal costs) and to consumer preferences on the demand side. This makes an elaboration sequence ideal for discovery learning, inquiry learning, and other approaches to the construction of knowledge.

The elaboration theory recognizes two major kinds of domain expertise: conceptual (understanding what) and theoretical (understanding why). In their simplest forms, these are concepts and principles, respectively. In their more complex forms, they are *conceptual knowledge structures* (or concept maps) for "understanding what," and both causal models and *theoretical knowledge structures* for "understanding why."

The conceptual elaboration sequence is briefly described next, followed by the theoretical elaboration sequence, and finally the SCM sequence.

The Conceptual Elaboration Sequence

The conceptual elaboration sequence (Reigeluth and Darwazeh 1982) is based on several observations. The first is that concepts are groupings or classes of objects, events, or ideas that share certain characteristics. For example, "tree" is a concept that includes all individual plants that have certain characteristics, most notably a woody stem. The second observation is that concepts can be broken down into either parts or kind, which are narrower, less inclusive concepts. For example, parts of trees include the trunk, roots, branches, and leaves. Kinds of trees include deciduous and evergreen. And each of those parts and kinds can be further broken down into parts and kinds. The third observation is that people tend to store a new concept under a broader, more inclusive concept in their heads (cognitive structures). The broader concept provides "cognitive scaffolding" (Ausubel 1968). The process of learning that proceeds from broader, more inclusive, and general concepts to narrower, more detailed concepts was called "progressive differentiation" (Ausubel 1968) because it entails a process of making progressively finer distinctions.

The kind of relationship upon which the conceptual elaboration sequence is based is that of parts or kinds of concepts (called the relationship). Such relationships include superordinate, coordinate, and subordinate relationships. In Figure 2, classical music is subordinate to music, is coordinate to medieval music, and is superordinate to instrumental classical music. As you go farther down in the conceptual structure to kinds of kinds of kinds (or parts of parts of parts), the concepts become ever narrower and more detailed. David Ausubel (1968) proposed that new concepts are organized in our heads under more inclusive concepts. Thus if one learns a broader, more inclusive concept before its subordinate concepts, the cognitive structure is more likely to be a sound one that will not have to be reorganized to accommodate new learning.

The conceptual elaboration sequence is one that starts by teaching (or discovering) the broadest, most inclusive, and general concepts that the learner has not yet learned and proceeds to ever more narrow, less inclusive, and more detailed concepts until the desired level of detail has been reached. This kind of sequence might be used by a high school student interested in learning about the kinds and parts of animals and plants or by an employee interested in learning about the kinds and parts of equipment that the company sells.

How do you identify all these concepts and their inclusivity relationships? This is the purpose of a conceptual analysis. The result of such an analysis is a conceptual knowledge structure (see Figure 2), sometimes called a taxonomy. The term "hierarchy" is sometimes used, but that term usually refers to a learning hierarchy (Gagné 1968).

The conceptual elaboration sequence may be designed in either a topical or spiral manner. For a topical sequence, one could go all the way down one leg of the conceptual structure and gradually move on to other topics, one leg at a time. For a spiral sequence, one could go completely across the top row, then across the next row down, and so forth.

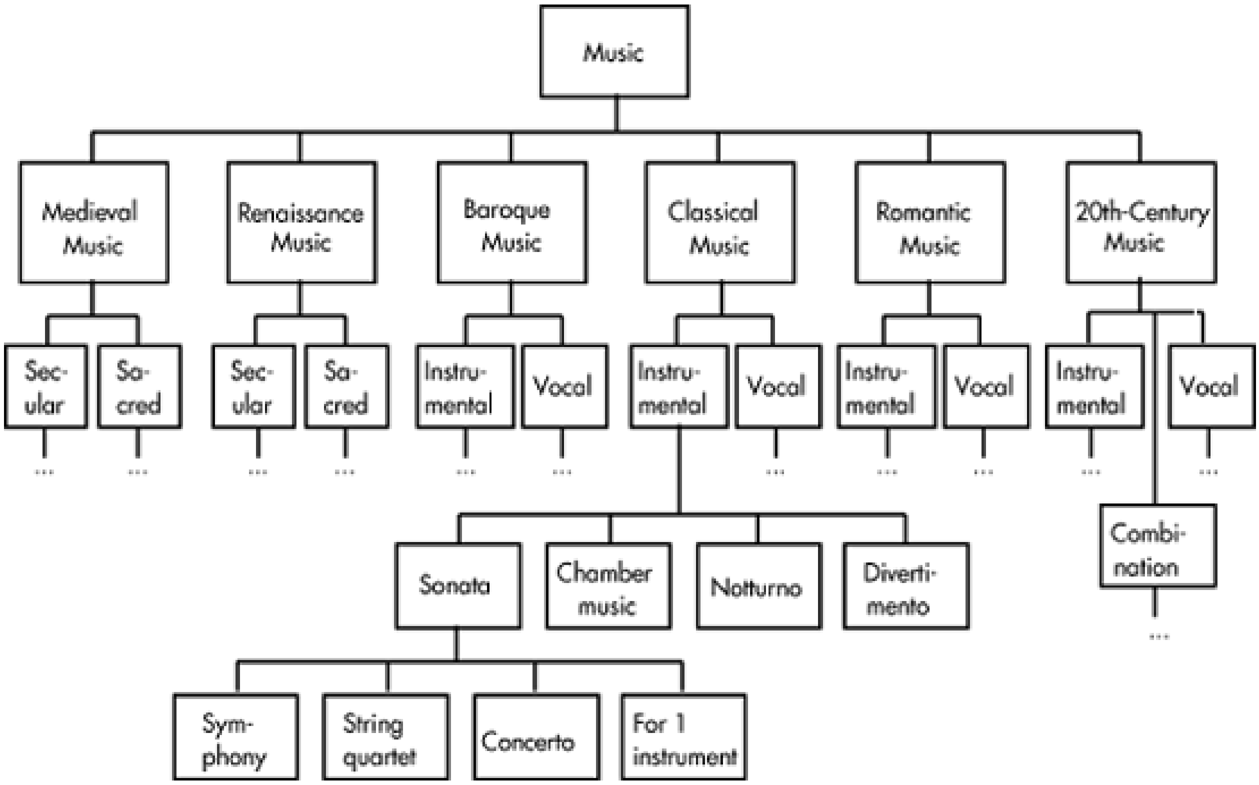


Figure 2:

An Example of a Conceptual Structure

Source: Reprinted from Charles M. Reigeluth, ed. (1999), Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory (Mahwah, NJ: Lawrence Erlbaum Associates).

The Theoretical Elaboration Sequence

The theoretical elaboration sequence is the second of the two sequencing methods currently offered by the elaboration theory for building domain expertise. It is intended for courses that focus on interrelated sets of principles, which are usually elaborations of each other, such as a high school biology course that focuses on principles of genetics, life cycles, and bodily functions, or a corporate training program on how and why a piece of equipment works.

This sequencing method is based on several observations. The first is that principles are either causal relationships or natural-process relationships (both of which concern changes in concepts). For example, the law of supply and demand says how changes in the supply of, and demand for, something influence its price, and vice versa (how changes in its price influence its supply and demand).

The second observation is that principles, like concepts, exist on a continuum from broader, more general, and more inclusive ones to narrower, more specific, and less inclusive ones. For example, a fairly general principle is: Temperature change in an environment causes behavioral changes in certain organisms within that environment. And two subordinate principles are: High temperatures in a desert environment cause certain organisms to be nocturnal; and high temperatures in a desert environment cause certain organisms to undergo a period of estivation (a summertime equivalent of hibernation). This last principle could be further elaborated by identifying specific physiological changes that occur in a particular species when it estivates. Figure 3 shows another example. So, unlike concepts, the broader principles are generally simpler and easier to learn than the narrower ones. This quality led principles to be the focus of the spiral curriculum (Bruner 1960).

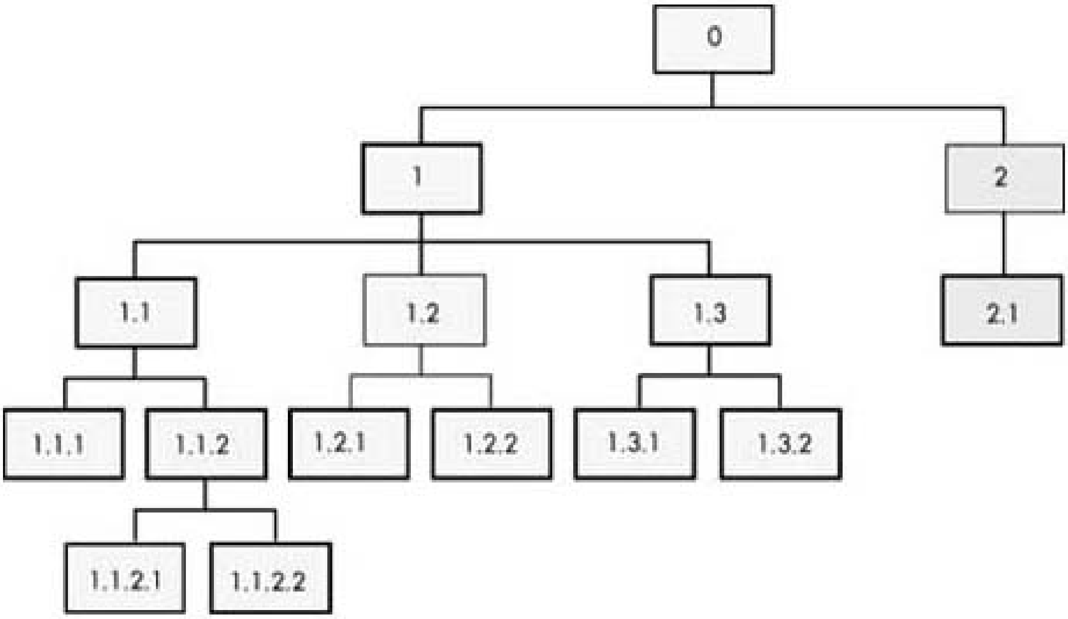
The third observation is that people tend to store a new principle under a broader, more inclusive one in their cognitive structures as they do for a new concept. Again, Ausubel (1968) discovered that the broader principle provides "cognitive scaffolding" for the narrower, more complex principles and therefore recommended the general-to-detailed sequencing method he called "progressive differentiation."

But there is a fourth observation for principles that does not hold for concepts. Principles can be combined into causal models that reflect the complex, systemic, and often seemingly chaotic nature of most phenomena in the world. A causal model is a set of interrelated cause-effect relationships, in which there are chains of causes and effects, and there are usually multiple causes of the effects and multiple effects of the causes (see Figure 4). These causal relationships are usually probabilistic rather than deterministic, meaning that the cause will increase the chances of the effect occurring rather than making it happen.

Figure 4 shows part of a complex causal model related to the water cycle. Each box shows a change—either an increase (shown by a rising arrow) or a decrease (shown by a declining arrow) in some activity or condition. The arrows between boxes show the direction of causality. So looking at the top of the diagram, one would read, "An increase in surface temperature causes (or more accurately increases the chances of) an increase in evaporation."

The theoretical elaboration sequence starts by teaching the broadest, most inclusive, most general principles that the learner has not yet learned in a theoretical structure (which are also the simplest principles and generally the first to have been discovered); and it gradually progresses to ever more narrow, less inclusive, more detailed, more precise principles (which are also more complex and were generally discovered later). Examples for economics (the law of supply and demand) and electricity (Ohm's law) are relevant. This sequence continues until the desired level of complexity has been reached. The fact that this order reflects the order in which the principles were usually discovered, and could be most easily discovered by learners, makes this sequence ideal for inquiry learning and other discovery methods.

When light rays pass from one medium into another (of different optical density):



0 they behave unexpectedly,
1 they bend at the surface,
2 a straight object in both media looks bent at the surface,
1.1 the rays bend because they slow down in a denser medium or speed up in a less dense medium (C),
es).
1.2 rays bend and change their distance from each other but remain parallel to each other (A),
1.3 a portion of each ray is reflected off the surface, while the rest is refracted into the new medium (A),
2.1 the apparent position and size of an object usually change (A),
1.1.1 if they pass into a denser medium, the light rays bend toward the normal (B, D),
1.1.2 the greater the difference in optical density between two media, the more the light rays bend (D),
1.2.1 when rays bend toward the normal, they become farther apart (B, D),
1.2.2 the sharper the angle between a light ray and the surface, the more the ray bends (D),
1.3.1 the sharper the angle between a light ray and the surface, the more of each ray that is reflected and the less that is refracted (D),
1.3.2 if the angle is equal to, or sharper than, the critical angle, all of the light ray is reflected (B, E),
1.1.2.1 the index of refraction (n) = c_i/c_r = (sin i)/(sin r) (D, E),
1.1.2.2 the relationship between the critical angle and the index of refraction is: sin i_c = 1/n (D, E).

Codes:
(A) What else happens? (B) When? (B) Why? (C) Which way? (D) How much?

Figure 3:

An Example of a Theoretical Structure

Source: Reprinted from Charles M. Reigeluth, ed. (1999), Instructional Design Theories and Models, Volume 2:

A New Paradigm of Instructional Theory (Mahwah, NJ: Lawrence Erlbaum Associates).

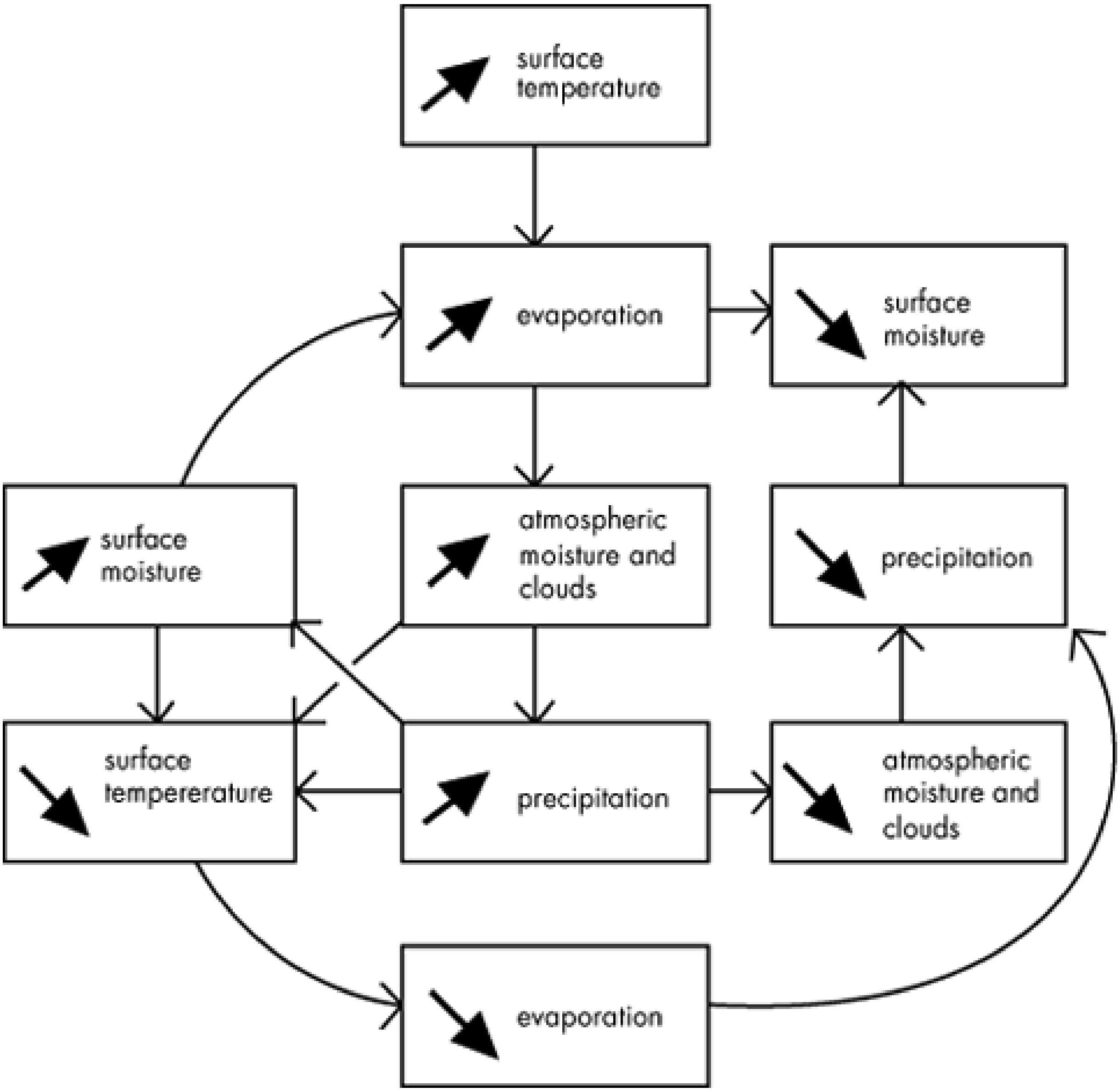


Figure 4:

A Partial Example of a Causal Model Related to the Water Cycle

Source: Reprinted from Charles M. Reigeluth, ed. (1999), Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory (Mahwah, NJ: Lawrence Erlbaum Associates).

How does a teacher or designer identify all these principles and their inclusivity/complexity relationships? This is the purpose of a theoretical analysis. The result of such an analysis is a theoretical structure (see Figure 3), which is different from a causal model (see Figure 4) in that it shows principles that elaborate on other principles (that provide more complexity or guidance on the same phenomena), whereas a causal model shows principles that combine with other principles (add new phenomena), usually at a similar level of complexity. In Figure 3, principles 1 and 2 elaborate on principle 0 because they each provide more complex information about what happens when light rays pass from one optical medium into another of different optical density.

It should be noted that more detail can be provided by elaborating on either the causal factors or the resultant factors (effects) or both. And elaboration can occur by answering several different kinds of questions, such as:

- What else happens? or What else can cause this?
- When does this cause have this effect?
- Which way (direction) do things change?
- Why do they change?
- How much do they change?

The theoretical elaboration sequence may also be done in either a topical or spiral manner. For a topical sequence, one could go all the way down one leg of the theoretical structure, then gradually broaden out from there. For a spiral sequence, one could go completely across the top row, then across the next row down, and so forth.

The Simplifying Conditions Method

For building task expertise, SCM is a relatively new approach (though practitioners have long used it intuitively) that offers guidance for analyzing, selecting, and sequencing the “what to learn” (content). Briefly, SCM provides practical guidelines to make a very different kind of simple-to-complex sequence from the parts-to-whole (hierarchical) sequence—one that is holistic rather than fragmented. Any complex task has some conditions under which it is much easier to perform than others. For example, driving a car is easier when you have an automatic shift, no traffic, good weather, no need to start on a hill, and no need to parallel park. An SCM sequence begins with mastery of the simplest version of the task that is still fairly representative of the task as a whole; then it teaches ever more complex versions of the task until the desired level of complexity is reached, making sure that the learner is aware of the relationship of each version to the other versions. Each version of the task is a class or group of complete, real-world performances of the task. This process contrasts sharply with the hierarchical approach to sequencing, which teaches all the prerequisites first and does not teach a complete, real-world task until the end of the sequence. Figure 5 shows the differences between the hierarchical approach and the SCM approach. Note that as you conduct a hierarchical task analysis, the subskills become ever more varied (diverse) yet steadily simpler. In contrast, when you conduct a simplifying conditions analysis, the subtasks become ever more varied yet steadily more complex.

For procedural tasks, the focus is on the steps (mental and/or physical) that experts use to decide what to do when. The SCM’s selection (scope) and sequencing methodology were derived primarily from the work on “path analysis” of a procedure (Scandura 1973; Merrill 1976, 1980). Every

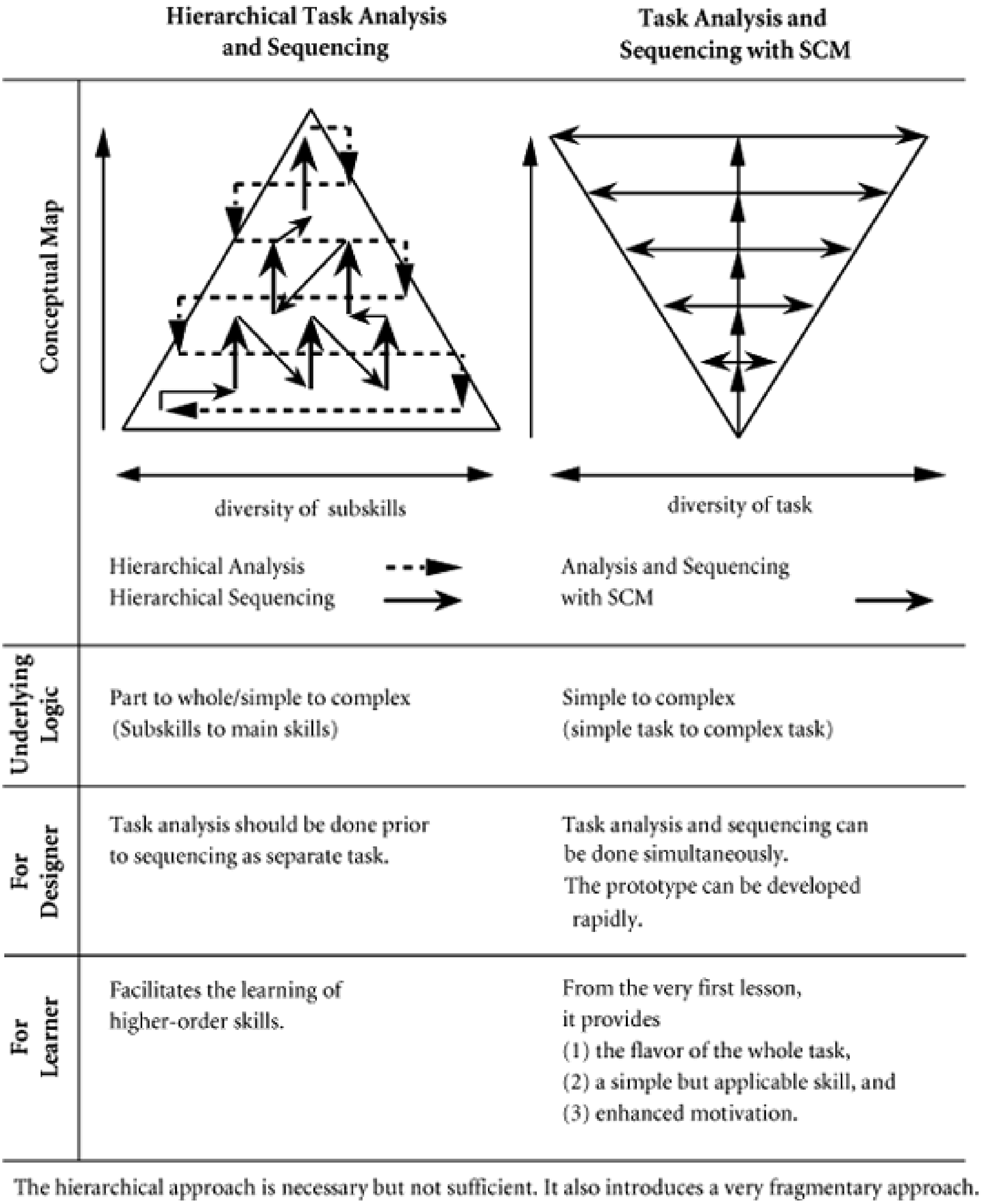


Figure 5:

Hierarchical Approach and the SCM Approach

Source: Created by the author.

decision step in a complex procedure signals at least two different paths through the flowchart of the procedure (one of which is almost always simpler than the other). It also represents at least two different conditions of performance.

In contrast, for heuristic tasks (Reigeluth 1992; Reigeluth and Kim 1993) the focus is on principles, guidelines, and/or causal models that experts use to decide what to do when (rather than using a set of steps). Such heuristic tasks differ greatly in the nature of an expert's performance, depending on the conditions of performance. Thus, experts do not think in terms of steps when they perform the task. This sequencing methodology was derived by Reigeluth primarily from the procedural SCM sequence.

Both types of SCM sequences are used simultaneously when the task is a combination of both types of knowledge (procedural and heuristic). And the SCM and domain-elaboration sequences can be used simultaneously as well. These are referred to as multiple-strand sequences (Beissner and Reigeluth 1994).

The SCM (for both procedural and heuristic tasks) is composed of two parts: epitomizing and elaborating. Epitomizing involves identifying the simplest version of the task that is still fairly representative of the whole task. Elaborating involves identifying progressively more complex versions of the task.

The principles of epitomizing are based upon the notions of holistic learning and schema-building. Epitomizing utilizes: (1) a whole version of the task rather than a simpler component skill; (2) a simple version of the task; (3) a real-world version of the task (usually); and (4) a fairly representative (typical or common) version of the task. The epitome version of the task is performed by experts only under certain restricted (but usually real-world) conditions, referred to as the simplifying conditions.

The principles of elaborating are similarly based on the notions of holistic learning and assimilation-to-schema. Each subsequent elaboration should be: (1) another whole version of the task; (2) a slightly more complex version of the task; (3) equally authentic (or more so); and (4) equally or slightly less representative (typical or common) of the whole task. The simplifying conditions are removed one by one to define each of the more complex versions of the task.

An SCM sequence is designed by integrating task analysis with design. The analysis/design process centers around the questions, "What is the simplest version of the task that an expert has ever performed?" and "What is the next simplest version?" and so forth. As each version is identified, its place in the sequence is simultaneously determined. (More detailed guidance for analyzing and designing an SCM sequence is provided by Reigeluth 1999a.) Since designing an SCM sequence is more of a heuristic than a procedural process, the guidelines include heuristics as well as steps.

There tend to be more procedural elements at the upper levels of analysis (the major phases of the task). However, there comes a point at which it is no longer productive to break a given step into substeps, for that is not the way an expert thinks. Rather, one must identify the heuristics upon which an expert's performance of the step is based.

The Importance of the Elaboration Theory

The paradigm shift from teacher-centered and content-centered instruction to learner-centered instruction is creating new needs for ways to sequence instruction. In the industrial age paradigm of education and training, the need was to break the content or task down into little pieces and teach those pieces one at a time (Reigeluth 1999b). But most of the new, learner-centered approaches to instruction, including simulations, apprenticeships, goal-based scenarios, problem-based learning, and other kinds of situated learning, require a more holistic approach to sequencing, one that can simplify the content or task, not by breaking it into pieces but by identifying simpler real-world versions of the task or content domain. Elaboration sequences accomplish this and simultaneously make the learning process more meaningful and motivational to learners.

Charles M. Reigeluth

See also

Analysis; Bruner, Jerome S.; Gagné, Robert Mills; Instructional Design; Vygotsky, Lev

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Electronic Books (e-books)

An electronic book is the result of combining a digital text with an electronic reading device so that the text can be read in the same manner as a paper-based book. The advent of e-books signals an advance in on-screen reading. Computers and other electronic devices have always supported the reading of text files. However, the text that makes up an e-book is coded to provide many of the features that book lovers and scholars value in printed works. Users “turn” electronic pages by tapping the screen or by pressing a button on a computer or on a hand-held device. Users can also highlight important passages and make annotations or sketches as they read. Other features take advantage of the technology inherent in the computers and electronic readers on which e-books are read. Users can acquire updated versions of texts in minutes, use hyperlinks to move about in the textual world, view multimedia, access definitions and related texts, adjust text size and screen backlighting, and even hear the e-book read by a digitized voice. Furthermore, dozens, perhaps hundreds, of e-books can be stored on a computer or other device, making it possible for an e-book user to have a portable and current library of information constantly available.

The convergence of printed text and electronic devices has potential in education. This potential is particularly apparent at the postsecondary level, where self-directed learning and the need for current content thrives. Currently textbook publishers like Houghton Mifflin are moving to provide up-to-the-minute, tailor-made versions of textbooks that can be downloaded to electronic reading appliances. Students attach an electronic reader to a phone line or a computer through a USB connection, visit the appropriate website, purchase the e-textbook, and receive the book in a matter of minutes. Students read the text as required and can use the highlighting features or add notes. Annotations can be shared with study groups or uploaded for review by the instructor. Instructors can also arrange for their annotations to be available to guide student reading or to relate textbook materials to class lectures. In addition, instructors can customize textbooks by selecting specific chapters rather than requiring students to purchase an entire book.

In K-12 settings, e-books have had little exposure thus far. Beyond the issue of the expense and delicate nature of electronic reading devices are issues surrounding the instructional purposes of K-12 settings. Though e-books may be appropriate for the self-directed, content-rich mode of instruction typical in postsecondary settings, it is unclear whether e-books will be advantageous for younger students or for students who need to develop focused, sustained attention and critical thinking skills. Electronic-based texts may not support or encourage sustained reading, a key component in developing as a sophisticated, critical reader of alphabetic texts (Crawford and Gorman 1995). On the other hand, e-books invite active reading and involvement with texts, strategies that proponents of alphabetic literacy have long held in high regard (Schilit 1999). This debate is not likely to disappear, but neither are e-books. Ultimately, the future of e-books in K-12 settings will depend on how understandings of literacy change and how e-books themselves evolve.

Barbara Pace

See also

E-texts and Readers; Handheld Technologies; Virtual Library

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Electronic Emissary

The Electronic Emissary (emissary.wm.edu) is a web-based service and resource center that helps K-12 teachers and students with Internet access locate expert mentors in various disciplines for the purpose of setting up curriculum-based, extended electronic exchanges among teachers, students, and experts. In this way, the face-to-face teacher-student interaction in the classroom is supplemented and extended by e-mail, chat, and teleconferencing exchanges.

Resources available via telecommunication technologies are providing creative K-12 teachers with new ways to engage their students in authentic learning experiences—those that reflect how knowledge is built and used in the world outside school. Today a teacher no longer needs to be the sole expert in the classroom. It is possible, for example, for students to learn about current weather phenomena from meteorologists, or to discuss the paleontological implications of a recent T-rex skeleton discovery with evolutionary scientists, using simple telecomputing tools such as e-mail and chat. Volunteer subject-matter experts, such as the meteorologists and paleontologists mentioned above, can work virtually with students over an extended period of time, developing and sustaining mentor-protégé relationships that contribute to the richness and relevance of curriculum-based learning in K-12 classrooms. This practice has come to be known as telementoring.

The Electronic Emissary is both a telementoring service and a research effort—its staff both facilitates and investigates the nature of primarily e-mail communication between adult subject-matter-expert volunteers and elementary, middle-level, and secondary students and their teachers. It has been online since February 1993 and on the World Wide Web since December 1995. It serves students and teachers globally, but the majority of its participants are in North America. Emissary-related research has focused upon the nature of telementoring interactions in which K-12 students are active inquirers, the motivations and perceptions of their volunteer subject-matter mentors, effective telementoring facilitation techniques, and what teachers learn as they help students participate in curriculum-oriented telementoring projects.

Though simple and appealing in concept, successfully planning, implementing, and completing telementoring projects is challenging. Online communication lacks the full spectrum of visual and audible information that we depend upon, often unconsciously, in face-to-face exchanges. Therefore, it requires somewhat different interaction strategies if it is to be used to create maximal educational benefit by and for students and teachers. These techniques can be modeled and made explicit by someone closely following online conversations in the role of facilitator, helping participants to construct the online teaching/learning experience in mutually beneficial ways. The Electronic Emissary's years of customized project assistance have shown that the people best prepared have experience in online communication and education. The most important and valuable part of the Electronic Emissary's services is its individualized online facilitation for each and every telementoring project, providing just-in-time teaching and learning assistance to teachers, students, and subject-matter experts.

Sample Telementoring Projects

Table 1 provides some examples of curriculum-related work supported by Electronic Emissary–facilitated telementoring.

Members of Emissary-supported telementoring teams are engaged in in-depth, dynamic exchange. Project evaluation results provided by team members have emphasized the importance of the relationships that have developed among participants. Subject matter "came alive" for students who could interact with someone for whom curriculum content is part of everyday life—and a passionate interest. Many participating teachers develop close, apprentice-like relationships with the experts, requesting and receiving assistance with content-related concepts, resources, and activity design. Subject-matter experts often delight in opportunities to revisit and delve deeper into their disciplinary specializations by interacting with interested others. Online facilitators express fascination with the often challenging, personal, and in-depth communication created by people who know each other only through pixels on a screen.

Table 1: Telementoring Examples from the Electronic Emissary

Examples from Elementary Schools

- A ten-year-old student in Connecticut corresponded frequently with a professor in his seventies in Arizona. They continued their study of Arthurian legends that began in the spring semester of 1995 for more than three years. The student, the professor, their online facilitator, and the Emissary's director coauthored an article describing their online educational experiences (Harris, O'Bryan & Rotenberg, 1996).
- Nineteen fourth- and fifth-grade students in McAllen, Texas, compared the experiences of their families on the Texas "La Frontera" to colonial life in

the original thirteen U.S. colonies with the help of the director of a historic preservation center and museum in Fredericksburg, Virginia.

- Second-grade students in Reading, Massachussetts, who were studying about magnetism posed questions that were answered by a physicist from Arizona State University.
- A marine biologist from California State University–Monterey Bay helped thirty-two third-grade students learn about coral reefs, in particular, damage to reefs from pollution and the diversity of life on a coral reef. The students originally planned to create a saltwater aquarium in their classroom but decided to create a freshwater aquarium with local species instead. They gathered plant and fish specimens from a local stream, monitoring their activity in the classroom aquarium. The mentor guided this process, providing scientific and technical information, answering questions posed by students, and directing them to web-based and paper resources related to their marine biology interests. He also assisted the teacher when she requested information specific to the marine unit that she was building with her students.

Examples from Middle Schools

- Ninth-grade students from San Angelo, Texas, corresponded with an anthropologist from Los Angeles about civil rights. The topic was explored with reference to the first Rodney King trial (taking place at the time of the exchange) and historically by examining the struggle for African-American rights during the late 1950s and early 1960s, emphasizing the contributions of Dr. Martin Luther King Jr.
- Sixth-grade students in Houston, Texas, who were engaged in multidisciplinary study of the Middle Ages posed questions to a medieval history professor who worked at the University of Illinois, addressing her as “Learned Sage.” She, in turn, answered their questions, calling them “Seekers of Knowledge.”
- Ninth-grade students in Hart, Texas, corresponded with an engineering professor from Boston University about waves and wave phenomena, including radar, sonar, light, sound, radio, seismic waves, ultrasound, and water. The focus of the communication was discussion of applied physics experiments and activities that the students conducted about different types of waves and their interactions.

Examples from High Schools

- High school students in Delaware who were studying Nathaniel Hawthorne’s *The Scarlet Letter* communicated with the character Arthur Dimsdale, who was actually an American literature professor at the U.S. Naval Academy. During the following semester, the students communicated with the professor himself about Mark Twain’s *Huck Finn*, culminating their exchange by creating a newspaper that they called *The Mississippi Times*, an idea first suggested by the expert. The teacher and the professor shared instructional ideas, resources, and perspectives about Mark Twain’s works and views.
-

- An advanced placement Spanish literature class in Ross, California, communicated with a professor of Spanish at Ball State University. All communication was conducted in Spanish. Topics addressed included the *nivolas* of Miguel de Unamuno and how those works fit into the cultural and historical contexts of Spain.
- Sixteen- to eighteen-year-old students from Salmon Arm, British Columbia, who were curious about virtual reality technologies corresponded with a computer scientist working for Boeing and NASA, later commenting upon his skill in using humor and professional anecdotes to help them to understand technical information.

Source: Created by the author.

Why Telementoring?

We have learned that students and teachers exploring real-world, multifaceted, curriculum-based topics need to actively build deep and sophisticated understanding. One of the most effective ways to do this is by engaging in ongoing dialogue with knowledgeable others, as the students form, refine, and expand their comprehension. Classroom teachers typically serve as the subject-matter experts with whom students interact in such complex areas of inquiry. Yet when the issues being explored are multidisciplinary, technically and conceptually sophisticated, or dependent upon current and highly specialized research and theory, additional expertise must be made directly available to students and teachers longitudinally and on an as-needed basis. This is what telementoring offers to learners and educators today—and what the Electronic Emissary Project brings to students and teachers worldwide.

Judi Harris

See also

Cognitive Apprenticeship; Collaborative Technologies; Computer-Mediated Communication; Computer-Supported Collaborative Learning; Telementoring

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Electronic Performance Support System (EPSS)

During the past ten years there has been a paradigm shift revolutionizing the training industry. Both the public sector and the private sector have been changing their focus from developing high-quality learning solutions to supporting human performance with alternate approaches. One of the many solutions available to improve human performance is Electronic Performance Support Systems.

EPSSs include tools with an electronic infrastructure that can support a user and allow him to complete a job, function, or task in the time of need. The primary goal of an EPSS is to enhance human performance and productivity regardless of a person's preexisting knowledge or skills (Stevens and Stevens 1995). This goal is accomplished by developing a number of different components or structures that make up an EPSS (see Figure 1). The underlying foundations used to develop these structures are based on two types of electronic performance support: extrinsic and intrinsic.

Extrinsic Support

An extrinsic EPSS is performance support that is integrated with a system but is not inherent to the system itself (Gery 1995). In other words, a person has to break away from the task at hand in order to access information that supports performance. Extrinsic support can be grouped into the following categories/structures: (1) online learning experience; (2) context-sensitive tools; (3) online reference; and (4) knowledge management.

Online Learning Experience

Traditionally, online learning experiences are in the form of computer-based training (CBT) or self-paced modules of instruction. These courses last anywhere from thirty minutes to two hours. However, when a person needs just-in-time support, a traditional CBT is not practical. Granular CBT has become a popular form of extrinsic support. This type of CBT lasts no more than five to ten minutes, therefore truly falling under the category of just-in-time support. Granular CBT allows a person to become oriented and to develop skills through explanations, demonstrations, tips, or practice activities (Gery 1995). Granular CBTs are exemplified by Lotus Screen Cam technology. This software provides an animated sequence that demonstrates an application's functionality when performing a certain task. People can learn how to perform tasks by viewing demonstrations, which can be reviewed as many times as necessary.

Figure 1:

Illustration Depicting the Structures and Designs That Reflect the Different Intrinsic and Extrinsic Types of EPSS

Source: Created by the author.

Context-Sensitive Tools

While learning experiences are structured around demonstrations and practice activities, context-sensitive tools are most commonly structured as online coaches, templates, and task wizards. The common use for this type of extrinsic support is task guidance and task execution, which ultimately lead to consistent and rapid task completion (Gery 1995). Online coaches provide task guidance when using an application. This technology is particularly helpful when someone is unfamiliar with the nuances that are inherent to an application. It allows people to quickly learn by referencing the support.

Microsoft Word's Mr. Paper Clip is an example of this type of extrinsic support. This help provides procedures or troubleshooting guidelines based on a person's answers to a series of questions. After running through a number of options or choices, the user is given a step-by-step procedure plan on how to perform a task. This is particularly useful for someone who is a novice at using a software system.

Templates and wizards allow people to develop documents using a particular style or format, based on a series of questions and answers posed to users. Again the advantage of using this performance support is for rapid development. Microsoft PowerPoint is a perfect example of the template and wizard support. Each time a user launches this application he is given the choice of developing his presentation using the wizard or template option. Users are led through a series of questions, beginning with what type of presentation must be developed through the process of actually developing each slide in the presentation.

Online Reference

Online reference systems (generally known as online help) usually provide step-by-step instructions on how to perform a specific task or function, whether technical or nontechnical. Online help systems can be stand-alone or embedded within a software application. An example of this extrinsic support is the online help embedded in Microsoft Word. When accessing this help, people can drill down to the step-by-step procedures on how to perform a given task. Even though the help is part of the application, it is considered extrinsic because people must break away from their tasks in order to access the information located in the online help.

Knowledge Management

Where online learning experience, context-sensitive tools, and online reference may support specific tasks, knowledge management encompasses a higher level of extrinsic support. Knowledge management supports the creation, archiving, and sharing of “intellectual capital” and best practices within and across communities of people and organizations (Rosenberg 2001). Intellectual capital is the compilation of people’s collective knowledge, within a given organization, that may reside in policies, procedures, instructional materials, or within an individual’s experiential wisdom. The knowledge management system’s main purpose is to consolidate this information into one central location for the purpose of rapid reuse. Generally, public- and private-sector organizations use web-based technology as the infrastructure for knowledge management systems. The structure of a knowledge management system would look like that of a search engine, organized for flexible search, review, and navigation (Gery 1995).

Intrinsic Support

Intrinsic EPSSs are those systems that are tightly integrated within a system or application. In intrinsic support, users do not see the difference between the support and the actual application. The higher the level of intrinsic support, the less aware the user is of its presence to the point that it is invisible (Gery 1995). Ultimately, the actual work environment (within an application) is centered on the tasks a user is responsible for completing.

The development of this type of performance-based environment is known as performance-centered design.

Performance-Centered Design

Performance-centered design is an approach to designing software that inherently supports work processes. The needs of the user are placed at the center of the development process (Rosenberg 2001). An expert system can be categorized as an EPSS created using a performance-centered approach. The two main attributes of an expert system include the following: The system should replace one or more experts; and the system should take a person beyond his current knowledge. In an expert system, the user has the opportunity to seek expert advice when executing important decisions. The idea behind having an "expert" built into the system is to allow a person to perform a task with minimal outside guidance.

Usually, a person using an expert system would not have the subject-matter knowledge or skill to perform a given task or function. That is why a person can perform above and beyond his current knowledge base when using this type of system. In this design approach extrinsic support structures may also be embedded, such as coaches, wizards, and online help systems.

A classic example of an expert system developed using a performance-centered approach would be Intuit's TurboTax. This expert system provides advice through a series of questions and answers and through the use of online help and coaches. TurboTax allows people to prepare tax returns using a self-guided approach. The software provides a series of questions formulated by tax experts that drive the creation and completion of a person's tax return. The question-and-answer dialog is used from beginning to end. Anytime in between, the user can choose to use the embedded help system or access an online coach to help understand certain concepts.

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See also

Analysis; Just-in-Time Training; Human-Computer Interaction; Knowledge Management; Performance Support

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Electronic Portfolios

An electronic portfolio is a purposeful collection of artifacts in a variety of media formats (audio, video, graphics, text, etc.). Artists have maintained portfolios for years, often using their collections for seeking further work, or simply for demonstrating their art. An artist's portfolio usually includes only her best work. Financial portfolios contain a comprehensive record of fiscal transactions and investment holdings that represent a person's monetary worth. By contrast, an educational portfolio contains work that a learner has selected and collected to show growth and change over time. A critical component of an educational portfolio is the learner's reflection on the individual pieces of work (often called "artifacts"), as well as an overall reflection on the story that the portfolio tells. The traditional formats for portfolios in education are paper-based documents stored in manila folders, three-ring notebooks, or larger containers. Most often, the artifacts are in the form of text and images on paper, but the use of electronic media is quickly emerging.

A commonly accepted definition of a portfolio is provided by educators in the Pacific Northwest who form the Northwest Evaluation Association (Paulson, Paulson, and Meyer 1990): "A portfolio is a purposeful collection of student work that exhibits the student's efforts, progress and achievements in one or more areas. The collection must include student participation in selecting contents; the criteria for selection; the criteria for judging merit; and evidence of student self-reflection." The learner's reflections provide the rationale that specific artifacts are evidence of achieving the stated standards or goals. Portfolios that use a paper-based organizer, a database, or hyperlinks to clearly show the relationship between standards or goals, artifacts and reflections, may also be referred to as a standards-based portfolio. Standards-based portfolios are frequently used in education and can take a variety of forms, including traditional paper-based portfolios, electronic portfolios, and digital portfolios. The terms "electronic portfolio" and "digital portfolio" often are used interchangeably; however, there is a distinction. An electronic portfolio contains artifacts that may be in analog (i.e., video- or audiotape) or digital (i.e., computer-based) form. In a digital portfolio, *all* artifacts have been transformed into computer-based form.

An electronic portfolio is not a haphazard collection of artifacts (i.e., a digital scrapbook or a multimedia presentation) but rather a reflective tool that demonstrates growth over time (Barrett 2000). An electronic portfolio is different from other collections such as digital scrapbooks, online resumes, and multimedia presentations because they (1) are organized around a set of standards or learning goals; (2) include learner reflection on her achievement of each standard or goal; (3) include a rationale for why each artifact was selected; and (4) provide an overall reflection of the process of putting together the portfolio.

There are three general purposes for developing portfolios: (1) learning (formative) portfolios, which are usually developed on an ongoing basis supporting professional development; (2) assessment (summative) portfolios, which are usually developed within the context of a formal evaluation process; and (3) employment (marketing) portfolios, which are used for seeking employment (Hartnell-Young and Morriss 1999; Wolf 1999). The benefits of developing electronic portfolios for either students or teachers include: minimal storage space, easily created backup files, portability, long shelf life, learner-centered activities, improved technology skills, multiple ways to demonstrate achievement, and accessibility (especially web portfolios) (Kankaanranta, Barrett, and Hartnell-Young 2000).

Development Process

Creating an electronic portfolio can seem daunting but is less arduous if viewed as a series of stages. A useful framework for electronic portfolio development is anchored in two bodies of literature: multimedia development, and portfolio development in K-12 education (Barrett 2000). Teachers and students gain a powerful tool for demonstrating growth over time if they understand how these processes fit together and how standards or goals contribute to electronic portfolio development. The multimedia development process typically requires the following stages (Ivers and Barron 1998):

- *Assess/decide:* The focus is on needs assessment of the audience, the presentation goals, and the appropriate tools for the final presentation.
- *Design/plan:* The focus is on organizing or designing the presentation. Tasks may include determining audience-appropriate content, software, and storage medium, developing a presentation sequence, and constructing flowcharts or storyboards.
- *Develop:* Materials are gathered and organized for the best presentation using appropriate software.
-

- *Implement:* The developer makes the presentation to the intended audience.
- *Evaluate:* The focus is on evaluating the presentation's effectiveness in light of its purpose and the assessment context.

Following are stages of portfolio development (Danielson and Abrutyn 1997):

- *Collection:* Teachers and students save artifacts that represent the successes and growth opportunities from their day-to-day teaching and learning.
- *Selection:* Teachers and students review and evaluate the artifacts they have saved and identify those that demonstrate achievement of specific standards, outcomes, or goals.
- *Reflection:* Teachers and students become reflective practitioners by evaluating their growth over time, their achievement of the standards, and gaps in their development.
- *Projection (or Direction):* Teachers and students compare their reflections to the standards, outcomes, or goals and performance indicators and set learning goals for the future. This is the stage that turns portfolio development into professional development and supports lifelong learning.
- *Presentation:* Teachers and students share their portfolios with peers. This stage can encourage collaboration and commitment to professional development and lifelong learning.

Five Stages of Electronic Portfolio Development

Combining the multimedia development and portfolio development processes, five stages of electronic portfolio development emerge.

Defining the Portfolio Context and Goals. The primary task in this stage is to identify the assessment context. This includes identifying the goals or standards to be addressed in the portfolio (these often come from state or national standards), the audience for the portfolio, and the resources available to complete the portfolio. This important step helps frame the rest of the portfolio development process.

The Working Portfolio. This critical stage occupies the longest span of time and involves determining the types of artifacts that best demonstrate the required standards, outcomes, or goals and gathering appropriate evidence. Portfolio artifacts should be selected from different points in time to demonstrate the growth and learning that has taken place, and a short reflective statement should be placed with each artifact at the time it is saved. These statements are revisited and expanded in subsequent stages.

It is also necessary at this stage to determine the software development tools most appropriate for the portfolio context, the content, and the resources available. The software used to create the electronic portfolio will likely control, restrict, or enhance the portfolio development

The Reflective Portfolio. This stage usually precedes evaluation reviews (for summative portfolios) or employment applications (for marketing portfolios). In this stage, portfolio reflections are derived from statements in the working portfolio, highlight significant points in the learning process, and ensure that formative self-assessment is occurring. Reflection on one's work is requisite if the portfolio owner is to learn from the process. Three questions should guide this reflective process (Campbell et al. 2000, 22): "What?" "So what?" and "Now what?" To use these questions, the learner would first summarize the artifact that documents the experience, in order to answer the question "What?" Second, the learner would reflect on what she learned and how this leads to meeting the standard, which answers the question "So what?" And third, the learner would address implications for future learning needed and set forth refinements or adaptations, in order to answer "Now what?" It is this process of setting future learning goals that turns electronic portfolio development into a powerful tool for professional development. A portfolio system encourages students to take an active role in their learning.

The Connected Portfolio. This stage is somewhat unique to the electronic portfolio because it assumes students have the ability to create hypertext links between documents, goal statements, work samples, assessment rubrics, and reflections. This stage may also include the use of appropriate multimedia artifacts and usually requires the creation of a table of contents to structure the portfolio. When using the portfolio for assessment, the transformation from "artifacts" to "evidence" is not always clear. The connected portfolio makes this thinking process more explicit. The ability to create links from multiple perspectives (and multiple goals) also overcomes the linearity of two-dimensional paper portfolios and permits a single artifact to demonstrate multiple standards (i.e., national technology standards and state teaching standards).

The Presentation Portfolio. At this stage, the portfolio is presented before an audience and is stored in an appropriate medium for future use and reflection. This individual strategy depends on the context, the type of portfolio, and the level of feedback and collaboration available. In an environment of continuous improvement, a portfolio should be viewed as an ongoing learning tool, and its effectiveness should be reviewed on a regular basis to be sure that it is meeting the goals set.

There are many technology-based tools that can be used to develop electronic portfolios throughout the stages that have been outlined in this article. The value of creating an electronic portfolio should exceed the efforts expended. Above all else, the electronic portfolio should showcase learner achievements and the growing capabilities of using technology to support lifelong learning.

Electronic Portfolios as Alternative Assessment

Portfolios are often used as a form of alternative assessment. The terms “alternative assessment,” “authentic assessment,” and “performance-based assessment” may be used synonymously “to mean variants of performance assessments that require students to generate rather than choose a response” (Herman, Aschbacher, and Winters 1992, 2). There are two central features to alternative assessments. “First, all are viewed as *alternatives* to traditional multiple-choice, standardized achievement tests; second, all refer to direct examination of student performance on significant tasks that are relevant to life outside of school” (Worthen 1993, 445). The characteristics of this type of assessment are: meaningful performance tasks; clear standards and criteria for excellence; emphasis on metacognition and self-evaluation; student-produced products and performances; and positive interaction between assessor and assessee (Burke 1999). Kay Burke (1999) and Robin Fogarty (1998) advocate a balanced approach to assessment, with a focus on three components:

1. Traditional assessment, which focuses on grades, rankings, knowledge, curriculum, and skills. Traditional assessment can be implemented through classroom assessments (tests, quizzes, homework assignments), as well as standardized tests (either norm-referenced or criterion-referenced).
2. Performance assessment, which focuses on observable results, standards, application, and transfer. Performance assessment is often implemented through standards-related tasks, criteria, and scoring rubrics.
3. Portfolio assessment, which focuses on growth and development over time. Portfolio assessment is often implemented through selection, reflection, and inspection of class work, goal-setting, and self-evaluation.

Nevertheless, there are importance differences between performance assessments and portfolios. “Performance assessment focuses on the direct observation of a student’s performance” (Fogarty 1998, 10). Students create projects or perform tasks based on predetermined standards, criteria, and indicators, which are evaluated by scoring rubrics. A portfolio is a container that holds examples of student or teacher work (the “artifacts”) and reflections on that work that transform the artifacts into “evidence” of achievement. Although many of these artifacts could be the results of performance assessments, it is the reflective components in the portfolio that provide the rationale for converting artifacts into evidence of learning.

Electronic Portfolios or Online Assessment Management Systems?

Many teacher education programs are adopting electronic portfolios to meet the National Council for Accreditation of Teacher Education 2000 Standard no. 2, Assessment System, and the implementation often resembles more of a grading or record-keeping system than the traditional paper-based portfolio (Barrett 2003). A portfolio that closely emulates a paper version and just happens to be stored in an electronic container is a very different document from the current implementation of these online database-structured systems, whether developed in-house or purchased commercially.

Electronic portfolios tend to be more learner-centered, with appearance, format, and structure controlled by the portfolio developer, requiring and demonstrating higher technology skills. Electronic portfolios may be constructed with a variety of software and may be published in a variety of formats, including CD-ROM, Internet, videotape, or DVD.

Online assessment management systems tend to be more institution-centered, with format and structure controlled by the underlying database, requiring and demonstrating lower technology skills. These systems are usually accessed using a web browser and published on a secure web server. More research is needed on examples of implementations that clearly differentiate between learner-owned electronic portfolios and the assessment systems used by institutions to record evidence of progress toward meeting standards, outcomes, or goals.

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See also

Alternative Assessment; Evaluation; Weblog

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Entertainment-Education (e-e)

The term “entertainment-education” describes the use of traditional entertainment media formats to deliver educational, prosocial message content. Terms such as “enter-educate,” “infotainment,” and “pro-development entertainment” are also used to describe this practice, with entertainment-education becoming most acceptable in recent years. This communication strategy employs a range of media and technology formats, such as radio and TV soap operas, street theater, songs, and films, among others. The strategy has been used by various institutions that have a message to convey to a specific target audience. The field of health communication, for instance, has used e-e extensively to raise awareness about problems such as population control and diseases such as HIV/AIDS. E-e is the process of “purposely designing and implementing a media message both to entertain and educate, in order to increase audience members’ knowledge about an educational issue, create favorable attitudes and change overt behavior” (Singhal and Rogers 1999, 9).

Although there is still some debate on the definition of e-e, the above is currently acknowledged as an acceptable guideline. However, the boundaries continue to be redrawn as the strategy continues to develop and newer formats appear in the communication spectrum. An example of this is the growing popularity of the talk-show format, which has elicited a lot of interest among e-e strategists due to its appeal among audiences and its educational potential. Many projects fall outside the boundaries of e-e; although they may contain elements of an e-e strategy, they do so intuitively and were not purposely designed to educate. Meanwhile, some professionals in the field consider only those projects that successfully increase knowledge, change attitudes, and influence behavior as e-e.

Furthermore, the definition provided above is based on the three-stage model of behavior change, whereas other models add additional stages. Martine Bouman (1999, 25) modifies the above definition and says that e-e is “the process of purposively designing and implementing a mediating communication form with the potential of entertaining and educating people, in order to enhance and facilitate different stages of pro-social (behavior) change.” In short, e-e is considered to be any project that contains educational messages embedded into an entertainment format, particularly projects driven by theories of social marketing, persuasion, and social learning. For instance, social marketing is based on the idea that social change can be communicated to audiences in the same way that commercial products are advertised. This involves an assessment of the target audience’s characteristics in order to find out how best to make the message appealing.

The idea of combining entertainment and education goes as far back in history as the oldest oral cultures. Mythologies, folktales, parables, tragedies, comedy, and games have all influenced thought, belief, and action, providing entertainment and simultaneously articulating, reinforcing, and shaping educational goals and value systems. However, e-e as a deliberate strategy grounded in communication and social psychological theories has moved beyond the oral traditions of earlier times to include the audiovisual mass media of today.

The e-e approach draws heavily on Albert Bandura’s social cognitive theory, which suggests people learn by observing the behavior of models. E-e programs thus capitalize on parasocial interaction, the quasi-interpersonal relationship between an audience member and a media character. This is evident among avid followers of television soap operas who cultivate a personal relationship with the characters, sharing all manner of emotions with them as the plot unfolds and engaging in discussion about episodes as if they were a part of their everyday lives. The idea is that by rewarding positive and by punishing negative behaviors audience members will identify with and model their behavior on the characters they observe.

There has been substantial growth in the application of this communication strategy globally. This is in part due to changes in the predominant development paradigms—from those that focus on technology and massive infusions of financial resources to those that focus more on education and communication to change behavior and aim at self-sustaining development.

The e-e strategy attempts to create a balance between entertainment-degradation and boredom-education. The former refers to a tendency to degrade a message to increase its attractiveness (e.g., the increasing use of sex and violence in entertainment television). But boredom-education programs are those that frequently overemphasize educational content without engaging audiences. With increased availability of different media content, audiences' choice of what to watch or listen to plays a big role.

The Archers is one of the earliest examples of e-e. Conceptualized and produced by the British Broadcasting Corporation in 1945, this radio serial was designed to promote the diffusion of agricultural innovations to British farmers and to help urban listeners understand rural problems.

Other innovative endeavors include the work of Miguel Sabido, the Mexican TV writer-producer-director who helped lay the theoretical foundations of the strategy. Sabido's telenovelas were inspired by the 1971 Peruvian soap opera *Simplemente Maria,* which led to increased enrollment of young women in literacy and sewing classes. Sabido's soaps were exceptional in that their message construction was guided by theories of human communication.

Examples of e-e from the United States include *Sesame Street,* a TV series produced by the Children's Television Workshop that helps prepare preschoolers for classroom learning. In the 1980s the TV soap opera *Hum Log* (We People) in India addressed issues of family planning, gender, and intergenerational values. In the 1990s in Tanzania, the radio program *Twende na Wakati* (Let's Go with the Times) focused on family planning and HIV prevention. In recent years the Johns Hopkins University Center for Communication Programs has made use of rock music to promote sexual responsibility for youth in Latin America and the Philippines.

One analysis (Bosch and Ogada 2000) found that e-e projects are concentrated primarily in Africa, followed by North America and Asia. In Africa and Asia most projects are centered on reproductive health and family planning, followed closely by HIV/AIDS. Most projects in North America deal with the environment, followed by HIV/AIDS. Globally projects utilize mass-media channels, frequently adopting an integrated multichannel approach. Radio and television are most used, and the soap opera genre is predominant. Research has further shown that mass-media channels are effective for disseminating knowledge, whereas interpersonal channels are effective in changing attitudes and behavior. Folk media, mass media, and the new media are all being utilized, either exclusively or in varying combinations.

Soul City, a multimedia initiative based in South Africa that has been successful in changing attitudes and behavior through entertainment, is an example of a multiyear, strategic communication intervention aimed at supporting social development in a new political climate. The multimedia approach that makes use of print and electronic media, such that they are mutually reinforcing, is more effective in its reach as well as its shelf life.

The themes and issues addressed by e-e interventions support the action agenda of the international development community. With the growing importance of research methods and processes that actively engage the target populations to be the principle agents of their own development, e-e programs are allowing the voices of primary stakeholders to be heard, an increasingly vital element of sustainable human development. E-e programs are beginning to contribute to national, regional, and global public agendas, demonstrating their utility and potential in nurturing the participation necessary for sustainable development. With the increasing application of new technologies in the field of education, the e-e strategy has an important role to play. The novelty of the technology alone cannot enhance the effectiveness of educational content. Attention has to be paid to aesthetics and more entertaining formats that will attract and hold the attention of a target audience that is already inundated with an abundance of more entertaining but less useful information.

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See also

Communication Theory; Diffusion of Innovations; Instructional Communications; Schramm, Wilbur; Television and Learning

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E-texts and Readers

The idea of a handheld reading device has been the dream of engineers and science-fiction writers for many years. In 1988 Apple Computer invited students from twelve universities to participate in a competition to imagine how computing technology would be used in education in the year 2000. The judges were Steve Wozniak, Alvin Toffler, Alan Kay, Diane Ravitch, and Ray Bradbury. The winning entry, from the University of Illinois, described a notebook-sized tablet that contained all of the students' texts as well as capabilities for multimedia and communications functions. A number of companies have attempted to achieve this vision. Although most of those ventures disappeared or were absorbed by larger companies, the development of a reading device has moved steadily forward.

The evolution of the electronic book and digital reading devices is a journey of courageous, bright, and visionary individuals in startup companies and corporate and university think tanks. Unfortunately, no large company—publisher or manufacturer—has been successful in bringing a reading device and the content that would support it to the market in a way that would allow it to proliferate. Recent corporate attempts to market e-books have been stymied by digital rights management, slow publisher commitment of content, and the high cost of the devices. The devices marketed so far have been closed systems focused on commercial content, not open systems that would support education. In spite of that, schools, administrators, and libraries have shown great interest in electronic texts and readers.

Variations of a text-reading device have been seen in movies such as *2001: A Space Odyssey* and on television in *Star Trek.* Alan Kay, who led the Learning Research Group at the Xerox Palo Alto Research Center in the 1970s, defined a DynaBook (a dynamic book), during the late 1960s. Alan Kay and his device are often mentioned as inspiring the recent wave of e-book readers.

The first generation of widely used e-text reading devices was the personal computer. At first, educators used special e-text software or plain-text programs to give students the experience of reading hypertext or plain text on the screen. To support the interest in desktop e-book reading, several extraordinary collections of books in the public domain developed. Project Gutenberg and Bartleby are probably two of the most well known.

Project Gutenberg was the first free source of electronic books distributed through the Internet. Though most books in the collection are in the public domain, works still in copyright are also distributed by Project Gutenberg under special agreement with the authors and publishers. Project founder and executive coordinator Michael Hart, with the help of many dedicated volunteers, continuously turned paper texts into digital files that are available through websites around the world. The first document Hart typed to distribute was the Declaration of Independence. Project Gutenberg began by producing one book a month and in 2002 had 2,500-plus e-books that readers downloaded at a rate of more than 1 million per month.

Bartleby is a small electronic text collection created for education that specializes in classic and modern reference works and poetry. It originated in 1993 as the personal project of Steven van Leeuwen while he was at Columbia University and was incorporated as a commercial business in 1999.

The Bartleby collection is small, consisting of about 300 titles. The library specializes in reference works, including poetry, quotations, and classic works. Bartleby’s sources are mostly from the early twentieth century. Except for the modern references, the average date of publication is reported to be in the 1930s.

The Electronic Text Center of the University of Virginia was the first academic site to allow the downloading of classic books that were in the public domain beginning in August 2001. The collection now includes books formatted to read on a desktop or laptop computer as well as on popular handheld devices with the Palm Reader or Microsoft Reader software. The mission of the center, under the guidance of associate librarian Kendon Stubbs, was to create a community of electronic text users and creators through standards and accessibility and by teaching others to create their own electronic texts.

Making books available to students, faculty, and the public has always been a great priority to the University of Virginia. Thomas Jefferson, architect of the Academical Village at the University of Virginia, placed a library in the Rotunda in the middle of the campus, underscoring the importance of information to academic life. The center continued this tradition by shifting the format of as many of its holdings as possible from print to networked technologies, thereby continuing to make information central to everyday life as well as accessible to the world.

More recently, software such as Adobe Acrobat has gained wide use for reading documents with text, images, and multimedia display on computers. The Adobe product was also developed for reading on a variety of personal digital assistants (PDAs). In the PDA handheld market, the first e-text readers were small-screen, low-resolution devices such as Newton and the Palm. The most widely distributed handheld PDAs today are PalmOS and PocketPC devices, both offering a wide range of e-text content.

E-books were provided to Palm users at first through a company called Peanut Press. As interest in e-book reading grew, this company was acquired by Palm and folded into the Palm Digital Media group. Today Palm offers a broad range of commercial publications for handhelds. Many college bookstores offer required texts in PDA formats. Today PDA readers have come full circle, and Palm offers free reading software for the desktop computer as well as the PDA. The same files that are purchased for the Palm can also be read on a computer as well as a PDA. Although there is not an education category in the Palm e-book offerings, there are many books that could apply to a broad range of courses.

Not to be left out of a market, Microsoft’s handheld operating system, PocketPC, also developed software to serve the growing e-book reading market. Microsoft’s Reader comes with its devices, and large publishers are now delivering commercial content in the Microsoft format. The Microsoft

Reader had a distinct advantage over the Palm Reader software as it employed subpixel rendering and created a much smoother text image on the small screens.

Franklin Electronic Publishers was an early distributor of e-text content on external cards that could be placed in handheld devices. Largely reference works, this content appealed to users in education as well as in the medical professions. In the late 1990s Franklin distributed the first dedicated e-text reader and later developed its own, the eBookman. In addition to playing music and audio books, eBookman included organizer software such as notes and calendars because of the popularity of PDAs.

Dedicated handheld readers were the next generation of e-text devices. Unlike PDAs, these e-book readers did not include any software other than software to support reading features such as a dictionary, e-book rendering, bookmarking, highlighting, and hyperlinking. The first and most popular device was the Rocket eBook followed by the larger and more expensive Softbook.

Launched in 1998 by NuvoMedia, the Rocket eBook could be held comfortably in one hand. It was about the size of a paperback and sold for under $300. The Rocket eBook could receive digital content from a desktop computer or through the computer from the Internet. The device attracted an enthusiastic and dedicated following for commercial e-books, and the e-books contributed to the freely distributed Rocket Library. The device’s design, affordability, and ability to load personal content made the Rocket eBook extremely attractive to e-book enthusiasts. Barnes and Noble was an early partner, selling the devices in stores and electronic books through its online enterprise.

Many tests of the educational application of the Rocket eBook took place. In 1999 Resurrection Catholic School in Dayton, Ohio, participated in the first e-book pilot program in a K-12 environment. Electronic readers were used for every subject in a fourth-grade classroom for a minimum of one grading period. Content came from the web, books were in the public domain, and materials were created by the teacher.

The Softbook Reader was the first handheld e-book reading device to operate without being attached to a computer. The Softbook was a large, backlit, touch-screen tablet with an attached brown leather cover and pushbuttons for navigating the software to read the specially prepared digital texts. Reading materials loaded to the Softbook could be annotated, underlined, bookmarked, and searched on-screen. The device included a stylus, an inkless pen-type implement common to handheld devices. Reading material was loaded to the device by connecting its internal modem by telephone line through the Internet to the Softbook server. The Softbook Reader was designed to make the experience of reading digital text as close to reading a print book as possible. Softbook was one of twenty-one technology and curriculum companies that the Texas Education Agency selected to conduct innovative pilot programs using existing and cutting-edge technology in an effort to boost student learning in thirteen school districts.

Primary Research found in 2002 that 13 percent of the libraries that it surveyed lent some type of e-text reading device (excluding CD-ROM/DVD devices). While public libraries were represented in that percentage, the greatest evidence of interest in reading devices was from libraries at medium-sized colleges.

A primary motivation for developing an electronic reading device for education in the 1990s focused on the size and weight of children's backpacks because of the books they were required to carry. Richard Katzmann's goReader was one reading device made specifically for the education market in the late 1990s to replace heavy backpacks. In spite of some promising university and K-12 testing, the goReader quietly folded in 2001.

E-text development will likely continue to move forward, but the idea of a dedicated reader may take a backseat to recent developments in the tablet format. Now that handheld computers can be small, comfortably held, and contain all of the features of a larger computer, electronic readers may simply become another feature of tablet computing. Tablet computers can take advantage of all of the web-based e-texts available, run the software of the e-book readers, participate in e-book collections, and download commercial e-books from online booksellers. As the form of the hardware evolves, the function of reading texts electronically becomes an increasingly accepted way of reading.

Susan Amirian

See also

Electronic Books; Handheld Technologies; Virtual Library

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Evaluation

Evaluation is the systematic process of determining the merit or worth of an object or thing; evaluations are the product of that process. Without evaluation we would not know which educational innovations (such as programs, curricula, and activities) to continue, stop, or modify. Evaluation is a systematic process.

In the broadest sense, evaluation includes all efforts to place value on events, things, processes, or people. In the field of educational technology, evaluation encompasses all efforts to place value on events, things, processes, or people with regard to learning and/or instruction. Evaluation can be conducted before, during, and after the development and/or implementation of an educational intervention. The appropriate time to conduct the evaluation depends upon the purpose of the evaluation.

In general, the purposes for conducting an evaluation are to inform, improve, and/or prove. Evaluation that is conducted to identify needs and to understand the nature of the needs is known as needs assessment or needs analysis. Evaluation that is undertaken to furnish information that will guide improvement to the educational program or activity is known as formative evaluation. For example, a formative evaluation might be intended to (1) help management improve community acceptance of a new distance learning program; (2) improve student learning through the use of a new software package; or (3) help a state improve the cost-effectiveness of a technology integration professional development program for teachers. Formative evaluation should be conducted in the early stages of developing an educational product or program or in the early stages of implementation when there is still sufficient time to make use of the evaluation results.

In contrast to formative evaluation, evaluation undertaken to render a final judgment is known as summative evaluation. For example, a summative evaluation might intend to (1) judge the effectiveness of learning a topic in a group classroom setting compared to an individualized computer-based learning program; or (2) show the extent to which accidents were reduced as a result of a new safety training program. An evaluation conducted to show outcomes of program A will most likely be quite different from an evaluation conducted to ascertain the outcomes of program B, although both evaluations are summative. Summative evaluation is conducted at the end of the educational program, module, or other activity.

Although it is first necessary for evaluators to determine the purpose of the evaluation, this alone will not provide the needed focus to conduct a meaningful evaluation. The evaluator must spend time understanding the definition, goals, objectives, and components of the evaluation, which might include policies, programs, curricula, courses, instructional software, instructional materials, delivery systems, learners, and so on. The focus of the evaluation and the evaluation questions should be reflective of the goals, objectives, definition, and components of the evaluation.

The process of conducting an evaluation requires that there be a methodology and that measurements be developed as well as standards against which measurements are judged. Although the terms “measurement” and “evaluation” are often used interchangeably in education, there is an important distinction. Measurement is concerned with the establishment of the degree or amount to which a characteristic, trait or feature exists. Evaluation goes beyond measurement by combining quantitative and/or qualitative ratings to establish the desirability and/or importance of the phenomena under evaluation. Measurement in any field involves three common steps: (1) identifying and defining the quality or attribute that is to be measured; (2) determining a set of operations by which the attribute may be made manifest and perceivable; and (3) establishing a set of procedures or definitions for translating observations into quantitative or qualitative statements of degree or amount.

Quantitative data are those observations that lend themselves to numerical ratings, such as answers to multiple-choice questions on an exam, number of dropouts in a class, and counts of aye votes for a technology integration project. Qualitative data are usually narrative in nature, although they can also be summarized in numerical form. Because qualitative data are generally collected to provide in-depth understanding of a phenomenon, it often is not desirable to represent qualitative data with numerical ratings. Numerical ratings are often replaced with or accompanied by narrative information that describes the evaluation in detail. Quantitative and qualitative data are used in both formative and summative evaluation situations. Generally speaking, quantitative data are used to gather information from larger groups and qualitative data are used to gather more in-depth information from smaller groups. For example, the objective of conducting a one-on-one formative evaluation of a piece of educational software with a subject-matter expert, stakeholder, or user is to gather unlimited, detailed, and exhaustive information. In that instance, a qualitative approach would be more appropriate for providing the kind of feedback needed. In contrast, if the objective of conducting a summative evaluation of a piece of educational software used by some 5,000 students in thirty-two school districts across the nation is to gather the same information on a limited number of predetermined criteria from a representative, valid sample, then a quantitative approach would be appropriate.

Evaluation includes, but goes beyond, measurement. Evaluation consists of appraisal, or valuing something. In order for an appraisal or valuation to have meaning, the appraisal must go beyond determining or reporting a numerical rating and place a value on that rating. That process requires reasoning and logic to determine the appropriate valuation system. Establishing the criteria for appraisal or valuation is the first step required if measurement is to lead to evaluation.

In the field of evaluation, criteria are often classified using the following categories: inputs, activities, outputs, and outcomes. Program inputs typically include resources and constraints applicable to the program. Activities include the products and/or services that the program is expected to provide. Outputs are the products and/or services that were actually delivered to program participants. And program outcomes are the results of a program’s efforts. Commonly, formative evaluation includes evaluating inputs, activities, and outputs, whereas summative evaluation includes evaluating outputs and outcomes, although it is possible for summative evaluation to include inputs and activities as well.

Once the criteria of merit have been identified, it is necessary to distinguish between good and bad, high and low, acceptable and unacceptable, and so on. For example, is a 5 percent improvement in test scores over a five-year period good? If school A receives a 4 percent increase in funding and increases its test scores by 2 percent, is this better than school B, which receives a 3 percent increase in funding and increases its test scores by 1 percent? Evaluating the degree or amount to which an event, program, product, process, or person is good or better than requires establishing a usable standard as a basis for comparison and evaluation. This process of establishing standards against which to judge the evaluation is the job of the evaluators and stakeholders. Stakeholders are constituent groups that have a vested interest in the program or activity. A measurement instrument does not place value on what is good or good enough, and unfortunately many numerical ratings garnered from measurement instruments are often misused and misunderstood. An example of this is the use of standardized test scores as a predictor of success in college. Evaluation is the process of placing value on measurement results.

Once standards are established, the next step in the evaluation process is to establish systematic methods for conducting the evaluation. This includes determining the evaluation design and creating a plan for managing the evaluation project. When designing evaluation, the evaluator must consider the following, often competing, issues: (1) the purpose of the evaluation (formative or summative); (2) what will be accepted as evidence; (3) the scale or size of the program; (4) the purpose of the program; (5) the context or culture; and (6) available time, money, and expertise. The following designs are among the most common: cyclic and comparative, posttest-only, and pretest-posttest.

Cyclic designs include subject-matter-expert review, stakeholder review, small- and large-scale pilots, and field trials with typical users. Data collected through cyclic evaluations can be used for formative and summative evaluation. Another type of cyclic design, more commonly used for summative evaluation, is the time series design. In a time series design outcomes are measured at several predetermined intervals. The predetermined intervals are specific points in time (e.g., before, immediately after, several months after, and several years after a program). Which intervals are appropriate for an evaluation depends upon the program purposes and the evaluation questions. Cyclic designs can require extensive time, money, and expertise but do not necessarily require that the number of program participants be large.

Comparative designs, commonly used for summative evaluation, are used when evidence is needed to demonstrate that observed outcomes are a result of the program. Comparative designs compare criteria from the treatment with the same criteria from a valid control group to discern whether the outcomes are different between the two groups. The time, money, and expertise required to conduct comparative evaluations can vary greatly. Larger numbers of participants are required for comparative designs.

Posttest-only designs, as the name implies, rely on postprogram measures as evidence. The disadvantage to this design is that it is almost impossible to attribute observations to the program. It is entirely possible that there was no change in the evaluation. When a posttest-only design is used, the use of a comparison group can be used to determine if treatment and control groups differ on the posttest. However, the posttest-only comparison design assumes that the treatment and control groups did not differ before the program, which could well be an inaccurate assumption.

Pretest/posttest designs provide stronger evidence by utilizing pretreatment and posttreatment measures to detect change. Although the observed change is often sufficient evidence of program effects, it is possible that observed effects are due to other factors, such as maturation, other conditions, and another program happening at the same time. If evidence based on a pretest/posttest design is not conclusive enough, then it might be necessary to use a pretest/posttest comparison group design. The pretest/posttest comparison group design collects information for both groups both before and after the program. With this design, both the treatment and the control group will experience change due to maturation, other conditions, and so on. Posttest-only designs require less time and money than pretest/posttest designs. The addition of a control group will require that the available participant group be larger. As a rule of thumb, as the need for rigor increases and the evaluation design becomes more sophisticated, the resources required also increase.

Systematic evaluation methods also include establishing a plan for managing the evaluation project. The evaluator should identify personnel required, project phases, inventory timelines, available resources, and constraints. Given this information, the evaluator should construct a detailed plan for managing the evaluation project and then implement the evaluation according to the plan.

Once data are collected, the next step in the formal evaluation process is to synthesize the evaluation results. The synthesis of evaluation results includes analyzing the various types of data that were collected and combining the results in a manner that provides a coherent representation of the evaluation. The purpose of analyzing data is to depict needs, current performance in contrast to desired performance, the effectiveness of a method, what was accomplished, and so on for a given program. Data analysis is the quantification or qualification of outcomes. Because programs are usually comprised of several inputs, activities, outputs, and outcomes, data analysis usually consists of measuring several variables. It is usually best to start by analyzing one variable at a time as well as the progress, then analyzing the patterns of single variables over time and/or relationships among variables. The variables, patterns, and relationships studied should answer the individual evaluation questions as well as form a coherent whole in a manner that can be used to compare the evaluation results to previously established standards.

The final step in the evaluation process is to draw conclusions, render judgments, and/or issue recommendations. With previously established standards as well as complete evaluation data in hand, the evaluator is in a position to complete the appraisal. In the case of formative evaluation, this step often includes determining areas where the program is performing to standard and areas where it is deficient; determining how the program can be improved; and issuing recommendations for improving the program. In the case of summative evaluation, this step often includes determining final outcomes, comparing final outcomes to standards, and rendering final judgments based on outcomes and standards.

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See also

ADDIE Model; Alternative Assessment; Analysis; Electronic Portfolios; Instructional Design; Rapid Prototyping

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F

Florida Virtual School (FLVS)

The Florida Virtual School is a pioneer in public school e-learning. Funded entirely by the state of Florida, its courses are available at no charge to Florida residents. Since it began serving high school students on a statewide basis in the spring of 1997 with approximately 200 student enrollments in six course offerings, FLVS has grown dramatically. At the close of the 2001–2002 school year, FLVS had 8,200 student enrollments in sixty courses. (Here, "enrollment" is defined as the number of course seats that students have taken or are currently taking.) The enrollment number is consistently larger than the student count number. This is because many students sign up for more than one course. It is not uncommon for one student to be enrolled in three courses; thus the student count would be one, but the enrollment count would be three.

Offering core curriculum, advanced placement (AP), and a variety of elective courses, FLVS provides students an alternative avenue for earning high school credits. In 2003 FLVS will offer middle school courses and a graduate equivalency diploma (known as GED) prep course. The FLVS's environment offers a choice for all learners. Home-schoolers, athletes, performers, and any students with scheduling conflicts or medical problems benefit from the "any time, any place, any path, any pace" environment. Time is flexible; therefore, students have choice in scheduling time for the online classroom. According to SCANS (1992), "In our current system, time is the constant and achievement the variable. We have it backwards. Achievement should be the constant and time the variable." Students and parents say that flexibility in time is key to student success.

Often, current educational systems ignore the fact that curriculum and teaching style play a major role in whether or not students are successful (Pollak 1999). What is missing in some classrooms is choice. An effective online classroom is not an “incidental pedagogical choice but a choice that shapes how and what students learn and, crucially, how they learn to learn” (Katz 1993). FLVS instructors create effective classrooms, engaging students in relevant applications that offer choices in how to process concepts and for demonstrating proficiency.

Each course begins with a real-world motif or metaphoric construct that allows students to have a specific role as they make connections with course concepts. For example, in the course on American government, through a virtual tour of Washington, D.C., students connect to concepts as they journey to different monuments and buildings. The goal is for students to become politically active and discover how to access the governmental system. Projects include writing letters to senators, researching interest groups, and creating a persuasive product to support a political issue of their choice.

As distance learning experts have emphasized, teacher-student interaction is the most important ingredient in student success. Students may have an interactive role in the courses. Through threaded discussions, e-mail, synchronous chats, phone calls to individual students, and conference calls, students and teacher stay connected.

To involve the students in the learning process, students are given choices on what resources to consult and how to demonstrate learning. For example, in AP Literature and Composition the dinner party motif casts students as guests conversing on literary masterpieces. In this role students enjoy appetizers (short stories and poems), examine entrees (often novels or plays they choose), engage in table talk, and have a choice of whether or not to take dessert (creative projects that are optional). The instructor models for students how to design a dinner party, and then toward the end of the course students become creators and make choices in designing their themed dinner party.

Learning in a context such as that outlined above is easily transferred to long-term memory. By only asking students to “give us right answers without asking how they arrive at them, make correct choices on multiple-choice questions, or distinguish true from false, . . . they will never see the value of working hard” (Glasser 1992, 208). FLVS provides a caring learning environment that gives students choices in how they learn. By establishing high expectations and curriculum choices (projects) for demonstrating proficiency, teachers engage students in learning.

Expectations are focused on academic as well as workplace and lifelong skills. For example, students complete their registration process online and submit the information. This requires students to take the initiative of going to the website and following instructions independently to complete the process.

Throughout all the course work students decide a pace for assignment completion. Again, students are encouraged to take responsibility for learning as they look at their schedule and course requirements in choosing a plan of action. As in the workplace, students are expected to make choices and perform specific roles in a timely manner with minimal supervision.

FLVS courses integrate higher-order thinking and successful workplace skills, especially decisionmaking, throughout the curriculum. According to Florida high school evaluators, “This is in vast contrast to most of the teaching occurring in Florida and the United States today” (Bergquist, Bigbie, and Richardson 1999; National Center for Education Statistics 1999). Teachers create problem-solving activities that allow students to create hypotheses, gather information, and apply information to test hypotheses. For example, in the ninth-grade English course students analyze the effectiveness of advertisements to discover what people buy and what strategies cause them to buy. After researching products online at sites provided by the teacher, students create a chart to determine the target audience, the type of delivery, and the effectiveness of the advertisement. Finally, students choose and create their own product and design an accompanying marketing strategy that they present to their online classmates.

In FLVS courses, to encourage students to take responsibility for their learning, they have the option of submitting assignments for review. Teachers give feedback and invite students to revise and resubmit the assignment for another evaluation. Formative and summative assessments are an integral part of the learning process, but at FLVS students decide when they want to take advantage of formative assessments.

Using technology as a tool to design and deliver content, the FLVS curriculum has changed the way teachers interact with each other and teach students. FLVS educators have reshaped the routine learning modes of the traditional school day to a dynamic, interactive, real-world learning environment that gives choices to students and requires students to take ownership of the learning process as they click through school.

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See also

Collaborative Technologies; Distance Education

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G

Gagné, Robert Mills (1915–2002)

In addition to instructional hardware, technology is also viewed as “a systematic process of solving problems by scientific means. Hence, educational technology properly refers to a particular approach to achieving the ends of education. Instructional technology refers to the use of such technological processes specifically for teaching and learning” (Ely 1995). Using this definition, Robert Mills Gagné was one of the preeminent scholars in the field of educational technology. His work in learning research focused on the applications of psychology to the design of instruction, especially the role of information processing as it affects learning.

Born in 1915 and raised in North Andover, Massachusetts, Gagné decided while in high school that he wanted to study psychology. He earned his B.A. at Yale in 1937 and his M.S. and Ph.D. from Brown University in 1939 and 1940. Gagné was influenced at Brown by Walter Hunter, who was interested in cognitive processes. In 1941 Gagné enlisted in the military and served in the aviation psychology program until 1945. In the military he continued his interest in perceptual and motor learning and worked at two different Air Force laboratories on simulator design and other training devices. There he developed an early conception of how information processing affected human performance.

Gagné taught at Princeton University between 1958 and 1962. In 1962 he became director of the American Institutes for Research. At Princeton he expanded on the definition of domains of learning and developed the concept of learning hierarchies. Learning hierarchies are important because they establish the importance of learning readiness in the form of prerequisite skills. In 1965 he published *Conditions of Learning,* which established a framework for looking at instructional requirements for different types of learning outcomes. Gagné tried out his ideas in applied settings. He collaborated on the development of a mathematics curriculum at the University of Maryland, which further strengthened his belief in prerequisite skills.

In 1966 he moved to and taught at the University of California–Berkeley, and in 1969 he moved to the Department of Educational Research at Florida State University, after he was recruited by Robert Morgan, to help develop a new curriculum in instructional systems. While at Florida State, Gagné focused on instructional research, continuing to develop his ideas about the internal and external conditions of learning. In 1974 he coauthored *Principles of Instructional Design* with Leslie J. Briggs. This book was one of the first to develop an integrated model of instructional design based on a psychological model of learning. In this book, Gagné and Briggs explicated the idea of "events of instruction," which were correlated with phases of the information-processing model. Gagné was also interested in schema theory. He felt that schema were structures for organizing, storing, and recalling knowledge and that schema played both proactive and reactive roles in learning. Later, in 1990, Gagné and David Merrill explored the relationships of goals and schema in the form of enterprise schema. Enterprise schema probably are as close as either scholar would come to embracing some of the ideas associated with constructivist theory today. One of his last publications, *The Conditions of Learning: Training Applications,* with Karen Medsker, integrated instructional theory with workplace training (Gagné and Medsker 1996). Gagné was a prolific writer, and in 1989 he gathered a sample of what he felt was his most important research into an annotated anthology (Gagné 1989).

Gagné is often categorized as a behavioral psychologist because of some of his early writing and affiliation with other behavioral psychologists. However, he didn't feel that the behaviorist theories were adequate to explain human learning. Rather, Gagné should be considered one of the early cognitive psychologists. His important research was centered on how the events in the instructional environment facilitate learning. In all, Gagné was mainly responsible for the development of five instructional theories: (1) the five domains of learning; (2) events of instruction; (3) conditions of learning; (4) role of the media; and (5) integrated goals. These theories are briefly described below.

Five Domains of Learning

Three researchers (Krathwohl, Bloom, and Masia 1964) had defined taxonomies of learning in the cognitive and affective domains. Alternatively, Gagné and Briggs defined five domains: verbal information, intellectual skills, motor skills, attitudes, and cognitive strategies. Within the intellectual skills domain, they described five kinds of learning outcomes: problem-solving, rule-using, defined concepts, concrete concepts, and discriminations (see Figure 1).

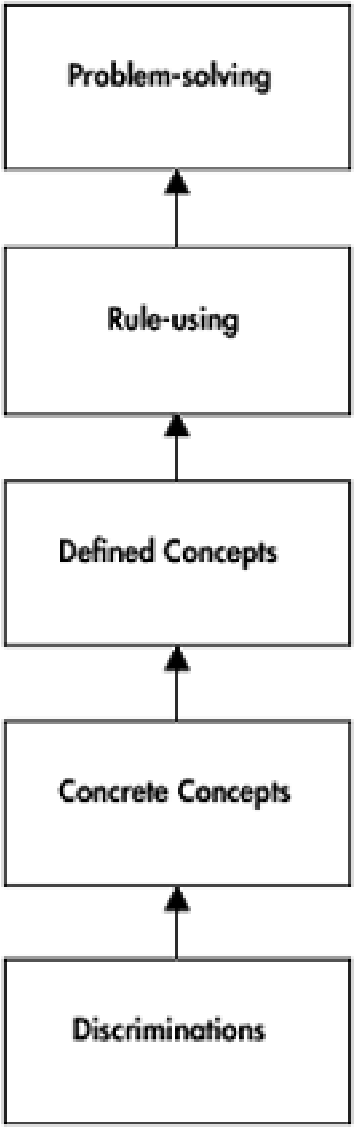

Figure 1:

Intellectual Skills Hierarchy

Source: Created by the author.

The intellectual skills domain interested Gagné most, as he saw it as a hierarchy of skills. In other words, to learn to solve problems it was first necessary to learn rules and procedures; to learn to apply rules and procedures it was first necessary to learn concepts; and to learn concepts it was necessary to be able to make discriminations. From this hierarchy, Gagné built a theory of prerequisite skills. The theory is that in order to learn higher-order skills, lower-order skills must be attained first. In order to describe the hierarchy of skills, say, for a particular rule, one would ask the question, “What concepts must the student first acquire to be able to apply this rule?” Similar questions would be asked between other adjacent types of learning.

The intellectual skills hierarchy implies that learning is cumulative and that certain prerequisite skills are necessary for learning related higher-order skills. The most obvious example is that long division can't be mastered before multiplication, because multiplication is used in the long division process. It doesn't mean the concept of division can't be learned before multiplication, but the process itself can't be learned.

The intellectual skills domain represents most of the important skills learned in school. Problem-solving skills are at the highest level and involve what Gagné referred to as productive, or generative, learning. Gagné felt that the product of problem-solving was the generation of a new rule or procedure—a synthesis of other rules and related concepts that were never used together or learned together in the particular way they were applied.

Verbal information involves names, labels, and facts. Verbal information is generally learned by reception; it isn't deduced or inferred. For example, an insect has six legs. This is a fact. It is a definition, or a declarative statement. It is also an attribute of the concept of insect. However, being able to recall the verbal statement does not mean that an individual would necessarily be able to apply it or use it in a knowledgeable way. A lot of what is taught in school is information. Information is best learned and remembered when it can be placed into a context, or schema.

Motor skills are behaviors that involve coordinated muscular movements. Gagné believes that motor skills have an executive component that is initially a mediator of motor performance. This executive component can be learned as verbal information, such as the seven steps for parallel parking a car. However, with practice the verbal mediator drops out and the motor skill becomes automatized, or performed without thinking about it. In order to unlearn incorrect motor performance, sometimes a coach will drop back to the verbal components of the performance to correct a step in the coordinated performance.

Gagné classifies strategies related to learning as cognitive strategies. An example of a cognitive strategy would be underlining text as you read a book. This is an focusing strategy, to reduce the text to fewer important pieces of information to be remembered. There are also formal mnemonic strategies, such as making acronyms for memorizing lists of items. And there are processing strategies, such as Survey, Question, Read, Recite, and Review, a strategy for comprehending text. Sometimes cognitive strategies look like metacognitive strategies. Metacognition is cognition about learning and is often directed toward monitoring on-task behavior, understanding, and so on.

Attitudes, according to Gagné, are choice behaviors. These seem to be mostly social issues such as volunteerism, honesty, bravery, eating habits, and the like. Attitudes are often mediated by values, opinions, and beliefs. Gagné suggests that in order to teach attitudes it is helpful to have a human or anthropomorphic model, respected by the learner, that is shown engaging in the desired behaviors (such as refusing a cigarette or drugs). Attitudes can never be directly measured because the obtrusiveness of measuring them may cause a change in the voluntary nature of the behavior.

Events of Instruction

Gagné believes that information goes through a series of processes before it is stored in long-term memory (Gagné, Briggs, and Wager 1992) (see Figure 2). These processes involve:

1. reception of stimuli by receptors
2. registration of information by sensory registers
3. selective perception for storage in short-term memory (STM)
4. rehearsal to maintain information in STM
5. semantic encoding for storage in long-term memory (LTM)
6. retrieval from LTM to STM
7. response generation by effectors
8. performance in the learner's environment
9. control of processes by executive strategies

Events external to the learner can influence the processes of learning, especially processes 3 through 6. The external events as they relate to the information processing steps are:

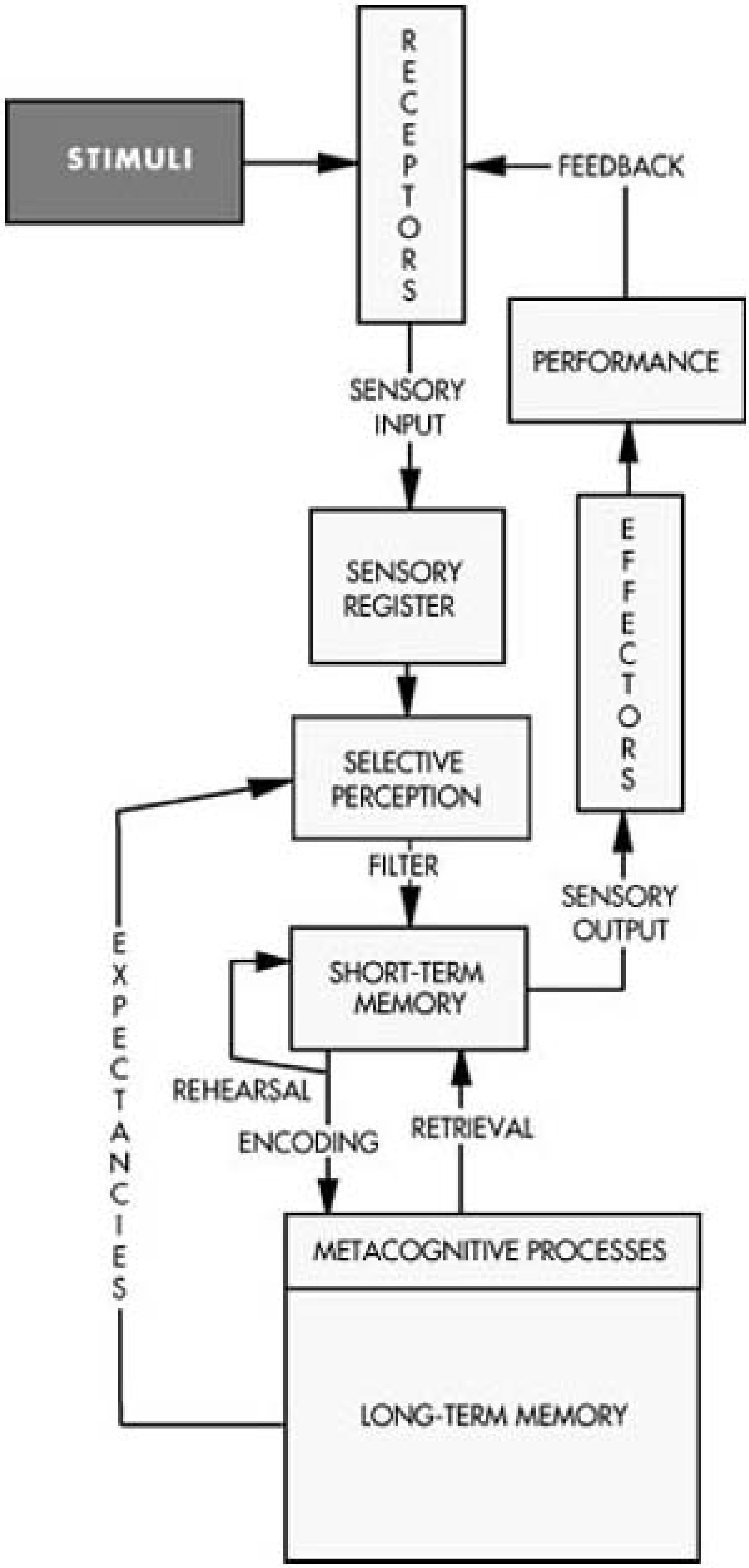

Figure 2:

An Elaborated Model of Learning and Performance Underlying Gagné's Conditions of Learning Model

Source: Created by the author.

1. Gain attention to ensure reception. Techniques for gaining attention can involve physical or mental activities. The idea is to focus the learner on the instructional environment.
2. Present the objective to establish expectancy in the learner and start the filtering process. Expectations affect selective perception.

If the student knows the lesson is about classifying types of abnormal behavior, she can focus on the attributes for such behavior.

3. Reminding the learner of related material she has already stored in LTM. Recalling prerequisite concepts helps the learner encode and store the new concepts.
4. Presenting the material in a clear and focused way to aid selective perception. Organizing the material in a clear and well sequenced manner aids in making connections in memory.
5. Guidance of learning to aid semantic encoding. Guidance may include examples, elaborations, or additional information.
6. Eliciting performance to involve response generation and development of cues. Eliciting performance serves many functions, but probably most important is allowing the detection of misunderstanding.
7. Providing confirmative or corrective feedback about performance. Feedback can confirm correctness or remediate errors.
8. Assessing performance. Assessing performance certifies a level of understanding and performance, indicating whether further learning is needed.
9. Providing opportunities for use in context to aid retention and transfer. Learning often deteriorates quickly if it is not exercised.

These nine events of instruction can be used as building blocks for developing instructional materials; such events have been called learning activities (Dick and Reiser 1996). However, what goes into the events will be different depending upon the conditions of learning for a particular kind of learning outcome.

Conditions of Learning

According to Gagné, each type of learning outcome has different internal and external conditions. For example, the internal condition for learning a rule or procedure is the recall of prerequisite concepts into working memory. The external event is some type of learning activity that requires the recall of prerequisites, and the internal condition is that the proper concepts have already been learned and therefore are to be recalled. The condition for learning problem-solving skills is that the learner must have a reasonable set of rules, principles, or procedures that can be recalled in considering solutions to the problem. The external environment presents the problem, but the way it is presented can make it easier or more difficult to solve, because it can contain cues that allow the learner to more readily recall the appropriate rules, bring them into working memory, and synthesize new rules to solve the problem.

The Role of Technology and the Media

Gagné has always been interested in the role of technology in learning. From his early experience with designing training simulators to his later experiences in the classroom, he tried to draw connections between media and technology to events of learning. Gagné worked on many media selection models based on the notion that the purpose of media was to create the learning environment, and to do so they had to be able to provide the stimuli called for by the conditions of learning at the appropriate time according to the events of instruction. With another researcher (Reiser and Gagné 1983), he created a flowchart that allowed an instructional designer to select media based on a number of logistical and psychological considerations. The user would follow the flowchart, answering "yes" or "no" to questions presented at each node. Eventually the user would come to a list of candidate media that had been whittled down by the questioning process to those that could provide the needed stimuli. The authors then assumed that the user could select among the suggested media as a matter of convenience or availability, since theoretically they would all be equally effective. Gagné viewed computers as a potentially powerful teaching tool because of their ability to recognize classes of errors and to give corrective feedback.

Integrated Goals and Enterprise Schema

Toward the end of his academic career, Gagné developed the notion of integrated goals (Gagné and Merrill 1990). Integrated goals involve multiple learning outcomes, but most notably they also involve an individual's tacit knowledge about how to achieve goals. He called such tacit knowledge an enterprise schema. An enterprise schema is all the goal-related knowledge and skills pertaining to an enterprise, that is, a purposeful effort. The concept of enterprise schema leaves room for speculation and research on how schemas affect learner motivation and time management, as well as how individuals view a learning task. In fact, enterprise schemas might be associated with the concept of the proximal zone of development, in that they might indicate what types of scaffolding would be appropriate for learners, depending upon their goal schema.

Gagné was president of the American Psychological Association's divisions on military psychology and educational psychology, as well as president of the American Educational Research Association. He also served as consulting editor to several professional journals, including the *Journal of Educational Psychology, Instructional Science, Human Learning,* and the *Journal of Instructional Development.* His honors included the AERA–Phi Delta Kappa Award for distinguished educational research (1972), the E. L. Thorndike Award in educational psychology (1974), and election to the National Academy of Education (1974). Gagné retired from Florida State

University in 1991 and moved to a retirement community in Signal Mountain, Tennessee. Gagné died peacefully in his sleep on April 28, 2002.

Walter Wager

See also

Cognitive Psychology; Instructional Design; Instructional Objectives; Research on Media and Learning

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H

Handheld Technologies

Handheld computers (also known as handhelds, handheld devices, and palmtops) are small multifunctional computing devices. They range in size from those small enough to fit into one hand and use a stylus to those with keyboards that are a fraction of the size of a typical laptop computer. Although relatively new to instructional settings, handhelds hold promise for education because of their versatility and low cost. Handheld devices may make it possible for every student and teacher to have access to a computing device at all times.

One of the first handheld computers marketed commercially was the Apple® Newton®, which was introduced in 1993 and discontinued in 1998. The chairman of Apple at the time, John Sculley, accurately predicted handhelds would become ubiquitous tools. The Newton used a proprietary operating system (OS). Unfortunately, the Newton was a bit ahead of its time and did not find enough of a market to survive.

In 1996 U.S. Robotics introduced the first Palm OS device, the PalmPilot™. (The generic use of the term "PalmPilot" for all handheld computers, though popular, is incorrect.) The PalmPilot helped people organize information, and this handheld was quickly embraced by the business world.

In 1996 Microsoft introduced the Windows® CE operating system, based on the popular Windows for desktops. Casio, NEC, Compaq, Philips, and Hewlett Packard all have produced handhelds running under the Windows CE operating system. In 2000, Microsoft introduced its Pocket PC 2002, its latest version of the Windows CE–based operating system. (See Table 1.)

Table 1: Handheld Manufacturers by
Operating System and Advantages of Each

	Operating System	
	Palm OS	**Pocket PC OS**
Handheld computer manufacturers	Palm, Handspring, Sony, AlphaSmart, Handera, Acer	Compaq, Toshiba, Casio, Hewlett-Packard, Dell, Acer
Advantages	Simple to use Lower initial cost More software available Longer battery life	More multimedia and software built in More processing power Solution is Microsoft-compatible

Source: Created by the author.

The successful early handheld devices, intended primarily for business or personal use, were called personal digital assistants (PDAs). They were designed to hold and organize address and phone lists, calendars, and other personal information.

The devices have evolved to become faster and more powerful. While they still organize calendars and contact lists, they can also act as word processors, spreadsheets, databases, e-book readers, graphing calculators, Internet browsers, digital cameras, scrapbooks, graphic organizers, global positioning systems, digital audio recorders, digital music players, telephones, and game devices. Thousands of software programs are available for handheld computers.

Today, a handheld device can be purchased for less than $100. They are portable and can be carried in backpacks, pockets, and purses. Handhelds use batteries and do not require an external power source while in use. Handhelds can be used in the classroom, at home, and out-of-doors on the playground or a field trip. Properly configured, handhelds can provide wireless access to the Internet and e-mail. They are relatively easy to use. Users can work together and share information by “beaming,” or using infrared technology to transfer data from one handheld to another. Educational software spanning all content areas and grade levels is available for handhelds, and administrative and management tools for teachers are also readily available.

One of the most promising aspects of handhelds is the ability to provide equitable access to computers to all students. Handhelds make it possible to achieve 1:1 student-to-computer ratios, providing students with computing tools anytime, anywhere. By comparison, in 2001 the ratio of students to computers in the United States reached an all-time low of one computer to nine students. Many of those computers are in lab settings, and as a result many students have only a few minutes of access to a computer at school each week. It is difficult to expect technology to produce gains in student achievement with such limited access, so the use of handhelds is gaining much attention. While every student cannot be provided with a $1,000 desktop computer, it is not outside the realm of possibility to imagine a time when every student will have his own handheld computer.

The challenges of using handhelds in instructional settings include the lack of compatibility between operating systems. In addition, the small devices can be misplaced or stolen. Because it is a small device, the screen is small and can be difficult to read. Little is known about the prolonged use of the handheld computer's possible impact on student health. Concerns include eyestrain and carpal tunnel syndrome. Handheld technologies and applications are evolving rapidly, so obsolescence will be a continuing problem, as in desktop technology. Additional challenges include the ongoing needs for professional development and school-based technology support.

Handhelds come with a hardware cradle that connects to the desktop computer through a universal serial bus or serial connection. A push of a button begins the synchronization process. Data is updated from the handheld to the desktop and from the desktop to the handheld (bidirectional synching). Users may also specify unidirectional data flow, from the desktop to the handheld or from the handheld to the desktop, for specific applications.

Just as with larger desktop and laptop computers, handhelds have a variety of ways to input and output data. Both Palm OS and Pocket PC devices have handwriting recognition features, using a stylus on the face of the device. Handwriting recognition schemes are not difficult to learn and provide the most convenient method for data entry at this time. Desktop computers may be used to input data, and then the handheld must be synchronized (or synched) to the desktop. Other data input techniques include receiving an infrared beam from another device, using an onscreen keyboard, and using an external keyboard. External keyboards range in size from thumb-type mini to full-size keyboards. Some of the current handheld devices will accommodate the addition of memory modules such as flash cards and memory sticks to access data. Data may also be input with probes, modems, network cards, digital cameras, and other peripherals.

The primary output device is the handheld's own screen, which can vary in size, resolution, and readability. Data may be beamed to another infrared device, including another handheld or a printer. Flash memory modules and memory sticks may also be used to store data, or data can be sent to the desktop computer during the synching process.

The ability to communicate wirelessly is becoming a popular feature of handhelds. Beyond infrared, which has line-of-sight and distance issues, other wireless capabilities exist, including cellular (using a similar service to cell phone technology). Another variety of wireless service lets users connect to a local area network. Wireless technologies hold particular promise for education in the area of assessment. With wireless assessment tools, teachers can get real-time feedback on student mastery of content.

Many software companies are providing handheld versions of popular software, and other companies are providing solutions solely for handhelds. Applications include word processors, databases, spreadsheets, presentation software, drawing programs, and graphic organizers. These can be used to create multimedia reports, charts, graphs, lesson plans, lists, e-books, outlines, journals, timelines, notes, and illustrations. Peripheral devices will allow handheld users to gather data (probeware), take photographs (digital camera), record music or voice (digital recorder), make a presentation (VGA card), determine and map locations (global positioning system), and access the World Wide Web and send e-mail (modem or network card).

Commercial software developed specifically for teachers includes grade-book programs, attendance modules and student information systems, curriculum standards databases, rubric generators, assessment tools, concept mapping tools, lesson plan generators, quiz generators, teaching tips, and idea organizers. Students will find software developed especially for their use, including web browsers, e-books and readers, reference tools, graphing calculators, graphing tools, music editors, visual scrapbooks, educational games, content review tools, concept mapping tools, and other software to help manage and organize information. New applications are being developed rapidly.

Under a grant from the National Science Foundation, the Center for Highly Interactive Computing in Education at the University of Michigan (www.handheld.hice-dev.org) has developed a number of free software applications for education for Palm OS handhelds. They include a word processor, a photo scrapbook, a visual organizer, an animation and drawing tool, a flashcard application, a virus simulator, and a handheld-based quiz and worksheet generator. The Concord Consortium (www.concord.org), a nonprofit educational research and development organization, focuses on the use of probeware for handheld computers and has an online library of free software.

Donna Baumbach
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See also

E-texts and Readers; Probeware; Virtual Library; Wireless Networks

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Human-Computer Interaction (HCI)

Human-computer interaction is the study of people using computers. Although the principles involved are applicable to more general systems, in practice the goal is to make computational and networked technologies easier to use for people, improving *usability*. The reasons for this include making people more efficient in accomplishing their tasks, reducing errors, and increasing the subjective experience.

Historically, computer time was costly and rare, so the burden of communication was put on the user; people found themselves translating problems into language the machine understood. As computer power increased and prices dropped, the emphasis shifted to the point where now we can put the burden of translation on the computer. Pragmatically, HCI has involved the design of computer *interfaces*—the representation through which the computer communicates to the user and the mechanisms provided for the user to communicate to the computer.

HCI involves a scientific component, including a body of theory about how people accomplish tasks mediated by tools such as computers, as well as an applied component indicating how to design usable systems. As an interdisciplinary field, involving technology and people, many different approaches are relevant. A minimal list includes social, cognitive, and organizational psychology, sociology, linguistics, artificial intelligence, software engineering, ergonomics, and mathematics as relevant disciplines. More recently, anthropology, activity theory, and semiotics are among the areas that have contributed to analysis. The underlying notion is to understand how people act in the world, alone and together, and how tools or cognitive artifacts, specifically computers, can mediate those actions.

The concern is broader than just an individual at a computer; it includes other computational and networked devices such as handheld computers, interactive kiosks, wearable computers, augmented workspaces, and the like. In addition, it concerns the context in which computing is performed, the other tools used as part of a task, collaboration and communication between individuals, and the organizational contexts in which the task is situated and the design processes occur.

HCI and Educational Technology

There are similarities with instructional systems design, which combines research and theory on how people learn with an applied approach to the design of educational technology. The main conceptual difference is that with HCI the user is assumed to know the task to accomplish, whereas with educational technology the learner is inherently involved in something new. The boundaries blur when the systems at issue are performance support systems. There has been cross-fertilization as well; for example, the HCI field first popularized the notion of user-centered design in moving to a design perspective focusing on the end user, motivating ISD to move the focus to learner-centered design.

Principles

The science side of HCI is concerned with frameworks that give researchers leverage in understanding how people act. As an interdisciplinary field, there is a rich set of such frameworks that have been brought to bear in understanding the ways users interact with a system. There has been a synergistic strength from the diversity of approaches that have been the familiar tools from each field.

Involved is the study of input devices like mice, trackballs, keyboards, voice, and the like, as well as output devices such as screens, printers, and speech generators. Perhaps more important, the issues involve how to map the ways people understand those devices to operate and how to use the output representational capabilities to present a coherent *system model,* or representation, of how the system works. Thus, we have seen graphical user interfaces that use metaphors (such as the desktop) to convey a system model and provide mappings between common input devices and different tasks (such as using a mouse to control one-dimensional scroll bars).

One of the most useful has been the seven stages of action model of Donald Norman (see Figure 1). This model captures the cycles of a user's interaction with the system. Users start with high-level goals that they need to accomplish. They need to transform these goals into specific actions that the system understands. This forms a gulf between the user and the system that the interface bridges. A similar gulf exists between the output of the system and the information that users need to determine whether their goals are met and how to accomplish the next task.

From this diagram we see that users, to achieve their goals, must specify their current intention, determine an action to accomplish the intention, and execute some physical motion that implements the action. Once the system has responded, the user must perceive the response, interpret the response with respect to the current system, and evaluate the response in relation to the overall goal.

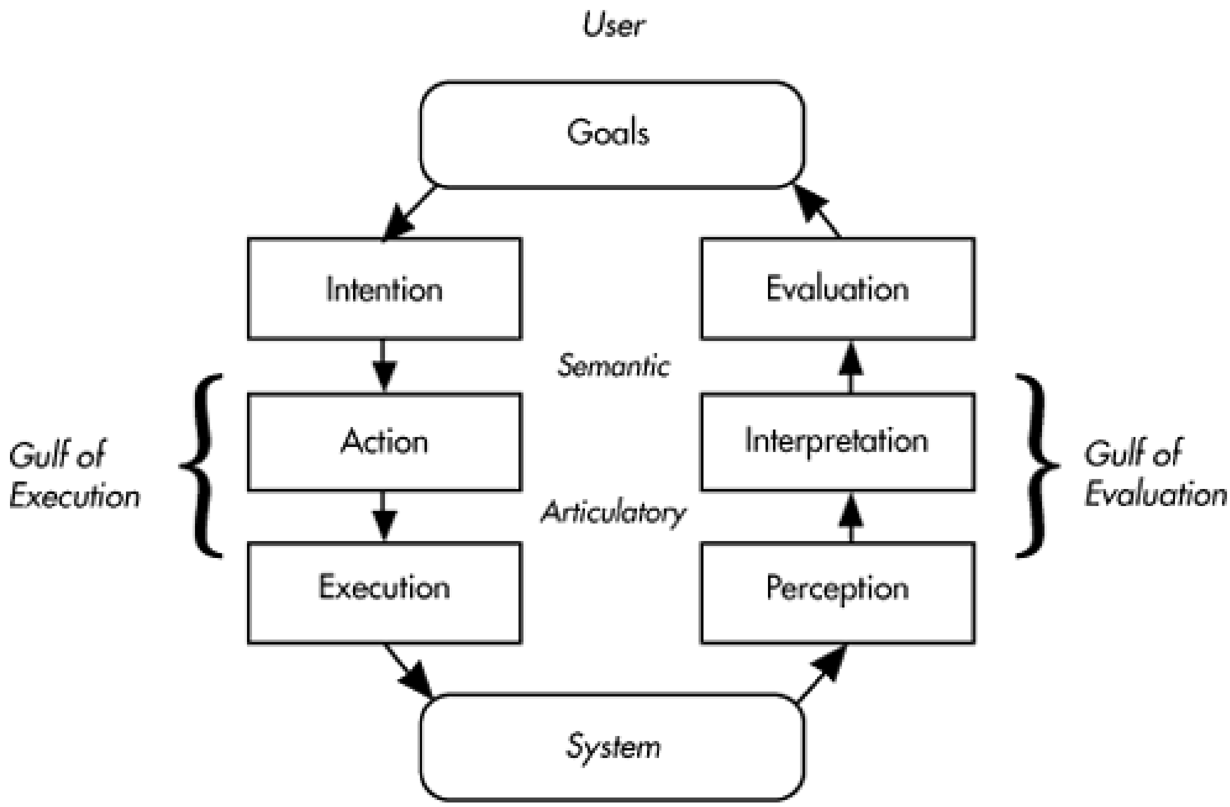

Figure 1:

Norman’s Seven Stages of Action Model

Source: Adapted from D. Norman (1990), The Design of Everyday Things (New York: Basic Books).

More concretely, imagine that a user has an overall goal to clean up a current file directory. At one point this may translate to an intention to remove an old file. The user must then decide how files are removed in the current system to generate an action. Let us say that in this system the user must use the delete command. Then the user must figure out how to execute a delete command, specifying the command and the file. Does the user type “delete” or “del,” hit a delete key or key combination, or pick the delete command from a menu? Does the user point to the file, name it, or use a wildcard abbreviation? Which of these maps most closely to the user’s preferred level of thinking about goals? (Note that the correct answer, generally, is all of the above. Redundant interaction options allow the user to be flexible and choose which options are currently most convenient.)

Once the user has executed a command, the system can respond. That response may be that the file disappears from a visible list, or the system prompts the user that the file has been deleted, or, simply, a new prompt is available. The user must then decide whether the response indicates successful completion of the task. At each of these points, errors can occur. This potential for error is a guiding motivation for user-centered design.

Using the terminology from the diagram, we wish to minimize the distance between the system and the user, bridging the gulfs of execution and evaluation. One way is to train the user to be familiar with how a particular system operates. This puts the burden on the user. The other way is to design the system to work at a level close to the user's goals. This is the ultimate purpose of user-centered design and the way to make technology transparent to the user.

The focus has broadened to recognize that these elemental interactions are not independent of the multitude of contexts that surround them. The nature of the organization and cultures that surround the practice fundamentally affect the characteristics of the interaction. Recent work has focused on understanding these contexts and how interactions are situated in the broader world.

Elements of Design

HCI extends beyond understanding interactions to specifying a design process that can achieve a system that matches user goals. Ideally, one pass through a process would result in a final design. However, the real world does not submit to such finality. One of the results of understanding people is the realization that people are not completely deterministic: They make mistakes, they get caught in old patterns, they can't remember all the necessary information, they can't foresee all possibilities, implementations often don't work the first time, and so on. To truly apply what we know about people, we must not only design for common foibles but also use a design process that accounts for those same foibles on behalf of designers.

Original design methods (e.g., software engineering) called for a straightforward progression through the design process. The components of the general design process include:

- *analysis:* define the task
- *specification:* design the solution
- *implementation:* develop the solution
- *evaluation:* test the solution

However, this method has been recognized to produce software that requires revision and improvement due to the foibles of users (and designers) identified above. The standard approach fails to work because people are not capable of specifying what it is they want the first time through. Working from a definition of the task to be performed and applying the relevant principles are not enough to ensure good design.

Furthermore, design principles can and do conflict. Two such principles are (1) design for consistency, and (2) match the way the user thinks about the task. Both seem obvious and useful, but they can come into conflict in even seemingly simple devices. There will be no one right answer for everybody; the constraints will always result in making tradeoffs. And since users can be inconsistent, arguments for consistency can conflict with arguments for considering the user.

Process Guidelines

The approach that has been advocated to remedy this problem is user-centered design. Three major strategies that characterize the user-centered approach are that the design process should be *iterative, formative,* and *situated.* "Iterative" means that the design process should cycle through stages of the design process, with evaluation followed by reanalysis, redesign, and so on. Iteration is tied to outcomes that when achieved indicate success. "Formative" means that the results of evaluation feed back into the design process. "Situated" means that evaluation needs to be performed in realistic settings, based in the real activities of the task, and not designed for hypothetical and abstract situations. Representative user participation is required to test these prototypes. Data must be collected on these intermediate tests to illuminate further design. Each stage of the design process needs to be modified to reflect the user-centered approach.

Analysis

As in ISD and design in general, the first part of designing a system is determining the need. The initial phase of data collection includes surveying the potential users to determine the range and then picking representative users to participate in design. Design can be viewed as a process of *multiple constraint-satisfaction.* Imagine that there is a space of potential designs. Each constraint on the design helps to narrow down the solution space of possible designs. It may come to be the case that the design space is effectively constrained out of existence. In this case, some constraints may need to be relaxed. Typically, however, the greater the number of constraints, the easier the design process is. Thus, effective information-gathering is critical.

Although such a systematic approach does not guarantee a brilliant design, it is more likely to produce a good design. The exhaustive nature of the analysis stage suggests, in addition to an initial conceptual analysis, considering how the task would be accomplished without support, how it is currently being accomplished, and what solutions others have proposed. To assist with the specifics of the information-gathering exercise, checklists should be consulted. One of the limitations of designers is their ability to recall all the relevant criteria. The use of external memory support provides a greater likelihood that all issues have been examined.

Design

The processes of design are fairly well understood. Approaches such as divergent thinking (using techniques like brainstorming) followed by convergence are as common in interface design as in other design tasks. Although there is still a role for art in the design of an interface, increasingly systematicity is depended on to yield a high probability of a successful outcome. Again, the limitations of designers are to focus too early on evaluating designs, and support for extending the divergent phase tends to yield benefits.

A valuable empirical lesson has come from HCI approaches to design. The approach of design rationale—the deliberate recording of assumptions, arguments, and ultimate decisions for the stages of the design process—has proved valuable in extended design processes. This record prevents revisiting arguments due to a lack of recollection, supports new team members in understanding the project, and supports ongoing development in future updates and maintenance.

Understanding the relationship between the conceptual model and the representation is important. The emphasis is to make a distinction between the *information architecture*—the underlying structure of the system—and the interface—the representation of that structure to the user. Design processes recognizing this place the design of the architecture before the design of the interface.

Implementation

An important element is prototyping to answer questions that user analysis cannot answer. Design rules of thumb (or heuristics) are increasingly viewed as insufficient due to their ad hoc nature and potential conflicts. The focus has passed to quick implementation and testing of alternatives to help resolve design questions. The emphasis is on low investment in technology for prototypes, using thought experiments, storyboards, and paper prototypes early and often along the path to successful design. Designers tend to find it hard to abandon work invested in prototypes, so minimizing the investment supports greater willingness to experiment with alternate conceptions.

Evaluation

One of the major areas is determining how to evaluate the results of the design process in ways that are effective and efficient. Full evaluation would require large amounts of user testing. Pragmatically, that is often prohibitively expensive. Heuristic approaches have been investigated to combine expert review with limited user testing to good effect. Most approaches are eclectic and must be customized to the particular characteristics of the design problem.

Methods used include inserting code in the prototype or running a separate application to trace user activities with the system. This can be combined with videotaping user activities, audiotaping voice protocols (or records of user thoughts), or observation by experimenters. Subjective measures include questionnaires and interviews with users. Expert reviews have a place in the methods for usability analysis as well.

The measures used should align with predetermined goals for evaluating system suitability. Typical measures include time per task or tasks per time, time taken to acquire proficiency, number and type of errors per task or time unit, and subjective satisfaction with the software. The issues of when and where to emphasize qualitative versus quantitative data increasingly appear to have situational and contextual answers. A combination approach is often recommended.

Cost-Justifying Usability

One common problem in improving usability is justifying the cost and time to perform these iterations. There are numerous opportunities for benefits, however. Savings can be attributed to decreased time to learn, lower support costs, fewer errors, more productivity, and greater satisfaction, which can and should be tied to design criteria. Obstacles come from trying to integrate usability practices into existing development processes. Recent work has attempted to identify ways in which to address organizational and process barriers to improving usability.

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See also

Analysis; Electronic Performance Support System; Instructional Design; Performance Support; Rapid-Prototyping; Usability

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Hypertext

The term “hypertext” refers to blocks of texts creatively joined together by a series of links, or paths. The concept is extremely important to the field of educational technology, as it forms the basis of interaction on the World Wide Web. When users click on webpage links—a word or set of words connected to other pages and known as hyperlinks—they are transported to a new block of text (generally a new webpage on the same or even a different website). These hyperlinks usually take the form of underlined words in web browsers. Hypertext is a central tenant of hypertext markup language (HTML), one of the primary programming languages for the World Wide Web. Hypertext is often used interchangeably with the term “hypermedia,” which actually refers to a system that is more than just text-based (textual). Thus, in hypermedia, text and images can be linked to other blocks of text, images, videos, sound sources, and even other programs. Some researchers and scholars differentiate hypertext from hypermedia in order to focus on the concept of hypertext as a literary term and concept. With great fluidity in the definition of the concept of hypertext, some have argued that there is no practical agreement on a real or true hypertext. Researchers and scholars agree only that it is a mode of interacting with text, in both electronic and nonelectronic formats. It is a definition, like the concept, that continually evolves.

Although consensus has not been reached on a pure definition, it is important to note that hypertext refers to more than simply a functional, *electronic* linking of texts. Theodor H. Nelson first coined the term in the 1960s in the development of his computer-based Xanadu™ system, but cognitive psychologists and communication theorists argue that we thought and spoke in hypertext long before it materialized into computer technologies. Carolyn Guyer, representing this perspective, states that human beings are associative in their thinking processes, and so text and other forms of language have always actually been hypertext. This history of hypertext existing a priori to technology is one hypothesized reason the hypertextual format of technologies such as HyperCard, HyperStudio, and the World Wide Web have been so quickly adopted. Proponents argue that these tools do not present a new schema or way of thinking; rather, they fit into what we as humans already do without computer technologies.

Vannevar Bush (1945), in a famous article entitled “As We May Think,” was one of the first to consider an *electronic* hypertext. He asked readers to consider the future use of a device known as a memex, a mechanized device used to store large amounts of personal information such as books and records. Being mechanized afforded the memex user opportunities to quickly and flexibly search and access stored data. This “memory supplement” was designed to store and retrieve information based on the weblike structure of the mind. Bush’s system even came complete with links. This associative indexing (or coding) would allow any item to immediately and automatically be related to other items.

Roland Barthes was another major theorist who discussed this new textuality in detail. He described text blocks (lexia) composed of words or images that were electronically linked by multiple paths or trails. This open-ended system, one that was perpetually unfinished, created textuality with limitless and interactive networks of text galaxies. More important, it had no beginning and no end. Its limits were constrained only by the infiniteness of language.

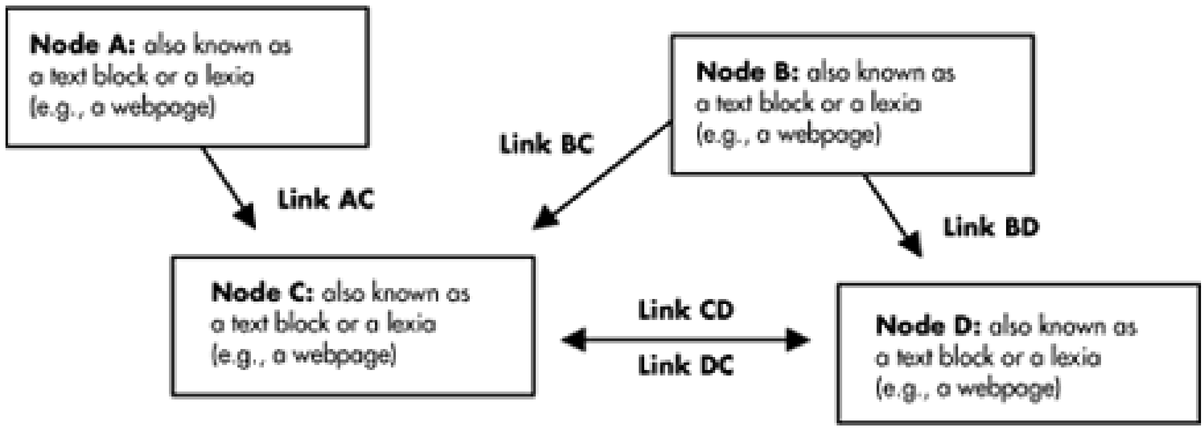

Figure 1:

The Use of Nodes and Links in the Concept of Hypertext

Source: Created by the author.

Drawing on both Barthes and Bush, Theodor Nelson (Bush's student) coined the term "hypertext" while designing an electronic form of nonsequential writing. In Nelson's mode of publication, readers were able to choose different pathways through text blocks. A text block, also known as a node or a lexia, was joined electronically to other text blocks, creating multiple branches of text and thus numerous choices for the reader (see Figure 1).

Notice in Figure 1 the links between nodes. This illustration also demonstrates the difference between hypertext and hypermedia. Hypermedia refers to nodes and links that are more than textual. Thus, in hypertext a text block contains text links to other text nodes; in hypermedia text blocks could contain text and graphic links to other text nodes as well as to sound, video, graphics, and even other programs.

The birth of the term in the 1960s spawned more than twenty years of research and development on large-scale hypertext systems. These systems were designed to realize the potential in the writings of Bush, Barthes, Nelson, and others. Innovations included nonelectronic writings (such as *Choose Your Own Adventure* books and Nabokov's *Pale Fire*) and electronic inventions (such as Doug Englebart's Augment/NLS hypertext system and Nelson's Xanadu, as well as more globally in technologies such as bulletin boards and news groups).

Perhaps the concept of hypertext gained its greatest fame, though, in the late 1980s and early 1990s when it became more concrete, available, and personal to the novice user. In 1987 Apple began packaging HyperCard with every computer purchase. HyperCard is a hypertext authoring system that resembles Rolodex cards or library card catalogs. With HyperCard, users can create various sets of cards that contain text and graphics. However, authors can also put buttons on cards that trigger events like playing sounds or linking to different cards. The simplicity and ease of use made the concept of hypertext more concrete to computer users and nonusers alike.

Another important event in the history of personal use of hypertext was the creation of the World Wide Web in 1991. Tim Berners-Lee is credited with the creation of the World Wide Web while he was working at the Conseil Européenne pour la Recherche Nucleaire (CERN), in Geneva, Switzerland. Drawing on the concept of hypertext and Nelson's Xanadu system, Berners-Lee's proposal for the World Wide Web included technologies for writing, distributing, and reading webpages. The proposal called for webpages to be written using hypertext markup language. Essentially a system of text attributes and tags, HTML allows authors to format text and create hyperlinks to other webpages. HTML is similar to standard generalized markup language (SGML), developed in 1986 by the International Organization for Standards. Whereas SGML provides the rules for tagging elements, HTML provides the definitions and interpretations of those tags. HTML is important to the concept of hypertext because it provides standards for the creation of nodes and the links between them.

The other two components in the original CERN proposal were Hypertext Transfer Protocol (http) and the web browser. Http is the protocol that defines how messages are formatted and transmitted. The web browser is the application that allows webpages to be displayed. Mosaic was the first web browser (the first that had a graphical user interface); current web browsers include Netscape Communicator and Internet Explorer. Recent surveys estimate that more than 513 million users worldwide experience the concept of hypertext via use of the World Wide Web.

The concept of hypertext, regardless if the hypertext is electronic, nonelectronic, systemic, or personal, is important to the field of educational technology for various reasons. First, it is the underlying concept behind numerous educational software titles (i.e., HyperCard and HyperStudio) and, on a larger scale, the World Wide Web. However, it is also important because it gives learners opportunities to guide their own learning. This type of learning—one based on theories that espouse the individual as the creator of knowledge and meaning-making—can be tested empirically as students navigate their own paths to information. Although hypertext research in education is a relatively new area of study, some early research has demonstrated evidence of the possible importance of hypertext-based educational tools.

First, the use of hypertext improves knowledge transfer. It highlights critical relationships between various components. Second, hypertext allows individuals to move freely within programs or within text. That feature, in turn, provides opportunities for interaction and subsequently higher scores and performances on posttest measures. Third, hypertext-based systems allow for adaptive learning. Users create personal strategies for accessing information, which increases the chances of retrieval and application. Finally, hypertext lets users navigate and choose their own paths through information and text. As highlighted above, this puts the individual as the creator of knowledge and affords opportunities for serendipitous learning. Future research in this area will include gathering and analyzing empirical evidence comparing hypertexts with more structured texts.

Richard E. Ferdig

See also

Web-Based Instruction

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Information Literacy

Information literacy is the ability to locate, evaluate, and use information in an effective and appropriate manner. Information literacy has gained significance as a means for addressing the problem of information overload, prompting educators to stress its importance as a skill necessary to support lifelong learning. An information-literate person is able to evaluate information from a variety of sources. Although the term has a far-reaching impact on many disciplines, it is most closely aligned with library science. One of the leading organizations advocating the importance of information literacy is the Association of College and Research Libraries (ACRL), a subdivision of the American Library Association. The ACRL describes an information-literate individual as one who is able to:

- Determine the extent of information needed;
- Access the needed information effectively and efficiently;
- Evaluate information and its sources critically;
- Incorporate selected information into one's knowledge base;
- Use information effectively to accomplish a specific purpose; and
- Understand the economic, legal, and social issues surrounding the use of information, as well as access and use information ethically and legally (Association of College and Research Libraries 2000, 3).

Students should be able to describe and understand how scholars and researchers use information and keep currently informed, how practicing professionals use information and keep currently informed, how the use of information can improve the quality of scholars' and professionals' work, the commodity nature of information (who generates, controls, and uses information, in particular the role that the government plays), and the costs of misinformation (Olsen 1989).

Four Main Features of Information Literacy

In order to use information effectively, the user must first recognize the need for information. The information-literate person should be able to define and articulate his need for information, identify a variety of types and formats of potential sources of information, and reevaluate the nature and extent of the information needed (Association of College and Research Libraries 2000).

Second, an information-literate person must locate appropriate information sources. Locating information includes knowing how to select and search databases, constructing and implementing an effective search strategy, knowing what resources are available, retrieving information online or in person using a variety of methods, and refining the search strategy as necessary (Association of College and Research Libraries 2000).

Third, one must evaluate retrieved materials. Evaluating information requires determining the authorship of a publication, determining the publication date, reviewing references, and determining whether it is from a peer-reviewed source, an important criteria for determining quality. Additional criteria include being able to distinguish popular from scholarly treatment of a subject, distinguishing between primary and secondary sources, defining various standard formats for storage of information (CD-ROM, print, online, etc.), and identifying appropriate information resources and references within the discipline (encyclopedias, directories, indexes, etc.) (Olsen 1989).

Finally, the ability to organize and manipulate the information retrieved must be demonstrated (Olsen and Coons 1989). Relevant to this is choosing a communication medium, applications, and tools. The information-literate person, individually or as a member of a group, should be able to use information effectively to accomplish a specific purpose (Association of College and Research Libraries 2000). This may include using a bibliographic file management package to organize downloaded citations and personal files of references, conducting a needs assessment, using electronic spreadsheets to reformat and analyze numeric data, using a word-processing package to format papers and construct bibliographies, and writing correct bibliographic citations. In short, one must apply new and prior information to the planning and creation of a specific end product, as well as communicate the end result effectively to others in various formats (e.g., face-to-face, presentation software, transmission over the Internet, videotape).

The Challenge of Information Overload

The introduction of the personal computer as a gateway to the World Wide Web of information resources has heightened the importance of information literacy. This increased access to information requires a greater degree of skill to effectively find and use information, as far more information is available today than there has ever been in the past. The problem is being able to wade through all of this information to find the specific pieces needed. To become information, raw data must be processed into a usable form. In turn, once information is applied toward further understanding, it may be considered knowledge. This differentiation between data, information, and knowledge is key to understanding information literacy as a developmental process. But sheer abundance of information is not enough (Association of College and Research Libraries 2000). The ability to find relevant data is what makes information valuable as knowledge.

Increasingly, information comes to individuals in unfiltered formats, raising questions about its authenticity, validity, and reliability. In addition, information is available through multiple media, including graphical, aural, and textual formats, which poses new challenges for individuals in evaluating and understanding it. For example, using search engines to find websites, as well as evaluating those sites, often has a direct impact on the quality of information located. The evaluation of websites requires specific considerations. It is important to look at the currency of the information (when was the webpage last revised or updated?); the content (is it organized, accurate, and pertinent, and is the same information available in another format?); the authorship (who is the author and where does the site originate from?); and ease of navigation (is it clear and readable, with a clean layout and easily identifiable links, and do the images and other multimedia support the information?). Consequently, the ability to work with search engines is an important aspect of information literacy. This is not as simple as plugging in a keyword search but involves understanding how the search engine works, as some search engines are better for certain topics. Search engines vary in their collection methods, quality control, and how they index and rank results.

Information Literacy in Education

The ACRL supports student-centered learning environments where inquiry is the norm, problem-solving becomes the focus, and thinking critically is the dominant process (Association of College and Research Libraries 2000). Information literacy competencies are crucial to supporting this learning environment. These abilities are also the basis for lifelong learning and enable people to become self-directed learners and to take control over their own learning. Increasingly, librarians and faculty are developing collaborative relationships, as a team effort is needed to create new courses and curricula within the framework of information literacy (Stoffle 1998).

Another important example of how information literacy serves the education process is in the evaluation of research studies, a task that reaches across all disciplines. When evaluating retrieved information such as research articles, one must consider many of the following:

- **Purpose**
- What are the goals of this study?
- What is the problem or issues at hand?
- What assumptions, if any, are important to note?
- What are its limitations?
- What practices will it influence?
- Why do the authors want to conduct it?
- Why should we care about the results?
- Why is the study worth doing?

- **Conceptual Context**
- What is going on?
- What theories, conceptual frameworks, literature, and experience will guide the study?
- What studies have been done in the past?
- Have the important terms been defined?

- **Research Questions**
- What is trying to be understood?
- What is not known about the phenomena being studied?
- What questions will the research attempt to answer?

- **Methods**
- What will actually be done?
- Has the methodology been described in detail and is it complete?
- How will observations be made?
- What approaches and techniques will be used?
- Why was the research site selected?
- How will interviews be convened?

- **Validity**
- How might the study be wrong?
- What are the plausible explanations?
- What is the researcher’s relationship to the study group?
- Why should the results be believed?

- **Findings**
- What was actually discovered or determined?
- Where should future research focus?
- Is the report clearly written?
- Is the report logically organized?
- Does the tone of the report display an unbiased, impartial scientific attitude?
- Are the conclusions significant?
- Are the conclusions relevant to the problem?
- Are the conclusions described clearly?

Although technology skills must be learned in order to use and apply higher information-literacy skills, “information literacy” is a broader term than “computer literacy.” This has stirred confusion over what is covered under information literacy. Information literacy deals with deeper concepts: understanding the role and power of information in society—its use and misuse; being able to handle the varieties of information formats; understanding the systems used in organizing information; and being able to generate information and manipulate it using electronic processes. Apart from these differences, some argue that computer literacy should be a prerequisite to information literacy (Horton 1983). Others argue that separate computer and information literacy programs only confuse students and teachers (Johnson and Eisenberg 1996). Increasingly, many educators believe that computer skills should not be taught in isolation and that separate computer classes do not really help students learn to apply computer skills in meaningful ways. They prefer a blending of concepts and instruction since they do go hand-in-hand. This shift to a more integrated approach supports a broader notion of information literacy, ensuring a far greater impact on the education process, as opposed to separate and unrelated experiences in the library.

Odin Jurkowski

See also

Curriculum Integration; Cyberculture and Related Studies; Netiquette; Virtual Library

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Instructional Communications

The systematic approach to communications theory dates back to the late 1940s when Claude Shannon and Warren Weaver, scientists working on ways to improve electronic communications at Bell Technical Laboratories, introduced the communications cycle. This cycle consists of a sender/encoder, a signal, and a receiver/decoder. Noise is an intervening (and disruptive) element, and feedback is the returning message from the receiver to the sender. (See Figure 1.)

Today many are revisiting this traditional concept in the context of instructional communications. It is a very useful tool because so many instructional communications are now electronic and involve the concepts of time (synchronous and asynchronous) and distance. There are two ways to define “instructional communications”: as a systematic series of outgoing and incoming signals designed to expand a learner’s field of experience (Heinich et al. 1996), and as a field of study that informs educators of all disciplines about the communication skills necessary to function competently in the classroom (Simonds 2001). These approaches are different but not mutually exclusive, and understanding one helps inform the other.

Instructional communications is also a specific academic discipline that seeks to investigate and apply the principles of human communication when the goal is to share and refine knowledge and skills. The need for more rigorous study in the field of instructional communications is being driven, in large part, by the growing impact of technology on our traditional instructional practices. Today’s trend toward technology-supported instruction, and the accompanying increased costs, are driving the need to evaluate both efficiency and effectiveness to justify those increased costs. It is forcing us to take a critical look at our teaching practices. Several authors (see, e.g., Willis 1992; Palloff and Pratt 1999; Heinich et al. 1996) agree that one of the best attributes of distance education is that it forces faculty members to organize their content. This is not a cynical comment but rather a statement of fact.

Instructional Communications: A Series of Actions

Instructional communications can be viewed as messages between a sender and a receiver where the intent is to transmit information and knowledge in order to improve comprehension and/or performance. These actions are usually considered in sets, or cycles. Instructional communications

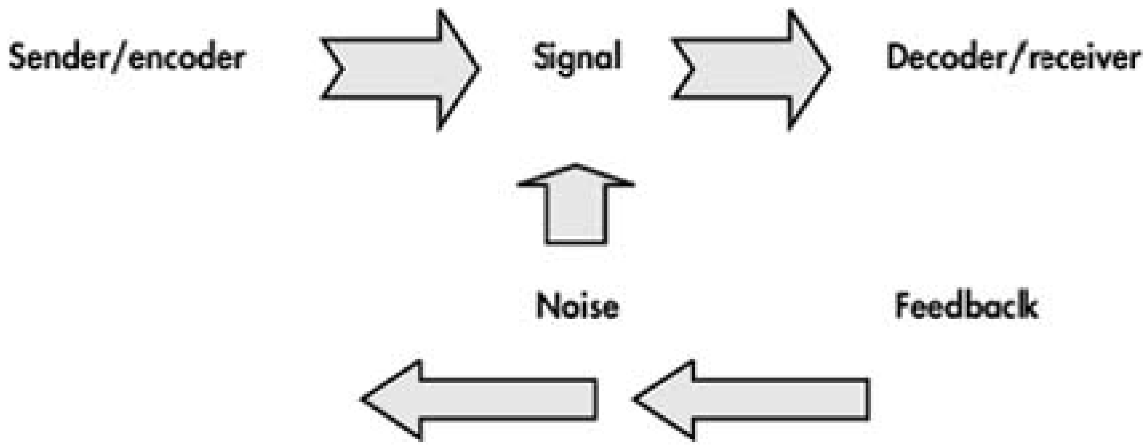

Figure 1:

The Basic Communications Model

Source: Created by the author.

cycles differ from standard communications cycles because the elements of guidance and assessment are introduced. For example, if a user were to go to the Internet to locate a map of Mexico and found and printed the map, she would have completed a communications cycle. If the user went to the Internet and found a virtual tour of Mexico, it would certainly be more engaging than just a map, and there is a good chance she would gain new knowledge. This transaction, however, would still not have met the criteria for an instructional communication. If the user went to the Internet and found a tutorial on the geography of Mexico, learned new facts, tested knowledge, and revisited the facts missed, she would have completed an instructional communications cycle. Not only would she have acquired new knowledge; she also would be secure in that knowledge because she had received guidance and assessment to confirm its accuracy.

When we apply this real-life example to the Shannon-Weaver model described above, however, we see it is not an ideal fit. The original model was designed to help in electronic and mechanical innovation, so naturally it was mechanistic in its approach. More recent versions (Schramm 1954) were able to humanize it by adding descriptors to the areas around sender and receiver such as “field of experience” to show that the communication must be put into a context. Between 1960 and 1990, this model fell somewhat out of favor because it was simplistic and tended to understate how drastic the disruptive effect of noise could be. But today we see its elegance and utility as we work to improve distance and other electronically enhanced instruction.

To apply the Shannon-Weaver model to instructional communications, we must accept the idea that the model can be duplicated and modified an infinite number of times. (See Figure 2.)

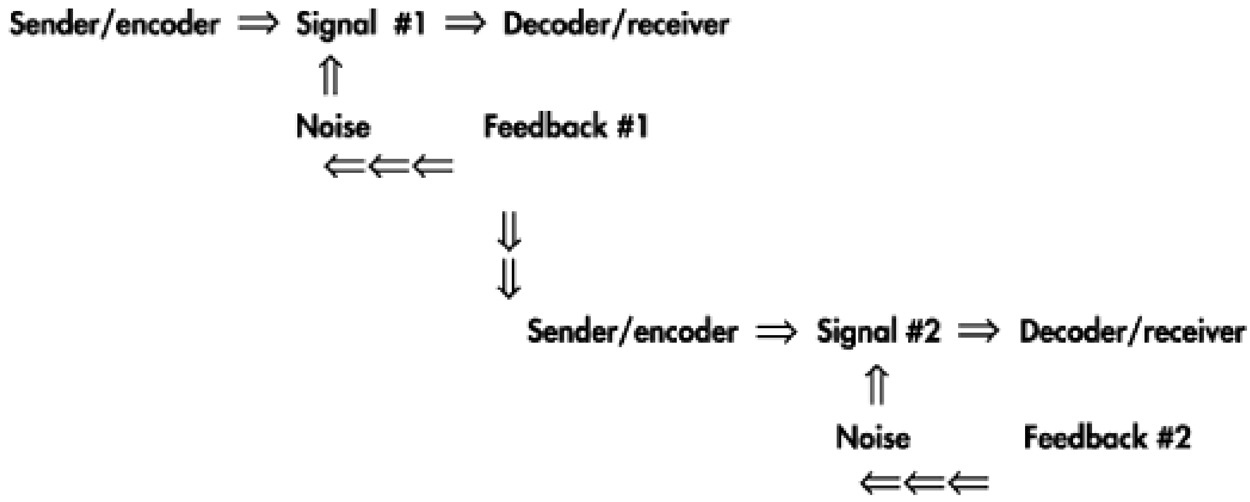

Figure 2:

The Looped Communications Model

Source: Created by the author.

Consider this analogy: If the Shannon-Weaver model represents a loop in a thread, instructional communications represents a series of connected yet varied loops. An entire lesson would become a woven fabric. Every loop or feedback cycle connects to the past, corrects any misconceptions, picks up new information, and discards what no longer needs to be carried. The feedback informs the next cycle. The new information is aimed at producing the final feedback from receivers, confirming that they have met the target level of success (comprehension and/or performance) at the end of the series.

W. Schramm’s communication model builds on the Shannon-Weaver model by adding the humanistic concept of “field of experience.” (Cognitivists often refer to this as the “schema” of the sender and receiver.) Experience, or the schema, colors the effect of the signal on both sides of the communication. An instructor sends a signal, and receivers process it by building on what they already know. If what receivers know is correct and they have formed the correct relationship between old and new information, the feedback should confirm that receivers are ready to receive a new concept. If receivers have made connections that are incorrect, the next message must be designed to correct these inaccuracies. The success of this application relies on frequent, thoughtful feedback.

It is human nature to assume that the field of experience of our learners is at least fairly similar to our own. Therefore, it is helpful to take purposeful steps to confirm or deny the assumption early in the communications process. If feedback from the opening communications cycles verifies common understanding of key terms and concepts, there is a solid foundation for instruction. If there are differences in the fields of experiences that will alter meaning, the sender and receiver must reach common ground before more meaningful instructional communications can occur.

The more recent constructivist approach to understanding learning presents the idea that receivers not only process information within their field of experience but also have the benefit of all previous signals and feedbacks. They are constructing meaning based not only on decoding the new signals but also on past experiences and the experience of developing and sending the feedback. Constructivists believe that the total is more than the sum of the parts because the receivers have constructed broader and richer meaning. When the model includes more than one receiver, the feedback can be developed and delivered by a group. Each member of the group benefits not only from the incoming signal but also from the additional signals, including the constructed meanings, of other group members. The feedback has become more complex; therefore the next signal will be more complex. This model supports richer exchange but presents more opportunity for error.

Although the theory of instructional communications as a series of actions sounds fairly straightforward, it is often a real challenge to develop efficient and effective instructional communications. The solution to meeting that challenge may lie in the series of assumptions and decisions that the sender (i.e., instructor) makes and in which order those decisions are made. Here is where we can put the concept of instructional communications as a field of study to very good use.

Instructional Communications as a Discipline

According to one researcher, “Much of the current theory and research in education emphasizes the important role that communication plays in a learning process. Unfortunately, that research is rarely informed by mature theories about communication” (Darling 1992, 205).

Part of the difficulty is that in the academic world, “communication” and “education” are typically seen as two distinct disciplines when, in fact, they grow from the same roots. They are more alike than they are different, and they are becoming more alike every day. Visualize, for a moment, a television tuned to CNN where the screen includes several active windows of information. Now picture a computer screen, again with several active areas. Finally, visualize a computer screen for a distance learning course. It is more than just similar technology that is driving these shared designs. Everyone, regardless of discipline or profession, is applying what current research has told us is the most effective design in the use of graphic arts, type design, spacing, color, and motion.

Today’s educators are often called upon to be both instructors and communications designers. And since most educators already have enough on their plates dealing with increased workloads and new instructional methods, knowing when to seek proficient technical support is probably a key. When that technical support comes from those who have applied communications research findings to their work, the chances of success are greatly increased.

Technology has made instructional communications more competitive. Learners are becoming increasingly more critical and selective (Brock 1990). They are now expecting far more than basic media presentations to capture and hold their attention. Learners today are more demanding because they have seen what technology can do. If they can receive a movie preview at their favorite website, why can’t they also see a video clip of their distant instructor making the major points in a lecture or lesson?

Tools of Instructional Communications

As instructional communications relies more and more on technology, education administrators have become more critical and selective in acquiring new technologies. Not only is there the initial cost of purchase; there are also the costs of staff training, installation, and maintenance. In the same way that technology has made us evaluate our teaching methods, we must now also evaluate our selection of media to deliver instructional content.

Not only must the message be well designed; the signal path must also be appropriate for the message. Should this be a synchronous or an asynchronous communications cycle? Does the convenience of asynchronous delivery and feedback outweigh the instructional benefit of immediate (synchronous) feedback? Is text the best vehicle for delivery, or are audio and video also needed? How much scarce and valuable communication time should be spent on feedback and assessment, and how much responsibility should be placed on the learner to meet the comprehension and/or performance goals? The answers to these critical questions underpin instructional design.

When instructional communications is delivered in highly structured electronic formats, such as the learning platforms used in distance and web-enhanced instruction, many design decisions must be made in advance. It is not practical to alter formats or presentation schemes in the middle of a course. Fortunate instructors can build on their own experience and the experience of others. Because distance course materials are often used more than once, decisions about the message and the signal path are made not with feedback from the current receiver but with feedback from those who previously had the experience.

When the course is launched, part of the initial field of experience communication must focus on the management of the learning platform, or signal path. Students must become familiar not only with the instructional content and style but also with the design of the course site. Where are course materials located, and how are they accessed? Are all materials located at the site, or are students expected to research and contribute additional materials? What feedback is expected from learners and in what format? A thorough understanding of instructional communications theory is critical in making good design decisions.

Challenges to the Instructional Communications Cycle

One of the most serious challenges to the instructional communications cycle is “noise.” In the original Shannon-Weaver transmission model of communication, noise was literally that: extraneous electronic sound that interfered with the clear reception of the signal. Today we use the term to cover a wider range of possible interference. In a traditional classroom, noise can be something as innocuous as the looming homecoming game that has distracted learners. In distance education, noise can be actual or virtual. Actual noise can include technical problems with websites and learning platforms, connectivity, transmission speed, and timing-out. Virtual noise is subtler but can be equally disruptive. A lack of 24/7 technical support; issues with locating online library resources; problems with students participating equally in chat rooms and online assignments—all have the same effect of distorting communications.

In traditional classrooms, instructors receive direct, immediate feedback from multiple sources, including body language, eye contact, spoken language, and written work. This provides intentional and unintentional feedback, both of which help the instructor realize the degree of noise in the environment. Instructors can quickly identify potential noise by a process of observation and elimination. In distance education, the issue of noise is more complex because the instructor typically has only intentional feedback to identify a problem. The instructor may not know that a link to a resource is broken unless a student tells her. The instructor may not know a quiz has gone offline prematurely unless she receives a frantic e-mail asking her to repost it. As for attention span, unless the instructor is using interactive television or is in a synchronous chat room, it becomes the learner’s and not the instructor’s problem.

The instructional communications cycle for distance education and web-enhanced instruction is more complex than face-to-face learning, but we would not be where we are today with growing ranks of distance students if it were not for a clear understanding of basic communications models. Good teaching is good teaching. The technologies of instructional communications do not make teaching better or worse. What they do is magnify the instruction. Instruction becomes more accessible, more visible, more tangible, and therefore more open to scrutiny. We’re no longer singing in the shower but have been moved onto a stage. The new environment is more challenging but also more rewarding—and more fun.

Karen Hughes Miller

See also

Communication Theory; Computer-Mediated Communication; Distance Education; Message Design; Schramm, Wilbur

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Instructional Design (ID)

The discipline of instructional design offers a series of complementary design practices that enable the identification of needs and the design of best solutions. These solutions are most often instructional in nature, but they can also be informational or activity-oriented—focusing on improved processes, tools, and conditions for human activity. ID is based on a systematic methodology for assessing needs and developing goals, analyzing the content domain and target population, and designing, developing, and evaluating solutions.

ID Practices

A hallmark of the instructional design discipline is the attention that it places upon the needs of the target population. Through the practice of *needs assessment*, the designer solicits evidence of need from members of the target population and from those having a stake in their success. The format of needs assessments can take many forms, including interviews, onsite observations, focus groups, surveys, and analysis of resources such as documentation or standards; depending on the situation, it can be complex and time-intensive or flexible and implemented throughout the design process. Learning and performance problems are made evident by examining differences between desired and actual performance. The physical and organizational contexts are also carefully examined to determine influential factors and to align possible solutions with the mission of the organization. An analysis of the needs data leads to one of the final products of needs assessment: the goal statement, indicating what members of the target population will be able to do upon completion of the instruction (or other initiative). Another outcome is an indication of whether this goal can be met by instruction (or practice, or feedback on performance, etc.) or by some other intervention (anything from performance support, like checklists or users' guides, to environmental modifications, such as task lighting or allocation of personnel or resources).

Clients often seek to have an instructional design created after deciding that they have an instructional need. They sometimes resist the conduct of a needs assessment, stating that they already know what intervention is needed. Needs assessment, however, has the potential for uncovering very different needs than initially anticipated; lack of performance is not always due to lack of knowledge or skill, and in this case an instructional solution will not result in achievement of the goal. When the client's assumed need *is* correct, needs assessment still enables a much better understanding of the need and the environment in which it is present.

In *instructional analysis* (also known as front-end analysis), an instructional goal is broken down into component parts, or tasks, in order to identify the knowledge, skills, and information that must be learned, as well as the type of learning each task represents (intellectual, psychomotor, or metacognitive skills; verbal information; and/or attitudes). Characteristics of the target population and environment are also considered to identify any characteristics that will affect the learning process. Specific learning objectives are then defined that specify the desired performance and, at times, the conditions and criteria for performance. In order to determine the effectiveness of the instruction, assessment methods are also defined at this point; these directly reference the performance, conditions, and criteria indicated in the objectives. The result is a clearly articulated set of specifications for the instruction that needs to be produced, as well as a methodology for assessing the effectiveness of that instruction for achieving the goal and objectives.

Design is the heart of the discipline. Here, instructional strategies are devised to help the target population achieve each one of the objectives. Frameworks such as the Nine Events of Instruction (Gagné 1974, 1977) are useful tools that guide the designer in:

- Capturing the learners' interest and attention
- Informing learners of the learning objectives
- Encouraging learners to recall relevant prior learning
- Providing distinctive stimuli
- Guiding the learner
- Providing practice opportunities
-

- Providing feedback on performance
- Assessing learner performance
- Encouraging retention of what is learned for transfer to novel situations

The design serves as the blueprint for the *instructional development* practice. Designers first search for existing instructional materials that address the instructional goal and objectives and that employ the desired strategies. If appropriate materials are found, they may be used as is or adapted to better meet the instructional goal and objectives. If new materials are designed, the instructional designer will select the most appropriate medium (if not already dictated by client or learning environment) via models (see, e.g., Reiser and Gagné 1982, 1983). The desired instructional materials are then produced and immediately subjected to evaluation.

The design and development practice of *formative evaluation* helps to determine the effectiveness of the instructional design. Rough materials developed in response to the design are tried out by increasingly larger groups of learners, with revisions to the materials between each evaluation. Although evaluation of materials in this formative stage is critically important, ideally evaluation takes place throughout the practices of instructional design.

An emergent trend in ID practice that encourages early evaluation is *rapid prototyping,* in which designs are evaluated beginning with instructional strategies or with materials in very early, very rough stages. Such prototypical drafts of the design or of its key features are evaluated by members of the target population. The design is subsequently revised and implemented a bit more fully with each version. The benefits of this approach are obvious: The designer arrives at the end of the instructional development phase with a set of materials that are already well on their way to meeting learner needs. Rapid prototyping also brings instructional designers and materials developers together early in the process; this early collaboration can increase the likelihood of appropriate media selection, strategies design, and development.

Summative evaluation, considered to be part of the instructional design process, takes place once the instructional materials have been completed and are in use. Effectiveness data are collected to help others decide whether to adopt the materials, or to determine whether preexisting instruction is meeting learner and stakeholder needs. In this way, it can lead directly to a needs assessment, and the ID cycle is begun anew.

Evolution of Instructional Design

The tools of instructional design practice are built upon the foundations that form the profession’s specialized knowledge, including systematic design, learning theory, communication, and technology. The foundations of these diverse disciplines can be traced as far back as the Elder Sophists, who developed tutorial systems that built upon expository lectures and group discussions (c. 500–380 b.c.), yet the relationship between them and the design of instruction began to evolve around the turn of the twentieth century. At this time, an extraordinary number of scientific discoveries emerged, and technological advances in communications, energy, and transportation changed the way people viewed the world. Systems thinking and the scientific method were embraced as methods for managing this new world, and the science of learning came to the forefront of public awareness.

Calling for a science linking theory to educational practice (Dewey 1916, 1944), educational psychologists integrated and expanded upon the theories of early learning and systems thinkers such as Aristotle, Comenious, Pestalozzi, and Herbart. Edward Thorndike's theory of connectionism, for instance, prescribed carefully refined and sequenced subject matter. It resulted in extensive laboratory research into instructional methods during the 1920s and 1930s that prescribed linear procedures for attaining new skills. This laboratory research also led to the formulation of several theories that would later influence the instructional design process. Franklin Bobbit argued that educational goals should come from an analysis of the skills necessary to succeed in society, and thus the idea of job (task) analysis was born. Ralph Tyler introduced user evaluation in 1933 when he argued that behavioral objectives and assessment could be used to evaluate and revise instruction until the instruction becomes effective in helping learners reach an appropriate level of performance (Pinar et al. 1995).

J. Dewey's most influential methods had their greatest impact on the instructional design process with the advent of constructivist-based design in the 1980s. They were the introduction of the progressive movement, individualized exploratory learning supported by instructors rather than direct instruction, and *reflective judgment,* a five-stage approach to the scientific method that placed emphasis on the learner's experience and on problem-solving as an iterative process (Saettler 1990). Instructional design's earliest ties to technology began during the 1920s with the birth of the audio-visual education movement. Technological innovations provided increasingly efficient means for communicating in the 1920s and 1930s and their usefulness in education was explored; film became popular as a medium for delivering information, and in the 1930s radio-based instruction was implemented. New markets for technology, including public schools, museums, and clubs, increased the need for audiovisual materials. Traveling educational museums, for instance, needed portable exhibits such as stereographs, slides, films, prints, and other curricular aids. Commercial enterprises saw a market for educational media and focused on the development of innovative technologies and their potential for instructional products (Reiser 1987).

Prior to World War II, much of the learning that took place was via the apprenticeship model: Experts were responsible for training adult workers by sharing what they knew and demonstrating their skills. Apprentices would learn these skills under their supervision and develop the skill required for a lifelong career. The onset of World War II, however, resulted in unprecedented demands in the United States for efficient training materials and instructional methods designed for mass distribution. Thousands of military personnel and industrial workers needed to be trained quickly and efficiently to perform and manage thousands of tasks, whether on the front lines or in the factories (Saettler 1990). Teams of instructional developers were created to meet this challenge, consisting of instructional designers, educational psychologists, subject-matter experts, and producers. Instructional design evolved as a systematic process that integrated design and development, implementation, evaluation, and revision (Dick 1993)

Introduced in the 1940s, general systems theory (GST) is considered one of the primary influences in the development of instructional design practice in the 1950s. In the work of one biologist (Bertalanffy 1969), GST was quite similar in principle to earlier systems analysis, yet it formalized the study of systems analysis as a discipline. It was a science exploring environments, their component parts, and the influences of input and output of components from other systems. Using the basic components of a living organism as a metaphor for systems analysis, GST offered a framework for instructional design by systematizing a means for analyzing tasks or problems and their effects on people or events. Grounded in the assumption that learning should be developed methodically and have measurable outcomes (Seels and Glasgow 1990), the systems view described the world as a hierarchy of interdependent components. When analyzed, they defined patterns that, in turn, could help humans understand the complexities of the world. Systems models describe these patterns and enabled users to interpret situations by guiding decisions and actions (Rowland 1999).

One of the earliest learning theories to influence instructional design was Bloom’s taxonomy (Bloom 1956), a classification system defining intellectual behavior as cognitive, affective (attitudinal), and psychomotor (physical) domains. Bloom and his team of educational psychologists explored the stages of intellectual development within the cognitive domain. They identified six levels of cognition that ranged from simple recall, or recognition of facts, to the higher-order abstract, or complex, levels of cognition, evaluation, and comparative contrast. They advocated mastery learning as a way to develop cognition (Bloom 1956) and suggested that instructional media could facilitate this process by offering a variety of instructional methods that met learner needs. This was one of the earliest methods directing designers to match content with instructional media and the learner.

Robert Gagné (1965, 1974, 1985) developed methods for creating behavioral objectives with a learning taxonomy that classified six different types of learning outcomes. Closely resembling Bloom's taxonomy, Gagné's taxonomy began to develop these methods when he designed instruction for the Air Force in the late 1950s.

All of this work informed the development of ID models. Prominent among them is the classic systematic design of instruction, a model advanced by Walter Dick and Lou Carey (1978, 1985, 1990, 1996, and 2001), which remains the predominant model used to teach the ID process. Core elements include goal analysis, learner analysis, objectives, design, development, evaluation, and revision. The most notable addition to this ID model is the needs assessment (Kaufman 1972). By the 1980s, more than sixty ID models had been identified (Andrews and Goodson 1980), accompanied by research and debates over which model offered the best method for designing instruction. Most of these ID models contain the ID practices described above.

Applicability of the ID Approach

The instructional design discipline is sometimes criticized as being slow and inflexible. Although ID can be time-consuming, it can also be performed relatively quickly and its practices flexibly applied. For example, in some situations only a needs assessment may be required, whereas in others design may be coupled with evaluation in an iterative prototyping phase. With increasing experience, designers are able to determine how to adapt ID practices in efficient and creative ways that are nonetheless effective.

Teachers often wonder if ID methods can be useful to them. After all, they already teach and guide their students and manage the classroom learning environment. Do they really need to adopt ID methods? The answer is frequently yes, because "teachers in today's restructuring schools may find themselves increasingly involved in design activities" (Morrison, Ross, and Kemp 2001, 13), particularly at schools attempting to meet national initiatives for educational reform. These initiatives frequently call for student-centered, activity-oriented approaches to solving real problems, methods that call on the teacher to design and implement appropriate instructional materials and methods (Morrison, Ross, and Kemp 2001). The need for a systematic approach to ID is even more important if teachers plan to share their instructional materials and methods with others; the ID process helps to ensure that the resulting materials are effective and can stand on their own without the teacher-designer being present to adapt and revise them en route. And when the content area is new and/or the student population is unfamiliar, ID is particularly valuable in providing structured processes for exploring content domains and learner needs.

The importance of good instructional design methods is important not only for the education of our children but also for the training and retraining of adults. The U.S. Census Bureau estimated that investment in corporate training, which was virtually nonexistent prior to World War II, grew to more than $36 billion in 1993. It is continuing to rise at 3–6 percent each year (Bremmer 1993). Organizations need workers who have the technology and cognitive skills that will enable them to solve problems and customize products and services in a timely fashion. Employees are finding themselves in positions where their tasks and responsibilities are in a constant state of flux. Technologies render some disciplines obsolete while spawning demands for new skills, or even careers, overnight. It is not uncommon that individuals must learn new skills or change career tracks. Learning is therefore becoming a lifelong undertaking, with the need for retraining being a constant. Instructional design will be a valuable tool in this process, facilitating success across learning environments.

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See also

ADDIE Model; Analysis; Association for Educational Communications and Technology; Bloom, Benjamin S.; Evaluation; Gagné, Robert Mills; Instructional Technology; Performance Support; Rapid Prototyping

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Instructional Objectives

Instructional objectives are clear statements that describe what a learner will be able to do or know as a result of instruction. Although there are many theories and models for developing instructional objectives, each with slight variations, objectives typically include references to the behavior, product, or performance that is expected, the criteria outlining successful performance, and the conditions under which the behavior is to be performed.

In theory, objectives are guidelines for curriculum developers, instructors, and learners. An explicit statement of the expected outcomes for instruction helps guide the development, delivery, and assessment of instruction while also helping learners set appropriate expectations and measure their progress. Because objectives are so useful, most models of instructional design or curriculum development include the creation of objectives as a critical component. In fact, the development of objectives is required for many types of projects, and virtually all curricularists and instructional designers consider sound objectives as indispensable to good practice in the design and development of technology-aided instruction.

Benjamin Bloom, along with a team of educational psychologists and university examiners, published what has become the standard model of educational objectives beginning in the mid-1950s. Bloom’s taxonomy, as it has become known around the world, consists of three domains: cognitive, concerned with matters of knowledge and thinking; psychomotor, concerned with physical skills; and affective, concerned with attitudes, values, and feelings. Most instruction, however, is centered on cognitive tasks.

Bloom’s model consists of a hierarchical ranking of skills. At each level, particular types of learning occur, and lower-level skills are prerequisites for higher-level ones. Though most instruction often takes place in the lower levels only (knowledge and comprehension), students seem to retain and transfer knowledge better when they engage in learning at the higher levels (application, analysis, synthesis, and evaluation). Implicit in the construction of the taxonomy is the alignment of instructional materials with test questions, such that each instructional objective has a corresponding test item.

Within a decade after Bloom’s taxonomy for the cognitive domain was published, objectives had become ubiquitous in educational circles; they became especially popular among instructional systems design theorists, whose focus is training outside the context of traditional schooling. Robert Mager’s model, for example, further clarified the construction of objectives and prescribed that they explicitly include the three basic elements: what the learner is to do, what criteria are to be used to measure success, and under what conditions it is to be done. Robert Gagné’s model created a slightly different taxonomy and described a five-component objective, which included more explicit items: a description of the environmental characteristics under which the learner will operate; a “learned-capability verb” that relates the objective directly to Gagné’s taxonomy; a description of the content or product of the task; an action verb that describes the task; and a list of any tools, constraints, or special conditions that may be required for the performance of the task.

In the instructional design process, the development of objectives is typically intertwined with the process of task analysis. By deconstructing

Table 1: The Looped Communications Model

Taxonomy Level	**Appropriate Action Verbs**
Knowledge	list, state, name, define, recall, recognize, identify
Comprehension	distinguish, compare, contrast, describe, discuss
Application	write, apply, create, use, choose, operate, construct, select
Analysis	diagram, assess, infer, explain, analyze, categorize
Synthesis	develop, design, synthesize, create, compose, generate, plan
Evaluation	decide, test, measure, rank, justify, judge

Source: Created by the author.

the component steps that make up a particular task, instructional designers can be more certain of the individual skills that a learner must know; those skills usually translate into objectives. Because objectives written in this way are so specific, they almost always correspond directly to testing and assessment items.

When designing objectives, it often helps to start by defining the action that the learner should be able to perform. Action verbs are key, as they can describe the learner's behavior concretely and specifically. A selection of common action verbs for the cognitive domain, and the cognitive category of Bloom's taxonomy that they represent, are listed in Table 1.

Almost inseparable from the action is the behavior or product that the learner will develop. When describing the outcome, be as specific as possible about the behavior or product. For instance, the following statement of behavior, though clear, is not as specific as it could be: "On an exam, the student will be able to *name the parts of speech.*" Therefore, better choice for an instructional objective would be the following: "On an exam, the student will be able to *name the eight major parts of speech in the English language.*" When defining the outcome, it is important to focus on what the learner will do to demonstrate mastery of the task rather than focusing on the instruction or the subject matter.

Once the product is determined, consider how to assess learners' performance of the task. Again, be as specific as possible and think only in terms of what criteria actually is to be considered when determining successful performance. Usually, performance criteria are measures of things like time, accuracy, and quality. For instance, the following statement has a relatively vague criterion for successful performance: "The student will be able to write a research report *as discussed in class.*" A more measurable objective might have the following statement, which describes in more detail what level of quality is expected in the finished product: “The student will be able to write a research report *of at least six pages, which contains the five basic parts of a research report, as listed on page 5 of the course pack.*”

Finally, performance objectives should list any conditions under which the behavior or task should be performed. This statement should include particular tools that the learner can use, or perhaps that the learner will not be able to use, when demonstrating mastery of the skill. Think of these as the definition of the performance environment, as in the following example: “*Without the aid of a calculator*, the student will be able to accurately complete four long division problems in two minutes.” The condition limits the objective to a particular context so that it can be more accurately taught and learned.

As tasks become more cognitively complex, it becomes much more difficult to write objectives that meet the requirements outlined by the models of Gagné, Mager, and others. For instance, tasks at Bloom’s levels of synthesis and evaluation may be difficult to state in terms of observable student behavior. On tasks like these, for which assessment may be relatively subjective or difficult to quantify, be sure to specify as much information as possible about the desired outcome; doing so provides a maximum amount of guidance to developers as well as learners. Vague objectives are meaningless and generally not helpful.

When developing objectives for technology-based learning projects, it is important to remember that objectives should be clear, concise, and focused on what learners should be able to do after they’ve completed the instruction. Avoid the temptation to create loosely defined objectives that don’t clearly specify outcomes, and try not to focus objectives on the subject matter or the technology itself. Regardless of the medium of instruction, well-planned and well-written objectives can help developers create focused and effective learning environments.

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See also

Bloom, Benjamin S.; Bloom’s Taxonomy; Gagné, Robert Mills; Instructional Design

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Instructional Technology

In popular usage, the term "instructional technology" refers to the use of communications media—hardware and software—to help people learn. At different times, different media have been central to educators' conception of instructional technology. The term first came into widespread use in the early 1960s; James D. Finn, a professor at the University of Southern California, was probably the most vigorous proponent. At that time, the focus was on audiovisual media such as radio, television, film, slides, filmstrips, and audio recordings. By the middle of the 1980s the focus had shifted dramatically to computers.

Within the field of practice of instructional technology, the term from its inception connoted a process or way of thinking about instruction. The idea of technology as a process was supported by economists such as John Kenneth Galbraith, who referred to technology not as things but as "the systematic application of scientific or other organized knowledge to practical tasks" (Galbraith 1967). This notion received influential sanction in 1970 when the Commission on Instructional Technology (1970, 21) issued a report defining instructional technology as "a systematic way of designing, carrying out, and evaluating the total process of learning and teaching." This definition also highlighted the growing commitment to a systems approach to solving problems. The systems approach emerged in the 1960s as a "soft" application of the scientific procedures of systems analysis that developed around the use of computers for military operations research during World War II. This orderly, logical process gave rigor to the rather artistic approaches that previously had characterized film and TV production and the integration of media in teaching.

By 1977 the largest professional association in this field, the Association for Educational Communications and Technology (AECT), adopted an official definition that began by referring to a complex, integrated process for analyzing learning problems and for creating, testing, and implementing solutions to those problems. This definition focused on processes and the systems approach. The most recent definition adopted by AECT refers to "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (Seels and Richey 1994). By this time, the emphasis is firmly settled on intellectual processes.

There are several difficulties in defining this term. First, there is the popular conception versus the conception held within the field. Although the process notion took firm root within the field of practice, the popular meaning continued to revolve around things, particularly computers. Second, even within the field, the process notion is embraced more by those with a theoretical bent than those engaged in daily use of the tools of the field. So the officially accepted definition, which dwells on processes, is rather disconnected from most users' concrete experiences.

Third, the engineering sorts of attributes encompassed in the process notion are at odds with the values of teachers, professors, and other educators, who are the principal users of instructional technology. The concept of a systematic approach implies to many educators a paint-by-numbers approach that does not resonate with their own view of how instruction is created. Also, the concept of efficiency, which is at the heart of the meaning of technology, evokes the emotive connotation of putting time and money before humane considerations. However, it is difficult to avoid the issue of efficiency. The main claim of instructional technologists is that they are able to achieve effective learning outcomes with less investment in time and resources than through other means. The centrality of this commitment to economy was expressed well in a nineteenth-century book on railroad construction:

> It would be well if engineering were less generally thought of, and even defined, as the art of constructing. In a certain important sense it is rather the art of not constructing: or, to define it rudely, but not inaptly, it is the art of doing well with one dollar, which any bungler can do with two, after a fashion. (quoted in Petroski 1992, 213)

Finally, attempts at defining instructional technology may fail to distinguish between instructional technology as a theory and as a field of practice. Viewed as a theory, instructional technology can be seen as the proposition that some ways of creating and presenting instruction are more efficacious than others. As a field of practice, instructional technology is what people do when they are applying the theory: analyze problems, plan solutions, create materials, use the materials, evaluate the results, and so on.

It is possible to construct a definition that deals with these difficulties explicitly, uniting theory and practice, encompassing both processes and things, recognizing both the artistic and scientific elements, and asserting efficiency claims in concert with humane ones. Thus instructional technology can be viewed as the art and science of designing, producing, and using—with economy and elegance—solutions to instructional problems; these solutions may combine verbal or audiovisual media and may be experienced with or without human mediation and may take the form of lessons, courses, or whole systems that facilitate learning efficiently, effectively, and humanely.

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See also

Association for Educational Communications and Technology; Computer-Assisted Instruction; Instructional Design; Research on Media and Learning

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Intelligent Tutoring Systems (ITS)

Intelligent tutoring systems are computerized educational systems that incorporate artificial intelligence methods. The original motivation for the development of computerized tutors was the observation that one-to-one human tutoring is much more effective than classroom teaching. Artificial intelligence methods provide reasoning comparable to human experts and are used in ITS development to make decisions in the role of a teacher. Although human tutoring for all students would be ideal, it is not always feasible, and many researchers believe that individualized computer teaching is an improvement over standard lecture methods.

More than forty years of research on intelligent tutors has produced a variety of systems and contributed to the basic understanding of human learning. Systems have been developed to support all educational levels, from grade school through college, as well as industrial education and military training. Subjects range from mathematics, physics, languages, speech, and computer science to customer support, factory equipment maintenance, and medical applications such as surgical training and cardiac care.

Intelligent tutoring methods have been built into computerized forms of standardized tests, homework systems, and complex simulations and embedded in training systems in factories and ships. These systems can operate on personal computers or may be distributed widely over the Internet for group training in large organizations.

An intelligent tutoring system may appear like any other educational system in actual usage. The student interface might be an educational game, a simulation, or a series of questions. Interaction can be graphical, textual, spoken, or involve other sensors. Any task that a computer can monitor can be the basis of an ITS. The intelligence, however, modifies the system response, problem selection, and adaptive customization.

The distinction between intelligent and other systems is ambiguous; to be considered *intelligent* a tutoring system requires computer algorithms that make significant instructional decisions. The knowledge upon which these decisions are based can be obtained from expert teachers, experts in the subject matter, psychologists, or other experts in cognitive science. Some knowledge may be derived from records of past student performance using machine learning techniques or statistical analysis. Applied research methods may be used to obtain specific knowledge required for the development of an educational system.

The capabilities of an ITS can be divided into domain knowledge, pedagogical knowledge, and student modeling. The domain knowledge of a system is its ability to do expert work, such as the ability of a physics tutor to solve physics problems, or the ability of an architectural tutor to design buildings. The pedagogical knowledge of a system is the teaching ability (at least to the degree that it can be considered separately). Manipulating information about a student’s needs and abilities is considered to be student modeling.

Sophisticated pedagogical knowledge improves the effectiveness of the educational approach. Some systems can vary their presentations from discovery modes to an example-driven approach or a Socratic style. Other systems always follow a single style of teaching. A sophisticated pedagogical model allows the system to reason intelligently about its teaching approach. Alternatively, a system with a fixed teaching approach may be said to encode substantial pedagogical knowledge if it expresses the approach of one or more expert human teachers or if the system has been used extensively and refined empirically. In either case, the system operates on the basis of substantial knowledge of how students really learn the material.

The student model in a tutoring system is a description of an individual student, including the student's abilities, preferences, and history. Automatic evaluation of a student's ability is generally based upon some analysis of the topics that can be learned in the domain. An elementary school mathematics tutor might evaluate the student's knowledge of fractions, decimals, and percentages, whereas a high school geometry tutor would consider lines, points, angles, and so forth. Other forms of student modeling can be based upon fitting a student into predefined categories, called stereotypes or profiles, or adapted from psychological testing techniques.

The important aspect of a student model is that it gives an educational system the ability to adapt instruction to suit the needs of individual students. The primary adaptive mechanism of an intelligent tutor is in the selection of problems and lessons. The goal for automatic problem selection is to keep the student learning material that is challenging but not overwhelming. It is obvious that learning cannot be effective when material is too easy or too hard; it is much less obvious how to automatically select material of an appropriate difficulty level.

Adaptive mechanisms that control factors other than problem selection have been developed but are generally less useful. Specialized adaptivity to ameliorate various handicaps are of great benefit but do not particularly involve tutoring mechanisms. The idea that students have different learning styles is often considered as a basis for student modeling, but few learning styles (other than visual versus textual) have been clearly defined. It has not been established that reasoning about learning styles contributes to better student learning in most systems.

The knowledge captured by an intelligent system can be an explicit, flexible, and modifiable part of the educational software, or the knowledge may be implicitly stored in the design or media content of the system. Neither an explicit nor an implicit manner of using knowledge is better; the reasons for any specific approach are complex. However, it is one aspect of a system that must be considered in selecting one for any specific need.

Often, the terms "knowledge systems" and "intelligence systems" are used interchangeably, but it is helpful to distinguish them. "Intelligence" refers to problem-solving based upon the explicit manipulation of representations, whereas "knowledge" is a measure of how much expertise is encoded in the system. Powerful intelligent reasoning makes a system more flexible in its responses.

Knowledge can be encoded by giving the system more reasoning ability (intelligence) or by providing more and better media for the system. A system with a large library of fixed problems created by a capable author might have more knowledge and greater teaching ability than a system with sophisticated problem-solving algorithms providing a high degree of intelligence. From an educational point of view, it is important that tutoring systems respond appropriately; the mechanism generating this response is only a means to an end.

Systems can be classified as intelligence-based, knowledge-based, or media-based, and there may be a historical progression in that order. An intelligence-based system uses flexible algorithms to compute responses directly from first principles, whereas a knowledge-based system responds using stored solutions to problems.

As developers gain experience with intelligent software, the best response to many choices becomes clear, and reasoning from first principles can be replaced by knowledge recorded in a database. As a system evolves so that more actions are controlled by knowledge, rather than reasoning, the term “knowledge-based” becomes more appropriate than the term “intelligence-based.” As the technology to meet educational needs becomes more specialized, the need for flexibility is reduced, handcrafted media (e.g., text, graphics, and animation) can replace explicitly encoded knowledge as well as reasoning from first principles. A system that is fully scripted to follow essentially predetermined paths should be called “media-based.”

Education and learning are influenced by many complex factors, some of which cannot be controlled or even known. It is easy to overlook the fact that a student’s private thoughts are of overwhelming significance and completely unknown to a computer system (as well as to human teachers). At best, tutors (human or computerized) can make educated guesses about a student’s private thoughts (motivations, attention, goals, prior knowledge, and personal theories); as a result, there is a fundamental limit in the degree to which tutoring can be customized for individual needs.

Moreover, systems that automatically change their approach in some fundamental way are very difficult to implement, understand, or deploy. Engineering requirements increase dramatically as a system becomes more complex. The quality of media (pictures, text, sound) is important for effective educational systems and must be developed separately for every approach used by a system. Real-time generation of graphic computer media might someday allow greater flexibility but is not currently feasible for most development projects.

Taken together, the great difficulty involved in creating extremely flexible systems and the unknowable aspect of private student thoughts provide justification for the current mainstream approach to intelligent tutoring, which is to build systems with substantial amounts of carefully crafted media combined with limited intelligent mechanisms.

Research on intelligent tutors has been in progress since the early 1960s and has resulted in contributions of significance far beyond the actual software developed. Early efforts to develop intelligent tutors greatly contributed to knowledge about education, learning, psychology, and computer science. The discovery that children make systematic rather than random mistakes in subtraction was based upon analysis performed during the development of an intelligent tutoring system. Researchers also claim that a primary impetus behind the invention of personal computing systems was the concept that computers could be used for teaching children. Tutoring applications were the original inspiration behind the development of some of the graphic technology now commonly used for computer animation in popular movies.

The long-term prospect for intelligent tutoring systems is a matter of speculation, but a global integration of educational knowledge into flexible teaching systems could develop quickly and have extraordinary consequences.

Chris Eliot

See also

Computer-Assisted Instruction; Knowledge Management; Learning Styles; Performance Support

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Interactive Television

Interactive television is the transmission of televised content ranging from a unidirectional telebroadcasting format with audio feedback to fully interactive videoconferencing via satellite, telephone line, or computer network. It has been a popular medium of distance education, particularly when supplemented by other technologies such as telephone, e-mail, or conventional mail used to transmit feedback. A good instructional design will exploit the advantages of interactive television while at the same time trying to work around the disadvantages. There are at least five advantages to interactive television (Claassen 1994):

1. *Instantaneousness:* a geographically dispersed population can be reached

immediately, irrespective of location;

2.

*Simultaneousness:*information provided to all remote areas at the same time, regardless of their distance from the source;

3. *Unfiltered information transfer:* All receivers get the same message;
4. *Accessibility:* the ability, particularly thanks to satellite technology, to reach anywhere within its footprint, irrespective of distances or geographic obstacles; and
5. *Affordability:* economies of scale (the larger the target population, the smaller the unit cost).

Although the power of conventional television is widely recognized, one of the frequently cited shortcomings of the medium is its lack of interactivity. Furthermore, although schools may have programs broadcast to them, it can be difficult to fit the broadcast schedule into the school's timetable. Nevertheless, television's strong visual emphasis makes it a much-considered medium to support (and sometimes even carry) education. A proposed solution to many of these problems is sought in interactive television. Thus interactive television's value as an educational technology relies on the level of interactivity and the modes of interactivity that are determined by the instructional design of the communication features. The level of the interaction is defined by the interdependence of participants. The mode of interactivity that takes place is the number of participants, the time frame, and the level of technological sophistication.

Level of interactivity may be determined by the degree to which parties are dependent on one another. There is a useful taxonomy of communicative interdependence, of which interactivity is the highest level (Berlo 1960). From lowest to highest, these four levels are:

1. *Definitional-physical interdependence:* without a sender there is no receiver, and vice versa;
2. *Action-reaction interdependence:* the existence of feedback confirms the sender's success and prescribes anticipated responses to future messages; if the audience supplies laughter as feedback, for instance, future messages will be tailored to evoke more laughter in the same way;
3. *Interdependence of expectations:* requires the receiver to infer meaning based on what the communicating party is doing;
4. *Interaction:* "When two people interact, they put themselves into each other's shoes, try to perceive the world as the other perceives, try to predict how the other will respond" (Berlo 1960, 120).

Most typically, television broadcasts support interactivity on the level of definitional-physical interdependence. Programming content is broadcast with a particular view in mind. When television is regarded as a conversation between the broadcaster and the audience, higher levels of interactivity may be achieved. Situational comedies, for example, provide canned laughter to simulate action-reaction interdependence. Television game shows may take this a step farther via a question-and-answer format. The presenter asks the question and studio audience or home audience try to answer before the contestant does. In this way, one can simulate interdependence of expectations in one-way broadcast television.

In addition to the level of interaction, the mode of interaction is an important aspect of interactive television. The mode of interaction reflects how many people participate interactively, in what time frame, and by which devices. These aspects are known as participation ratio, synchronicity, and symmetry. The level of interaction is directly affected by each of these variables.

Participation ratio is the number of participants and the way in which they participate. This can vary from one-to-one, one-to-many, and many-to-many. A single pupil at a remote site tutored by an individual mentor is participating in a one-to-one setting. Alternatively, thousands of matriculants watching a broadcast, and then phoning in their questions, are participating in a many-to-one setting. Four or five individuals linked to a team of several experts suggest a many-to-many setting. Typically, as participation ratio rises, interactivity drops. In a one-to-one situation, interaction can be potentially very high, whereas it is very difficult to reach the same level of interaction in a 1:800 or 1:8,000 situation.

Synchronicity is the time frame in which the interaction takes place. Synchronous interactivity is that which takes place simultaneously (i.e., both participants are present at the same time). The most obvious example of synchronous interaction is face-to-face contact. Live television broadcasts are synchronous but not interactive. Synchronous interactive television is usually facilitated via an open telephone link. The students react either verbally or via digitally networked technologies. Asynchronous interactivity is that which occurs when the participants are not present at the same time. This is most often achieved with written feedback. A television viewer sends in a written request and the presenter replies on air, which the viewer sees on videotape at a later time. The clearest benefit of asynchronicity is that it makes scheduling easier. One of the most frequent downfalls of interactive television lies in the fact that it is very difficult to get all participants to be available at the same time. Often participants convert synchronous communications to asynchronous ones by videotaping, but in doing so they lose the interactivity. In the same way that the level of interactivity decreases as the participation ratio rises, it also decreases as the participation becomes asynchronous.

Symmetry is the combination of technologies mediating the interaction. Symmetrical interaction takes place when both parties use the same medium. In videoconferencing, for example, each participant sits in front of a camera and watches a screen that displays one or all of the other parties. Symmetry is related to bandwidth and cost. Although it might be infinitely more preferable to have bidirectional video, this will cost a great deal more. For cost-saving purposes, therefore, most systems are asymmetrical; video is sent in one direction and feedback usually occurs through audio, fax, or e-mail. This can have educational consequences; for example, if the instructor does not see the learners, he is unable to receive valuable feedback cues such as body language and class response.

It can be seen then that interactive television can range from a low level of interactivity (such as definitional-physical interactivity) to a very high level of interactivity (such as interdependence of expectations), but that true interaction (Berlo 1960) is seldom achieved. Moreover, economic and technological constraints, as well as human nature and scheduling problems, lead to a tendency toward high participation ratios, a preference for asynchronous communication, and the use of asymmetrical mediation, all of which lower the level of interactivity.

It has been proposed that interactivity rests on immediacy of response, nonsequential access of information, adaptability, feedback, options, bidirectional communication, and appropriate grain size (Borsook and Higginbotham-Wheat 1991). Each of these is important for the effective educational use of interactive television.

Immediacy of response accounts for the preference of the telephone above written correspondence. In a synchronous time frame with a small participation ratio, such as a telephone conversation between two people, the response is immediate. In a synchronous time frame with a large participation ratio, such as a live broadcast with phone feedback, the response is delayed, at least until question time and until it is the questioner’s turn to be answered. In an asynchronous time frame, an immediacy of response among many participants can be achieved by electronic answering systems or even digital keypads that allow users to punch in numerical responses and have them evaluated immediately.

Nonsequential access of information means that synchronously one can interrupt the speaker and prompt a deviation from the original sequential preparation of the talk. This is what distinguishes live television from videotape. Synchronous nonsequential access of information is extremely difficult to achieve through high-participation interactive television, which means that instructional designers should look for other media instead.

Asynchronous nonsequential high-participation access to information will be achieved only when video on demand is technologically feasible given bandwidth constraints (Gates 1995).

Adaptability both of what is said and how it is said is hard to achieve in an asymmetrically mediated interactive situation, given the lack of visual cues between presenter and viewer. The adaptation of the presenter may therefore be highly dependent on the effectiveness of a remote-site facilitator.

Feedback is the foundation of interactivity. “Feedback allows interactive systems to personalize and adapt instruction” (Borsook and Higginbotham-Wheat 1991, 12). The problem with interactive television, though, is that so little feedback can be obtained, particularly if there is a high participation ratio. As indicated previously, digital keypad technology allows feedback to be sent to a computer that can process the feedback and echo it to the presenter in a graphic format. That is to say, in a well-designed system every remote learner may be equipped with a keypad. The learner’s response to a question is in the form of selecting a multiple-choice answer and then entering it. This information is then relayed to a computer that lets the presenter know how many users selected each distracter. The presenter can then *adapt* the presentation in accordance with the processed feedback

Options describe the ability of the receiver to select among several choices. One limit of high-participation-ratio interactive television is that if a certain option does not exist on the keypad, for example, then the learner has to select that which is next closest. Open questioning is very difficult to achieve.

Bidirectional communication means that the speaker and listener have to exchange their positions from time to time; otherwise there is no interactivity. Again this is difficult in large-scale interactive broadcasts and might have to be simulated by the methodology.

Grain size is the length of a presentation sequence before input is required. The larger the grain size, the lower the interactivity. The remote-site facilitator should be trained to give feedback in terms of grain size.

In spite of certain limitations, it can still be argued that interactive television needs to be explored as an educational alternative, provided the instructional designer exploits the advantages of interactive television and designs around its disadvantages. Thus it is worth noting two primary disadvantages of interactive television.

A lack of visual feedback is one of the filters that may obscure the interactive communication process. Another may be a lack of knowledgeable facilitators at the remote site. If the instructor/presenter is unable to see what is going on at every desk and cannot obtain a feel for the audience, there will be few clues that viewers are not comprehending the televised content. One solution is to ensure that a trained facilitator be available at remote sites who can inform the presenter if, for example, the pace is too fast or too slow.

A second concern should be the availability of instructional resources (i.e., prepared lessons that can be presented) and secondary resources (printed material to which the instructor may refer learners). Although the image, voice, and surroundings of the presenter may be broadcast, it is impossible to broadcast a library or an object needed to practice a skill.

Interactivity is likely to only be meaningful if it is based on activity. In deciding what learners should do, one might consider the factors that contribute to eliciting responses from television viewers (Fisch and McCann 1993). These are:

1. *Appeal:* refers to the degree in which the instructional design appeals to the target audience. S. Fisch and S. McCann (1993) describe, for example, how a game-show metaphor was used to appeal to a school-age target audience of a mathematics broadcast. Although the broadcast was noninteractive, interaction was simulated both by the presence of a studio audience and by the fact that participation was elicited from viewers.
2. *Clearly defined problems:* Clear problem definition depends on a number of factors. One should conceptualize the problem, then formulate a broad problem followed by subproblems. Fisch and McCann describe a mystery metaphor to engage the audience in problem-solving activities. Noninteractive television has many examples of such mystery games. An example mystery metaphor would be a treasure hunt in which the audience has to guess where a certain object is hidden while a television presenter searches for it. The audience can see what the searcher sees but can provide only audio input. The problem is clearly defined, though: Solve the clue and find the hidden object. The learners should have to achieve mastery of certain content before they can do so.
3. *Think time:* difficult to achieve during broadcast time, as a pause in the program will negatively influence tempo. A better way of allowing think time is by giving homework problems to which the solutions are broadcast in later sessions.
4. *Room for educated guesses:* Educated guessing means that the audience is allowed to “generate a solution even when they are not completely sure of their answer” (Fisch and McCann 1993, 107). This is done by giving clues, much in the same way as a detective story feeds the audience with clues as to whodunit. In interactive television the

presenter could pose a problem and ask the learners to discuss the problem among themselves and try to guess at a solution with the information at their disposal. At a later stage (after some think time) various groups could be asked for their solutions and the correct one could be given.

R. Clarke (2001) argues that it is the method and not the medium that influences the quality of what we learn. This suggests that it is not the technology of interactive television that matters but the way in which instruction is designed to take advantage of its strengths, such as visual impact and many-to-many broadcasting, while also seeking maximum opportunity for high levels of interaction and participation.

Johannes C. Cronjé

See also

Clark, Richard E.; Digital Video; Distance Education; Instructional Design; Schramm, Wilbur; Television and Learning

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International Society for Performance Improvement (ISPI)

Founded in 1962, the International Society for Performance Improvement is the leading association dedicated to improving productivity and performance in the workplace. ISPI represents more than 10,000 members throughout the United States, Canada, and forty other countries. ISPI's mission is to develop and recognize the proficiency of members and advocate the use of human performance technology (HPT). ISPI works toward achieving this mission by sponsoring an annual conference and exposition, conducting other educational events such as institutes and workshops, publishing books and periodicals, and supporting research. Improving organizational capability; increasing the ability to compete; and finding, hiring, and developing talent are issues that top the agendas of every business leader. When organizational leaders face the challenges of improving the performance and productivity of their teams and their people, it is increasingly likely that they will find themselves seeking support and advice from a member of ISPI.

ISPI has a long history beginning in 1962, when its first members formed the Programmed Learning Society during a dinner on January 29, 1962, at the officers' club of Randolph Air Force Base in San Antonio, Texas. The original purpose of the society was to collect, develop, and diffuse information about programmed instruction. In February of that year the first issue of the *Programmed Learning Society Newsletter* was published. In March the society adopted a new name—the National Society for Programmed Instruction (NSPI)—and adopted its first constitution.

Word of this new organization traveled quickly, and just a year later NSPI received inquiries about forming chapters in France and Germany. In March 1963 the organization held its first convention, and more than 650 people attended; that year, the NSPI publications began to bloom with the merging of the Institute of International Research and Development's magazine with NSPI's newsletter. The new publication, *NSPI Journal,* was one of the first to devote itself entirely to the area of performance improvement.

Throughout the late 1960s and early 1970s, NSPI continued to develop as an organization dedicated to research and practice. It was soon clear that with the size and growth of the organization professional management was needed, and in 1971 NSPI hired its first executive director.

A groundbreaking moment arrived in March 1972. Although training and instruction served as the initial focus of NSPI, the organization published a journal with much greater breadth. *Improving Human Performance* became a research quarterly. To match this philosophical shift, the organization changed its name once more in 1973. It was now the National Society for Performance and Instruction.

Over the next ten years, NSPI continued to gain greater recognition and win numerous awards for its programs and publications. In 1983 NSPI added corporate patrons as a new membership category. Its first patron member was DuoTech, Inc., from San Diego, California. Continuing its corporate outreach, four years later ISPI gained its first advocate: IBM.

In 1992 the human performance technology model was developed. That same year, the *Handbook of Human Performance Technology,* edited by Harold Stolovitch and Erica Keeps, was copublished with Jossey-Bass. The *Handbook* served as a unifying doctrine for the profession of performance technology while providing readers with the fundamental knowledge necessary to improve performance in the workplace.

In recognition of its international presence, NSPI again considered a name change and in 1995 became the International Society for Performance Improvement. With members living and working in more than thirty countries, this change more accurately reflected the membership while acknowledging the varied interventions offered by performance technologists.

Since then ISPI has continued to serve as the leading organization in the field of human and organizational performance. Members of ISPI include performance technologists, organizational consultants, academic leaders, training directors, human resources managers, instructional technologists, and human factors practitioners. They work in a variety of settings, including business, government, health services, banking, academia, and the armed forces. ISPI’s vision is that members have the proficiency and insight to customize human performance technology to meet the needs and goals of their organizations and clients, so that the members are recognized as valued assets.

Human performance technology is a systematic approach to the selection, analysis, design, development, implementation, and evaluation of programs to cost-effectively influence human behavior and accomplishment. It is a systematic combination of three fundamental processes: performance analysis, cause analysis, and intervention selection and can be applied to individuals, small groups, and large organizations. HPT encompasses a wide range of interventions that are drawn from many disciplines, including behavioral psychology, instructional systems design, organizational development, and human resources management. It stresses a rigorous analysis of current and desired levels of performance, identification of the causes for existing performance gaps, a wide range of interventions with which to improve performance, guidance of the change management process, and evaluation of the results. ISPI members recognize four principles core to the practice of HPT:

1. *HPT focuses on outcomes:* Focusing on outcomes, or results, allows for questioning, confirming, and reconfirming that people share the same vision and goals; that the job procedures support productivity, efficiency, and quality; and that people have the knowledge, skills, and motivation they require to perform at the level expected within their organizations. The initial question asked by human performance technologists is generally, “Where is there an opportunity or a performance gap, a difference between the present and the desired levels of performance?” The outcomes, or results, of an intervention will be measured to determine whether or not performance has improved. Sometimes it is necessary to challenge the assumed answer to a problem or the preconceived outcomes of an intervention and instead focus on the accomplishment or business need that is the client’s true priority.
2. *HPT takes a systems view:* Because organizations are complex systems, a change in one area is likely to affect operations in another. As

a result, competent human performance practitioners take a systems view in their approach to problem-solving. It is important to distinguish a systems approach from a process model. A process contains inputs and outputs with feedback loops. A system implies an interconnected complex of functionally related components. The effectiveness of each unit depends on how it fits into the whole, and the effectiveness of the whole depends on the way each unit functions. A systems approach considers the larger environment that impacts processes and other work. The environment includes inputs; more important, it includes pressures, expectations, constraints, and consequences.

3. *HPT adds value:* This is an assessment that clients will be asked to make. Clients should be offered a process that will help them fully understand the implications of their choices, set appropriate measures, identify barriers and tradeoffs, and take control. While HPT requires a focus on intermediate goals (such as improving quality, customer retention, and cost reduction), its success is measured in improvements in desired business outcomes (such as revenues, profitability, and market share). Alignment of individual performance to intermediate and business outcomes is critical to the HPT methodology. Measurement of results at both of these levels serves two important purposes: communicating the importance of what is being done, and assessing the amount of performance improvement.
4. *HPT establishes partnerships:* Performance improvement professionals work in partnership with clients and other specialists. A collaborative effort involves relevant stakeholders in the decisionmaking process and working with specialists in their areas of expertise. Working collaboratively means sharing decisions about goals, process steps, and implementation strategies. Partnerships are created from listening closely to clients and colleagues, with trust and respect for each other's knowledge and expertise.

To address HPT issues, ISPI members make use of six systematic disciplines familiar to human performance improvement practitioners:

1. *Systematically assess needs and opportunities:* Analysis occurs in the beginning of the project. Needs or opportunity analysis is about examining the current situation at any level or levels (societal, organizational, process, or workgroup) to identify the external and internal pressures affecting it. This process determines the deficiencies or performance gaps that require remedy. The output of this phase is a statement describing the current state, the projected future state, and the rationale or business case for action or nonaction.
2.

*Systematically analyze the work and workplace to identify causes and factors that limit performance:*Cause analysis is conducted to determine why a gap in performance or expectations exists. Some causes are often very clear, such as a lack of required skills among newly hired employees. This step in the systematic process determines what performance factors should be addressed to improve performance. The output is a statement of why performance is not happening or will not happen without some type of support. Job task analysis includes the identification of the important tasks that employees must perform as well as the knowledge, skills, and abilities to perform them. The output is performance objectives that describe the desired performance, delineate the conditions under which the performance is done, and identify the criteria for successful performance.

3. *Systematically design solutions:* Design is about identifying the key attributes of a solution. The output is a communication that describes the features, attributes, and elements of a solution and the resources required to actualize it.
4. *Systematically develop the solution and its elements:* Development can be done by an individual or by a team. The output is a product, process, system, or technology. Examples include performance support tools and equipment, measurement and feedback systems, a new or reengineered process, the redesign of a workspace, a change in compensation or rewards, election and placement of employees, or a training program.
5. *Systematically implement the solution:* Implementation is the deployment of the solution and management of the change required to sustain it. The outputs are changes in or adoption of the behaviors that are believed to produce the anticipated results or benefits. This standard is about helping clients adopt new behaviors or use new or different tools.
6. *Systematically evaluate the process and the results:* Changes in performance and learning systems are significant events and represent substantial investments of time, energy, and money. Evaluation is necessary to determine the impact a solution has had on the business. Likely measurement targets include the efficiency and effectiveness of what was done, how it was done, and the degree to which the solution produced the desired results so that the cost incurred and the benefits gained can be compared.

There is considerable debate over when to conduct an evaluation. As noted above, it is essential to determining if the desired results have been achieved. Many practitioners believe that evaluation is necessary after each phase of the process. There would be general consensus that some type of review is necessary. In the early phases of a project, formative evaluation would be used to assess the performance analysis, cause analysis, intervention selection and design, and intervention and change phases. Then evaluation focuses on the immediate response of employees and their ability and willingness to perform the desired behaviors. The final evaluations are centered on improvement of business outcomes (such as quality, productivity, sales, customer retention, profitability, and market share), as well as determining return on investment for the intervention.

All ISPI members operate under a set of professional standards intended to promote ethical practice in the profession. The society has recently developed and implemented a professional certification process not unlike those for accountants and financial planners. Certification applicants sign a statement agreeing to conduct themselves in a manner that upholds six core values on which the code is based. These values include:

1. *Add value:* The field of HPT would soon die if its members were incapable of adding value. ISPI expects its members to conduct themselves, and manage their projects and their results, in ways that add value for their clients, their customers, and the global environment.
2. *Use validated practices:* There is craft, and there is science. Craft is nonreplicable. There is no doubt that many sciences began as crafts—the medical field, for example. Although there are many beliefs about how to make people healthy, the majority of the population relies on remedies that have been rigorously tested and approved. In the field of human performance improvement, practitioners are also expected to use and promote only those practices, strategies, and standards that have been validated. First, do no harm.
3. *Collaborate:* ISPI members work in partnership with clients and users, functioning as trustworthy strategic partners.
4. *Continuously improve:* ISPI members are often viewed as organizational physicians. They diagnose, prescribe, and then reassess to ensure the systems are improving. As in the field of health care, the profession is constantly changing, and new advancements in the field allow organizations and their people to improve better, faster, and at less cost. ISPI members must remain abreast of these advancements if they are to serve their communities of interest.
5. *Uphold confidentiality:* Because of the nature of their work, performance consultants frequently have access to confidential material related to the performance of individuals and organizations. It is always necessary to maintain client confidentiality, not allowing for any conflict of interest that would benefit themselves or others.
6.

*Integrity.*ISPI members are expected to be honest and truthful in their representations to clients, colleagues, and others with whom they may come in contact while practicing performance technology.

Certification

Consumers, customers, and clients are entitled to information that better enables them to discriminate effective from ineffective performance improvement products, services, and practices. Practitioners are entitled to a set of standards that better enables them to judge their own work and manage their professional development. ISPI believes that certification:

- Encourages practitioners to pursue further professional education and development;
- Improves practitioners' career opportunities through professional contacts; and
- Results in greater recognition by colleagues and employers because certified practitioners have demonstrated their expertise in performance improvement.

ISPI supports the professional development of its members by offering a wide range of reading material on subjects related to the field of HPT. Available resources include:

- *ISPI bookstore:* ISPI offers a wide range of professional books, manuals, handbooks, and other publications through its bookstore. The bookstore operates onsite during conferences, institutes, and workshops and virtually via the ISPI website.
- *Performance Improvement Journal:* A monthly publication sent to all international members; publishes articles related to concepts, research, and the practical application of HPT methods.
- *PerformanceXpress:* The monthly newsletter of ISPI, published entirely online. *PerformanceXpress* has gained a huge following. Articles tend to be 300–500 words so readers have bare-bones facts about recent developments in the profession and on a wide range of solution ideas.
- *Performance Improvement Quarterly:* A peer-reviewed journal created to stimulate professional discussion in the field and to advance the discipline of HPT through publishing scholarly works. A table of contents for all issues published since 1998 is available via the web.
- *ISPI Buyer's Guide:* This guide is distributed to members in order to help them find products and services relevant to performance

improvement, training, instructional design, and organizational development.

- *Membership directory:* The directory provides current contact information for all international members. Local chapters also produce a directory for local members. The international directory is available via the web. Through it, members can locate others, renew their memberships, and keep ISPI up to date on address and profession changes. The online directory is updated twice a month.
- *Advertising opportunities:* Because ISPI represents a core part of the organizational improvement community, many companies that offer related products and services seek to advertise in ISPI publications. A comprehensive listing of ISPI advertising opportunities is available via the ISPI website or by calling the headquarters office.

One of the main factors that differentiates ISPI from other similar professional organizations is its commitment to research. ISPI has within its ranks a solid contingent of professionals with a long history of research in the many fields related to the development of human and organizational improvement. While many of these individuals have primary homes within academia, there are numerous others from the business community.

Each year, ISPI sponsors research projects that can add to the body of knowledge associated with HPT. Supporting these grants is a dedicated special fund. Each year, a specially designated committee reviews applications for grants. The board of directors reviews their recommendations, and grants of varying size are distributed. Grant recipients are asked to provide reports upon conclusion of their work, to publish a related article in one of the many ISPI publications, and to present their findings at the annual conference.

As part of its mission, ISPI seeks to recognize outstanding achievement. The ISPI Awards of Excellence program is designed to showcase the people, products, innovations, and organizations that represent excellence in the field of instructional and human performance technology. Nominations are accepted annually, typically in October, and awards are presented at the conference the following year. In addition to its achievement awards, ISPI presents three special honorary awards that recognize outstanding individuals and organizations for their significant contributions to human performance technology and to the society itself.

ISPI conducts many events each year for the purposes of educating members about developments in the profession, providing opportunities for collaboration and camaraderie, supporting the need for professional development, and recognizing achievements in the field of HPT.

- *Conference and exposition:* This is ISPI's flagship event. Held in the spring of each year, the conference draws nearly 2,000 members from around the globe, providing the opportunity for them to share their expertise and learn from others. Over four days, attendees have opportunities to select from more than 200 concurrent sessions, keynote speakers, and masters from related fields.
- *Institutes:* These three-day events are conducted as public seminars and, upon request, can be customized for in-house delivery for businesses and other organizations. There are two main themes to the institutes, and the ISPI staff can help organizations select the one that is best for their needs.
- *Principles and practices:* This program offers the fundamentals of HPT from experts in the field. These first-of-their kind events provide participants a forum in which to work with a faculty of human performance improvement experts and colleagues to learn more about the theory, process, and practice of HPT.
- *Making the transition to performance improvement:* This event is designed to provide the knowledge, skills, and resources necessary for training, human resources, and performance professionals to make a successful transition to a human performance improvement organization. It is built around case studies.

On occasion, institutes are also held virtually. This innovation helps those who may wish to attend but cannot travel. The virtual institutes are fully interactive, require multiple collaborative exercises, and have led to the development of many postclass professional relationships.

ISPI Leadership

The day-to-day leadership of ISPI resides with an executive director who manages a small staff out of offices in suburban Washington, D.C., and San Francisco. The staff manages a strategic plan developed in conjunction with an elected board. The board is led by a president who serves for a one-year term, preceded by a year as president-elect. In addition, there are five board members, each of whom serves for a two-year term. The board meets quarterly at sites across the United States.

Supporting various projects, programs, and initiatives are numerous task forces and committees. Leaders of these teams are determined by the board and serve one-year terms that are renewable at the discretion of the board. The committee/task force structure is a key method by which ISPI develops its leadership talent pool.

Member Opportunities and Benefits

Professionals in the field of HPT gain numerous benefits from their ISPI memberships, and there are many ways to become a member. Individuals may join as regular international members, as students, or as retirees. These members receive the membership directory, *PI Journal*, and discounts to conferences and other offerings. In some cases, people choose to join a local chapter. Although this does not bring with it the international benefits, it is often a good way to increase one’s ability to meet others in their local environs who share the same professional interests.

Organizations have multiple ways they can support, and be supported by, ISPI. Membership options include patron, sustaining, and advocate. Each level brings various benefits, from multiple individual memberships for employees to special recognition at conferences and institutes. For organizations with numerous employees interested in ISPI, an organizational membership is often the most cost-effective.

Jim Hill

See also

Electronic Performance Support System; Evaluation; Just-in-Time Training; Knowledge Management; Performance Support

International Society for Technology in Education (ISTE)

Since its inception, the International Society for Technology in Education has been dedicated to helping educators use technology effectively. ISTE is a nonprofit professional membership society with a worldwide membership of leaders and potential leaders from K-12 and teacher education institutions. The organization’s mission is to provide leadership and service to improve teaching and learning by advancing the effective use of educational technologies. It meets its mission through knowledge generation, professional development, and advocacy.

ISTE grew out of a study committee of the Oregon Mathematics Education Council, which was formed in 1971. The organization started as a statewide technology group, known in the 1970s as the Oregon Council for Computer Education (OCCE). Dave Moursund, who later served as executive officer of ISTE for nine years, was a member of that first committee. This group was interested in teacher training and disseminating information about using computers in education. These tasks were accomplished with an annual meeting and a monthly newsletter.

In May 1974 Moursund published the first issue of *The Oregon Computing Teacher*, a periodical targeted at computer-using educators, especially at the K-12 levels and in teacher education. It became *The Computing Teacher* in 1979, when materials and advertisers from *Calculators*

Computer Magazine were transferred to OCCE. At this point, there were 320 members from thirty-two states and six countries. OCCE created the International Council for Computer Education (ICCE), with the OCCE executive committee providing ten of the eleven persons on the board of directors of ICCE. The title of *The Computing Teacher* was changed to *Leading and Learning with Technology*, effective with the May 1995 issue.

ISTE publications designed to support computer-using educators began to emerge in the early 1980s. These ranged from *Evaluator's Guide for Microcomputer-Based Instructional Packages* to a policy statement on network and multiple-machine software. The *Evaluator's Guide* was developed to help educators evaluate educational software. The policy statement outlined the responsibilities of educators and hardware and software vendors for ensuring copyright compliance. In 1987 the ICCE committee on ethics and equity issued the Code of Ethical Conduct for Computer-Using Educators. This code covered nine main areas: curriculum issues, issues relating to computer access, privacy/confidentiality issues, teacher-related issues, student issues, the community, school organizational issues, software issues, and hardware issues.

In 1989 ICCE merged with the International Association for Computers in Education to create a new organization, the International Society for Technology in Education. Its function was to carry on the publishing business and to provide an international organization for those people who had been OCCE members primarily for its publications. In addition to publications, ISTE has provided professional development opportunities for educators since 1979 through its support of the National Educational Computing Conference, which that year was called the Conference on Computers in Undergraduate Curricula. The conference has grown from offering thirty-two sessions to offering more than 350 sessions in 2002.

ISTE has offered professional development opportunities for educators and administrators for more than twenty years through the National Educational Computing Conference. The organization has supported other educational technology conferences as well, such as the Florida Educational Technology Conference and the Northwest Council for Computers in Education's annual conference. ISTE has shared best practices and current research through its journals and other publications.

ISTE is probably best known for its work on technology standards. The first technology standards were developed by the accreditation committee and were adopted in 1994. These standards outlined what teachers should know about technology. In the 1990s, ISTE formed a partnership with educators at all levels, as well as government, businesses, and private foundations, to develop technology standards, guidelines, and tools through the National Educational Technology Standards (NETS) project. To date, they have developed technology standards for students, teachers, and administrators.

The NETS standards have been adopted by schools, school districts, colleges, and other educational agencies.

The new ISTE is a result of a merger between the National Educational Computing Association and ISTE. The merger was completed in June 2002. Board members from both organizations felt a merger would strengthen their efforts to support improved teaching, learning, and administration through the appropriate use of technology.

The mission-driven programs that ISTE offers include: National Educational Technology Standards for students, teachers, and administrators; professional development services; the National Educational Computing Conference (NECC); and research and evaluation. ISTE's leadership team provides standards-based training for teachers, technology and curriculum coordinators, media specialists, administrators, and policymakers. NECC provides educators an opportunity to benefit from hands-on workshops, lectures, interactive sessions, and the largest educational technology exhibit in the world. ISTE's research team helps educators and administrators make informed decisions for technology planning and program design using the latest research findings and proven best practices.

For more information, visit www.iste.org or www.neccsite.org

Sally Brewer

See also

Association for the Advancement of Computing in Education; Society for Information Technology and Teacher Education; Teachers: Preparation and Training; Technology in K-12 Schools

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Internet Safety

Internet safety entails the guidelines and procedures implemented in public and private settings to protect the well-being of Internet users. Specific Internet safety measures include laws prohibiting illicit activity online and protecting children’s privacy; acceptable use policies that stipulate rules for children to access the Internet in schools; family guidelines and parental supervision; instruction in Internet literacy; and implementation of browser access controls and software to filter, block, and monitor children’s access to certain sites. As an educational tool, the Internet offers access to extensive resources and information; however, the speed and openness of this media necessitates awareness and intervention to promote safety and well-being.

Although many presume that a child who is linked to the Internet is safe under the protective refuge of his school or home, the potential risks online are comparable to the dangers noted in any expansive environment. The risks include exposure to hate, violence, misinformation, consumer exploitation, and sexual predators. Nonetheless, the Internet provides an extraordinary opportunity for enriching teaching and learning. Internet safety encompasses those initiatives that mediate the online experiences that are disadvantageous to a child’s physical, cognitive, and socio-emotional functioning.

Online Risks

The recognition of threats to children in cyberspace is an important first step in developing constructive solutions and a plan of action that fosters protective and productive learning experiences. Without Internet safety, children’s vulnerability to the dark side of computer technology is exacerbated by the relative degree of online anonymity coupled with the lack of system-imposed restraints. Although the details of the risks are discomforting, it is important to keep in perspective that awareness and Internet safety measures can facilitate children’s safe surfing of those aspects of the Internet that are educational and secure from danger. Moreover, Internet safety promotes the socially relevant use of digital media, including mobile phones, online games, instant messaging, and other emerging online technology.

Crimes against Children

The Internet has provided a new medium for the victimization of children. Children are often naive and trusting of others and simultaneously are in need of attention and affection. This combination of traits contributes to children becoming an easy target to be enticed into illicit interactions with predators.

Sexual exploitation in cyberspace encompasses a continuum of perils to children, including solicitations by predators who lure young victims into face-to-face meetings to molest the child, and engagement with perverse individuals who send lewd messages, engage them into online sex, or supply them with pornography. Reliable figures about the prevalence of the physical molestation of minors by predators in cyberspace are unavailable. However, the Internet creates a context where children are accessible to predators who can easily locate victims and where they can validate their interests by receiving support and advice for aberrant interactions with children through online newsgroups.

These offenders may be pedophiles who prey on children in cyberspace; however, adolescents are also at risk for engaging in situational offenses as they search online for pornography and sexual opportunities. The vast and loose-knit network masks identities and provides a new context where curious and rebellious minors can be seduced and manipulated into indirect victimization through the transfer of sexually explicit information and direct exploitation.

The online predator is skilled at collecting information from children, searching profiles for vulnerable targets, and acquiring personal information on a specific child. Information available online can be used to engage in an online friendship, which is the initiation of the grooming process. Trust is established between the predator and the child through the sharing of information, the use of false identities, sending of gifts and pictures, and eventual desensitization to pornographic content. Subsequently, a meeting between the predator and the child may be arranged.

Infringements on Privacy

The interactivity of the World Wide Web can compromise children's safety when they reveal information about themselves to others. As a child surfs among websites, he leaves a trail that can be used by website operators to make improvements in content or to target children with advertisements. The collection of information from children has been a common practice in cyberspace. Chat rooms, bulletin boards, games, contests, and other online forums have facilitated the disclosure of personal information to strangers. Passive and active information collection has resulted in detailed accounts and profiles of young people online. This widespread accumulation of personally identifiable information about children undermines their privacy. Children are at risk of having their safety compromised when this information is accessible to others interested in online and offline contact. In the interest of protecting children's privacy online while also safeguarding First Amendment and privacy values, federal legislation was passed and implemented through the Children's Online Privacy Protection Act (COPPA). Further protective action has been facilitated through awareness efforts to promote development of practical skills in data protection, personal privacy, and consumer protection of youth online.

Access to Inappropriate Information and Illicit Activity

Without much effort, a child may inadvertently or deliberately be exposed to online content that is obscene, pornographic, violent, racist, or otherwise offensive. The lack of oversight of the content in cyberspace means that misinformation is rampant, and access to contraband, including drugs, alcohol, guns, and gambling activities, goes unchecked. Among young people, computer misconduct can be more tempting in an environment that at least appears to be anonymous and devoid of standard rules of conduct. Without appropriate and clear identification of content and actions that are unsuitable for minors, the well-being of young people online is at risk. This reality necessitates explicit rules regarding access to content on the Internet, critical analysis skills, and implementation of reasonable consequences for violations. In educational contexts, some teachers also undertake the added precaution of prescreening all online material, including e-mail communication, as a preventative measure.

Harassment, Stalking, and Fraud

Youths may be both victims and perpetrators of harassment online. Some Internet users seek power and control by verbally attacking other vulnerable individuals online. Electronic harassment, threats, and humiliation can ensue. Online stalking can be a frightening result when online correspondents continue their harassing behaviors.

Young people who engage in online exploration may be curious about the allure of criminal acts and antisocial behavior. The intrigue and thrill of misconduct in a context that appears anonymous and devoid of consequences can result in the escalation of violations to computer crimes, including privacy infringements, computer hacking, and system intrusions.

Networks of young people may organize themselves online for purposes of collaboratively engaging in the activities of an online gang that harasses others and/or participates in illicit activity. These interactions are part of an online milieu that is conducive to deception. There are many examples of defrauders who attract victims through this inexpensive and quick means. In addition to the activity of the online gangs, children must be wary of deceptive online advertising practices, hoaxes, chain letters, pyramid schemes, and fictitious virus announcements. The challenge for users is to adequately judge the veracity of information online and to take precautions to protect themselves.

E-Commerce

Since young people are a large consumer base, e-commerce has specifically targeted adolescents and children. These age groups are especially susceptible to manipulative marketing techniques with offers of prizes, games, and products. Children’s privacy is compromised through marketing and advertising practices that solicit detailed personal information and track online computer use. The development of personal profiles for young people enables marketers to design individualized messages and ads.

Internet Addiction

The merits of the Internet for young people engaged in research and educational exploration are vast; however, these benefits can be overshadowed when individuals become preoccupied with online use. Adolescents may be enticed by the allure of cyberspace and may replace homework, social activities, and other important interests with online relationships and interactive games. Subsequently, excessive Internet use may contribute to a student’s failure to attend to school assignments. Poor school performance may be exacerbated by sleep deprivation when sleeping hours are eroded by time spent on the Internet. Excessive users of the Internet may avoid emotional attachments with family and friends in the community and rely on online friendships as a substitute for social interaction. Other activities and interests may decline as a child becomes further obsessed with computer activities.

Legislation

Applicable legislation has not been able to keep pace with technological developments, and the constitutionality of many legal solutions has been challenged. Nonetheless, many states have crafted statutes that address child pornography and computers. Federal and state law also has evolved to ban computers as a means of soliciting children for sexual activity, and the proposal of additional legislation may lead to future statutes designed to safeguard youth.

Recently, infringements of children’s privacy online resulted in the passage of COPPA, which focuses on commercial websites and the protection of children age twelve and under. The legislation requires active parental consent prior to the collection of personal information from children under age thirteen. Websites are allowed to respond to children’s requests for information via e-mail without parental involvement as long as the information is used for no other purposes than the child’s specific request. COPPA signals a trend toward federal efforts to ensure privacy in the interactive medium of the Internet.

Access Control Software

The arduous task of safeguarding children in cyberspace has resulted in the development of filtering and blocking tools. These tools include access control features available through the Internet service provider, websites geared toward children’s safe surfing and online interaction, and software that blocks, filters, and/or monitors objectionable content. In classroom settings, tools can integrate chunks of websites into a page accessible to students without going online.

Whereas child-friendly sites provide a contained environment that features fun and educational activities, software may guide children’s online exploration with control access. These applications screen sites when a user attempts to gain access and uses researched lists to evaluate the location with a predetermined database of approved and blocked sites. Pre-established lists of blocked areas may be overridden to allow greater access or to restrict online exploration. Some software also provides features that prevent children from divulging personal information, such as their name, age, address, phone number, or school name, to online acquaintances through websites and chat rooms. Users can establish a log of all sites accessed, programs used, and words and phrases typed or received. Similarly, many Internet providers and online services offer site blocking, restrictions on incoming e-mail, and children's accounts that access specific services.

The most apparent weakness of these devices is the ability of a child to disable the tool or circumvent its control. Additional limitations occur when some illicit sites are overlooked and remain accessible or when valid sites are blocked for spurious or unknown reasons. A combination of guidelines for children's use of the Internet and adult supervision are necessary supplements to protective software. Restrictions to appropriate content are only one component of a vigilant process for protecting children.

Acceptable Use Policies

School policies frequently include guidelines designed to create boundaries and barriers that promote safety when accessing Internet resources. Structuring a safe environment involves a declaration of rules, policies, and procedures that clearly communicate that the school will not support behavior that places children at risk. The acceptable use policy typically outlines expectations for behavior and consequences for infringement of the privilege to use computer resources. The signature of a child and parent denotes an understanding and acceptance of the school policies for Internet access and use.

Building Children's Defenses

Since children can be easy targets for exploitation and victimization, awareness and supervision are necessary components of any Internet safety initiative. Children may access content in cyberspace that is obscene, pornographic, violent, hateful, racist, offensive, and illegal. Consequently, the active involvement of caring adults is necessary to prepare them for safe navigation. Direct observation of children online in a public space with periodic interaction and ongoing discussions of their web experiences are the foundations of Internet safety procedures. Without this discussion, young people may be unprepared to deal with the risks that they face. They may miss the warning signs or attempt ineffective solutions that can exacerbate the problem. Embarrassment and fear may prevent them from seeking assistance when problems do occur. Conversely, continual dialogue and preparation weave a net of safety.

In conjunction with early preparatory experiences that engage a child in assessing risky situations, developing appropriate coping techniques, and practicing responses to problematic situations, children can be adequately prepared for potential risks on the Internet. Avoidance techniques, deescalation skills, and protection strategies are additional safety mechanisms children need on the Internet.

Netiquette (online manners) defines acceptable conduct when engaged in an interchange with people in cyberspace. They represent guidelines for relating in a courteous and respectful manner and emphasize an awareness that computers are merely the mechanism for communicating with other individuals. The application of rules that assist young people in making informed decisions and allow them to demonstrate an ability to apply online critical thinking skills facilitates productive social participation. Moreover, it can counter the potential disengagement of young people from positive social interactions, especially when the guidelines limit time spent on the computer. Limits for children can also be set in the form of a contract and should be accompanied by open discussions about disturbing activity and online content.

Netiquette is integrally connected with global understanding, multicultural respect, diversity, and tolerance. With the advent of the World Wide Web, there is broad access to the world, but users lack cultural sensitivity that can foster collaboration in a global community. Young people are especially prone to misperceive the perspectives and opinions of others and to refrain from respectful interactions. Dialogue is important for countering misconceptions and bolstering children’s perceptions of themselves and others.

When rules for appropriate conduct are combined with skills in information literacy, young people are more capable of critically evaluating information found on the Internet. The ability to discern between commercial information, advertising, propaganda, opinion, and fact prepares young people for wondrous discoveries and counters potentially frightening realities in cyberspace. It is common for the technology skills of youth to surpass their critical thinking and judgment skills. While laws and attitudes struggle to keep pace with activity online, educators, mental health professionals, and parents have the opportunity to systematically attend to issues of accountability, responsibility, tolerance, and respect.

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See also

Acceptable Use Policies; Netiquette

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Jasper Woodbury

The Adventures of Jasper Woodbury is a video series of instructional materials with accompanying printed teacher manuals designed to facilitate higher-level thinking skills via motivating and authentic problem-solving and reasoning, interdisciplinary mathematics instruction, and collaboration. The Jasper series is distinctive from other video-based instructional efforts because students are presented with complex, believable scenarios and a challenge that must be solved by integrating mathematic concepts and skills with the story details. The series was developed by an interdisciplinary staff at the Learning Technology Center in Peabody College at Vanderbilt University, whose goals include improving instructional tools for teachers through the use of technology. The series integrates learning theory such as anchored instruction, generative learning, and constructivism with classroom practice (Cognition and Technology Group at Vanderbilt 1992).

Overview of the Series

Each Jasper adventure consists of a fourteen- to eighteen-minute main story that ends with one of the characters posing the problem that has to be solved. The problem is posed as a challenge, and students must generate relevant subproblems to reach a solution. Each problem is complex, but all the information necessary to solve it is found within the main story. Each adventure also includes a possible conclusion that students can compare to their own solution after the activity is complete. Likewise, each adventure includes extension ideas, interdisciplinary suggestions, correlation with national standards, and teaching tips for instructors. The series consists of twelve adventures arranged into sets of three around four themes related to mathematics content areas. The four themes are: (1) complex trip planning centered around distance/rate/time; (2) business planning centered around statistics; (3) architectural design and way-finding centered around geometry; and (4) Smart Tool–building. Table 1 summarizes the adventures organized around each theme.

Table 1: Jasper Adventures

	Complex Trip Planning Distance/Rate/Time
Journey to Cedar Creek	Responding to an ad for an old boat, Jasper travels to the Cumberland River to Cedar Creek Marina. After test-driving the boat he learns the running lights are not working and that the boat has a temporary fuel tank. He decides to buy the boat, and the students are challenged to determine whether Jasper can make it home before dark without running out of fuel.
Rescue at Boone's Meadow	The story begins with Jasper's friend, Larry, teaching Emily to fly an ultralight airplane followed by a discussion among the three about Jasper's upcoming camping trip to Boone's Meadow. While camping Jasper finds a wounded eagle. Jasper contacts Emily to help him get the eagle emergency treatment. Students must determine the fastest way to get the eagle to veterinary assistance.
Get Out the Vote	Jasper visits Trenton to investigate a story for his newspaper about the city dumping excess garbage in Cumberland City. While there, Jasper meets a candidate for Trenton mayor, Ms. Clayton. Ms. Clayton has a good chance to win the election if she can get voters to the polls; her two children are helping with this endeavor. Two days before the election Ms. Clayton gets sick and cannot finish the driver itineraries for transporting voters. Students are challenged to make plans to drive as many voters as possible to the polls.
	Business Planning Statistics
The Big Splash	Chris, Jasper's young friend, wants to raise money to buy a camera for his school TV station. He wants to have a teacher participate in a dunking booth but must first develop a business plan to receive a loan from the school principal for the fund-raiser. Students must help him develop this business plan.
Bridging the Gap	Local students and two executives from a wildlife preserve in Jasper's town are challenged to develop a grant proposal for a nationwide competition related to projects to protect threatened and endangered species in the area. Various guidelines are provided, and students are challenged to use statistical concepts and environmental knowledge as they look for appropriate projects.

Table 1: *Continued*

A Capital Idea	Jasper's friend Larry and several high school students are involved in a recycling campaign to raise money for an annual school trip. Students conduct a survey to predict recycling habits in the community. The challenge is for students to prepare a business plan to gain support for their recycling project.
	Architectural Design and Way-Finding Geometry
Blueprint for Success	Two students visit an architectural firm on Career Day and subsequently hear about a vacant lot in their neighborhood being donated for a playground. The challenge is to design a playground and ball field for the lot.
The Right Angle	A young Native American has been left a challenge by her grandfather to find a cave with a family heirloom. Viewers learn about topographical maps and important geometry concepts during the adventure and are asked to use this information to locate the cave following the grandfather's map. They are then asked to determine the fastest way to get to the cave.
The Great Circle Race	Jasper's newspaper sponsors a "Great Circle Race." Students are provided information on this race and are then asked to determine who will win the race and in what time. They must interpret topographical maps, map the legal race area, and interpret velocity data to be successful.
	Smart Tool–Building
Working Smart	Students help create mathematical Smart Tools that will help them to solve a variety of categories of travel-related problems.
Kim's Komet	A particular soapbox derby competition in Jasper's town consists of five different events. Students help to create the Smart Tools that will allow a race contestant to quickly and accurately determine the best starting points for each event.
The General Is Missing	Larry's grandfather has been kidnapped but is able to get a message out that students must decipher. They help rescue Grandpa by using algebra to decode the note that tells the location of the secret hideout.

Source: Created by the author.

Design Features

The Jasper developers explicitly highlight seven design features and their benefits (Cognition and Technology Group at Vanderbilt 1992). These seven features mutually influence one another and help readers better visualize the series:

1. The *video-based format* provides motivation and searching capabilities. It also enables complex comprehension even for poor readers.
2.

The *narrative style*and *realistic problems*make retention easier for students, fully engage students, and help students recognize the need for mathematics in everyday life.

3. The *generative format* (the way students must generate subproblems to reach a solution) gives students motivation to determine an ending, helps students define problems and notice relevant information, and provides reasoning opportunities.
4. The *embedded data design* (the way all necessary data are contextualized in the video-based adventure) encourages decisionmaking and shows how relevant data are dependent on specific goals.
5. The *problem complexity* overcomes the common belief that math problems are solved quickly in a few steps, encourages perseverance, closely parallels complex problems in real-life, and develops problem-solving confidence.
6. The *related adventures* provide extra practice on core concepts, show transferability of knowledge, and illustrate analogical thinking.
7. The *interdisciplinary links* extend mathematics to other areas, encourage knowledge integration, and parallel real-world uses of mathematics.

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See also

Anchored Instruction; Constructivism

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JSTOR

JSTOR is a not-for-profit organization founded in 1995 to help the scholarly community take advantage of advances in electronic technologies. Its initial objective has been to build an archive comprised of the back volumes of important scholarly research journals, including a significant corpus of humanities and social sciences literature. The goal in building this centrally shared electronic archive has been to lower the systemwide costs associated with storing and preserving academic materials while simultaneously increasing their use.

Originally a grant project of the Andrew W. Mellon Foundation, JSTOR does not rely on the foundation for its ongoing support; rather, it has developed an economic model that has enabled it to achieve financial self-sufficiency and independent operation. In its first six-plus years, JSTOR has made remarkable progress. As of January 1, 2003, nearly 1,600 academic institutions in seventy-one countries have licensed access to the archive, contributing fees to support the preservation and ongoing maintenance of the archive. The organization has delivered on its original promise and is engaged in the process of adding more journals while also reaching out to new scholarly organizations and communities all over the world. It is fair to assert that there has been a clear endorsement from the scholarly community of JSTOR’s goal to serve as a trusted archive of electronic journal literature.

JSTOR’s approach to archiving seeks to balance the needs of libraries, publishers, and scholars for the good of the entire community. There are many examples of this, and a few are important to highlight and illustrate how deeply JSTOR is committed to its role as an archive.

First, JSTOR always digitizes journals back to the first issue. In doing so, JSTOR retains the look and feel of the original publication for preservation purposes and also employs technology to allow enhanced usability for scholars. JSTOR scans each journal page as a 600 dpi.TIF image and then creates a corresponding text file using optical character reading software. The text files enable full-text searching, while the image files are presented to users for viewing and printing. Users see exact replicas of the original published pages and can navigate through an issue just as they would in the print version. This approach is particularly useful in disciplines such as area studies, where diacritical marks and nonstandard character sets are common. All of the original content is captured and presented to users, including graphs, charts, and illustrations.

Next, the JSTOR archive does not include current issues. It has always been important to JSTOR not to jeopardize the participating publisher’s current content revenue streams. JSTOR allows publishers to select a moving wall, generally one, three, or five years. The moving wall defines the gap between coverage in JSTOR and the most recently published volume of the journal. For example, if a journal had a moving wall of three years in 2003, issues originally published in 2000 and before would be available. Important in the context of this discussion, the moving wall also provides libraries with an archive of material on which they (and their constituents) can rely.

As of January 2003, there were 182 publishers contributing journals to the archive. Six collections were available online: Arts and Sciences I, Arts and Sciences II, General Science, Ecology and Botany, Business, and Language and Literature. Together these collections contained 322 journals, many of which dated to before 1900; the oldest began publication in 1665. The archive contained more than 12 million journal pages and almost 900,000 full-length research articles. In 2002 alone, more than 10 million articles were printed from JSTOR, and users searched the archive more than 80 million times.

The Impact on Publishers

The scholarly publishing community is a key concern in the systemwide constituency that JSTOR actively serves. Publishers provide the content, or at least license that content to JSTOR in perpetuity, so that JSTOR can fully serve its archiving and access mission.

At the time JSTOR was started, there was very little electronic publishing activity in the humanities and social sciences. For many publishers, JSTOR was seen as an important experiment in determining if electronic content in these disciplines would be valued and if there was a viable economic model for providing content in this format. Also, at least initially, JSTOR was seen as a way for several publishers to begin the process of moving to an electronic publishing model (Bowen 1994).

It seems clear that JSTOR has provided an appropriate vehicle for unlocking older literature to humanities scholars. Literature that was either difficult to access (because of location or the condition of the material itself) or unavailable altogether (because the library did not actively collect the title or have the complete run) is now available to scholars everywhere. For publishers, this offers the potential to increase citations of that literature in current scholarship.

The sheer volume of humanities and social sciences literature that should be archived is somewhat daunting (and one could argue about what “should be” means in this context). Regardless, JSTOR is archiving but a small piece of this corpus of literature and is not in a position to archive even a significant portion of what is currently available. It is important, from a systemwide perspective, that this scholarship has the benefit of multiple archiving solutions and that other trusted third parties begin to address this issue.

The Impact on Libraries

Since its inception, JSTOR’s goal has been to help participating libraries expand their access role by taking advantage of advances in information technology (i.e., digitization). If we were to look back at the objectives of JSTOR when the project was originally conceived and evaluate the progress made to date on achieving those objectives, we could easily discern that JSTOR has already had a positive impact on libraries.

- By creating faithful replications of journal issues, JSTOR has helped libraries address issues of conservation and preservation. Incomplete runs (missing issues) of the titles digitized in JSTOR are made complete, the service lapses caused by mutilated pages are eliminated, and the long-term issues of the deterioration of paper volumes are reduced.
- By easing storage problems, JSTOR has assisted libraries in addressing vexing economic issues related to the capital costs associated with building additional shelf space while enabling the reduction of operating costs associated with retrieving and

reshelving back issues from stacks (Guthrie 2000). Many JSTOR participants are moving the bound volumes of titles digitized in JSTOR to remote storage, thereby freeing shelf space for additional journal literature. In some instances, libraries are getting rid of the paper volumes altogether.

- By dramatically improving access to this corpus of journal literature for faculty, students, and other scholars, JSTOR has helped libraries make available access to collections that may not have previously been collected in paper. Also, libraries have been able to improve service to their various constituencies by making resources available 24/7 while eliminating any dependency on physical location.

The Impact on Faculty and Students

Electronic media are rapidly becoming the primary mode of communication in the scholarly community, yet this is happening at such a fast rate that we know very little about how those changes are impacting research, teaching, and learning behaviors, much less the second-order questions (e.g., how it is impacting the quality of research and the productivity of researchers). Such widespread awareness and usage of the JSTOR archive across a number of scholarly disciplines offer opportunities for studying the usage behaviors and evolving attitudes related to electronic resources (Guthrie, forthcoming). Some interesting trends have emerged.

Electronic access is increasing the use of older materials at JSTOR participating sites. One thing that JSTOR has shown the academic community, at least to this point, is that faculty and students are using this digitized scholarly literature at unprecedented rates and in unprecedented ways. Simply looking at the patterns in access and printing from the JSTOR archive since its inception makes this point abundantly clear. (See Figure 1.)

Growth in the use of material in JSTOR might imply that there has been a change in usage patterns between paper and electronic materials. Clearly, use of older literature in paper form was not on this scale and not growing at this rate prior to the materials' availability in JSTOR, or institutions would have been adding staff over the years continuously just to reshelve back volumes. There is no question that availability in electronic form is increasing the use of back issues.

Citation data alone are not a good predictor of electronic usage. What emerges from any analysis of the JSTOR usage data is that citations do predict usage to a degree, but not nearly as much as might have been expected. There are many other reasons that articles are used. It is evident that highly cited articles are not necessarily the articles that are most used in a resource like JSTOR. This lack of a close correlation between these two

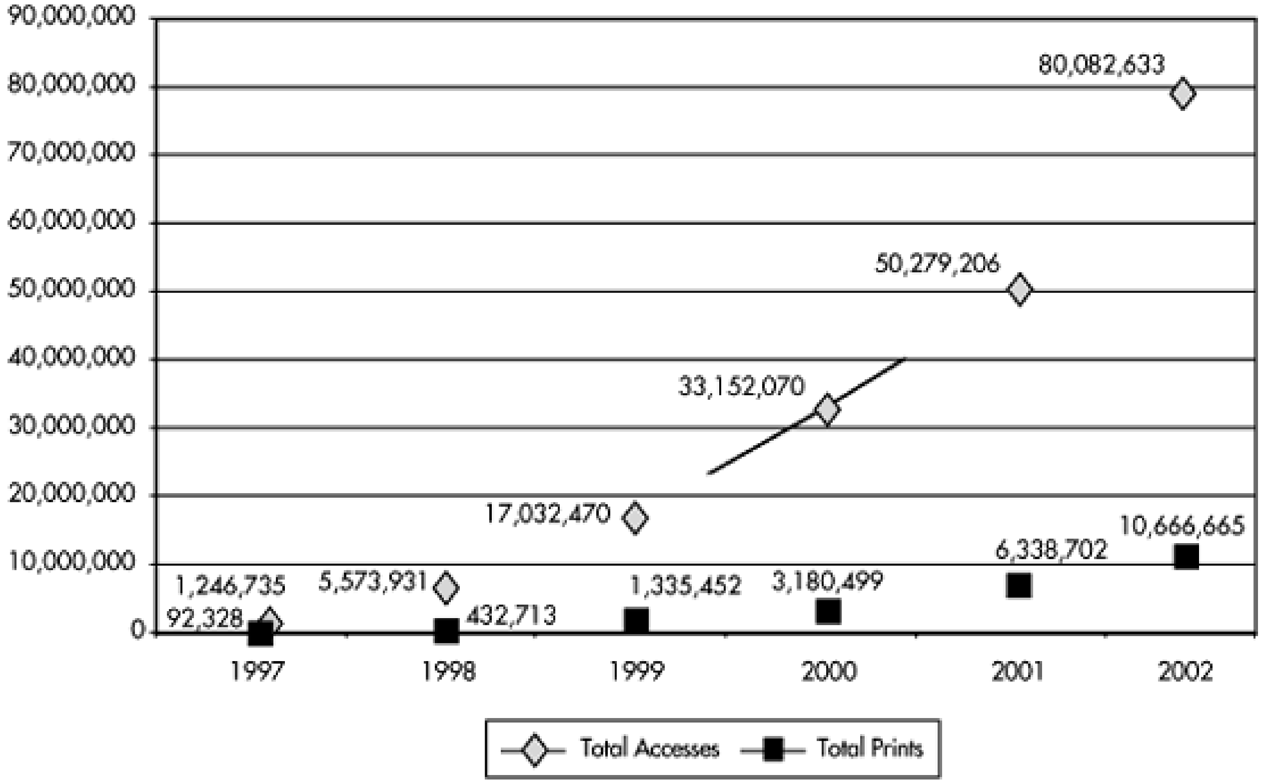

Figure 1:

JSTOR Usage

Source: Created by the author.

factors contradicts typical expectations about research resources and warrants further study.

Older literature remains valuable in many fields. In general, it can be said that there is not a close correlation between the age of the articles in the JSTOR archive and usage for the most commonly accessed articles in the disciplines represented in the archive. In other words, the most commonly accessed articles in JSTOR are not necessarily the most recent articles published; rather, they are widely dispersed across the chronological range of published articles.

Care should be taken to ensure that there is a clear understanding of the definition of “value” for research articles. Although usage data provide some helpful insight about how material is being used in comparison to traditional expectations and value measures, we must also be wise in our evaluations. Those articles that push forward research and intellectual understanding may not always be the most popular or most heavily accessed.

Reaching Additional Communities

When JSTOR was conceived, there was little expectation that the archive would have any demand beyond the U.S. academic community. As the resource has grown, however, new communities of users have emerged, and

JSTOR has worked diligently to make the archive available in these communities.

For the past several years, the international community of JSTOR participants has expanded dramatically. As of January 2003, there were more than 500 institutions participating in JSTOR from outside the United States. Although it would be difficult to pinpoint the impacts—good or bad—that JSTOR access may have had on the international academic community, for many institutions participation in JSTOR is helping provide access to scholarly journals that the library never owned previously in paper and probably never would be able to afford to own, in any format, in the future. In paper format, it has been estimated that the building, shelf space, and capitalized maintenance costs for the 117 journals and approximately 7,700 journal volumes represented in JSTOR's Arts and Sciences I collection is more than U.S.$125,000, exclusive of the initial acquisition costs. Add that to the estimated annual costs of U.S.$6,500 to provide access and circulation to those volumes, and it becomes readily apparent that it is well beyond the means of most libraries to acquire and maintain these journals in the paper medium.

During 2002, in an effort to provide access to researchers and scholars who may not be affiliated with a particular college or university, JSTOR launched an outreach effort to the public library community. Although very few public libraries place as much value on JSTOR's archiving mission as institutions in the academic community, it is clear that JSTOR can offer public libraries access to materials to better serve their constituencies.

Similarly, also in 2002, JSTOR initiated access for interested secondary schools. After a two-year pilot study with a number of public and private high schools from around the United States, it became evident that JSTOR could have significant value in the secondary school community by helping to address issues such as:

- *Access:* Historically in the secondary school community, journal material is not easily accessible. The cost and maintenance of substantial holdings in scholarly journals is generally not within the reach of most high school resources. Access to JSTOR's content has demonstrated a very positive impact on student scholarship, primarily by sustaining research projects at a level that was previously difficult if not impossible to pursue.
- *Professional Development:* As more teachers come out of education and graduate programs where they are accustomed to a certain variety and academic depth of e-resources, they are more particular about maintaining connections to such resources. Access to these materials enables them to be better teachers, in a sense, as it enables them to provide a better foundation

education at two levels: first, it strengthens content knowledge and has broad applications in curriculum enhancement; second, it provides an excellent opportunity to teach basic research skills. JSTOR has a naturally complementary relationship as an electronic resource with the print resources already in use at the high school level.

Creating a framework for building and extending communities that benefit participants who use the archive will continue as JSTOR's outreach efforts expand. Feedback from these communities will enhance the collections, the services, and infrastructure, thus improving the value of the JSTOR archive to scholars, students, and libraries around the world.

JSTOR will continue to focus on its mission of building a trusted archive of important scholarly journals and extending access to that archive as broadly as possible. This means adding important new collections to the archive and continuing outreach efforts to all the user communities served by JSTOR. In addition, JSTOR will begin to address two longer-term issues that are of considerable importance to the academic community: (1) developing an archival system for materials that are born digital; and (2) implementing new authentication methodologies that will still provide broad access to online resources yet provide increased security for those materials made available online. Both of these endeavors will be challenging, but both are instrumental in fulfilling JSTOR's mission.

Bruce Heterick

See also

Virtual Library

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Just-in-Time Training (JITT)

Just-in-time training is characterized by the immediate delivery of the knowledge and skills necessary to complete a given task at the moment it is needed. JITT systems deliver the necessary information directly at the jobsite instead of in the training room. JITT is performance-based, real-time, and can be customized to meet individual learners' needs. JITT involves the delivery of the right knowledge, in the right amount, at the right time, and in the right manner for the worker and the task at hand. Some examples range from traditional apprenticeships, to job aids, to complex integrated performance support systems such as those used by the military.

For educational technologists, JITT addresses questions of relevance, currency, and return on investment of training programs. Although an increasing number of training programs are emphasizing human performance technology and performance-based learning, many organizations are taking this a step further by borrowing the concept of *kanban*, or just-in-time, and applying it to their training programs.

In today's competitive global economy, an organization must be able to quickly adjust its products and services to meet changing and emerging customer needs; organizations must also be flexible enough in their processes and procedures to respond to new competition and abrupt market changes. These rapidly evolving environments highlight the importance of the adaptable modern knowledge worker, who must be able to learn new tasks and technologies in record time, sift through hundreds of gigabytes of data to find the information she needs when she needs it, and make on-the-fly decisions that previously were relegated to upper-level management.

Until recently, the average worker performed within a fixed skill set throughout most of her career. Workers received direction through the organizational chain of command, and decisions were made by upper-level management. However, several organizational and environmental factors have changed the worker's traditional role. Information technology has enabled anytime/anywhere access to almost any kind of information. Striving to improve the bottom line and to streamline organizational decisionmaking structures, businesses have been taking advantage of this increased access to information by slowly weeding out middle-management positions and relegating the decisionmaking tasks to various positions across the organization and across industries. Instead of waiting for directives from a higher level, workers have been empowered with the responsibility of decisionmaking that may have a significant impact on the organization. Thus workers need access to training materials that provide the right knowledge at the right time, which allows them to participate in managerial decisionmaking.

Job know-how has historically been delivered to employees through traditional training programs, which generally consist of curricula and courses. Employees were typically taken off the assembly line or out of the office for hours, days, or even weeks to complete training to remain current for one or two years. The tangible costs associated with this training model are twofold: the initial cost of lost productivity that occurs when employees are taken out of the work environment; and the actual cost of the training itself, which includes course development and implementation, travel expenses, material expenses, supplies, and other administrative expenses such as refreshments. Furthermore, there are intangible costs associated with this type of training. Traditional training programs tend to approach learning as a holistic exercise, often teaching everything there is to know about a process or technology, starting with the lowest common denominator, regardless of whether it is needed or relevant to the learner. The assumption behind this model is that while employees may not need this knowledge immediately, they will at some point be required to use this knowledge (i.e., the topic should be covered in training just in case employees need it). Unfortunately, research has proven the opposite. Knowledge and skills that are not used shortly after training are often forgotten in part or in whole. What is needed are smaller, more frequent chunks of training.

As a result of these workplace changes, training programs have become increasingly performance-based. Learning must equal performance, and it must be integrated into the work environment. Information and materials extraneous to the task at hand should not be included in a training situation but rather stored for later use, if and when they are needed. Training programs also must be more efficient. Workers cannot be taken off the job to learn new skills; instead, they must be able to implement the new skills in the context of the working environment even as they are learning and mastering the skill.

Driven by the need to address many of the problems above, training programs in business and industry, as well as more formal educational programs, are implementing just-in-time training as a viable solution. Just-in-time training can be compared to more conventional just-in-time production systems found in industry. The driving factor in the development of JITT supply-chain interaction systems was the elimination or reduction of inventory surplus. In the traditional “push” assembly line model, parts and supplies were stored up just in case they were needed. In an effort to streamline production, a large sector of industry now uses a “pull” system, in which inventory is ordered and fed into production only as it is demanded by the production processes.

The aims and functions of just-in-time training are parallel. JITT systems intend to impart knowledge to personnel only when the application of that knowledge becomes necessary. The knowledge gained from a JITT system is used immediately, thereby reducing the risk of wasted knowledge. Elimination of wasted information, or surplus information, is a key objective of just-in-time training programs. Instead of filling up employees with a knowledge inventory that they might use, JITT programs produce knowledge on demand. “Inventory” (i.e., the training modules) is fed into production as demanded by the processes. This inventory is delivered in small batches—just enough to cover a few small tasks for a few hours or days.

With its ties to total quality management, JITT is most prevalent in business and industry; however, it has begun to emerge in K-12 and higher education classrooms. Perhaps the most significant driving factor in the adoption of JITT in formal education environments is the increasing popularity of problem-based learning, in which students learn concepts, principles, and procedures by working through a problem. In a problem-based lesson, students begin to solve a problem with only a narrow understanding of the necessary information. As they progress toward a solution, students are given the necessary information just in time to move to the next step. This sort of scaffolded just-in-time learning addresses the same questions of relevance, both real and perceived, that JITT does in business and industry training programs.

Advances in Technology

JITT is more possible today than in the past because technology has advanced to enable anywhere/anytime access to data and information that can be intelligently classified, stored, retrieved, assembled, and delivered. This access is possible through networking technologies that link information systems together. Database technology has enabled storage of vast quantities of different data types, not to mention rapid data access tools and intelligent search functionality. Finally, object-oriented technology has had an immense and far-reaching impact on the flexibility and usability of software applications and operating systems, further enabling the intelligent classification, storage, retrieval, assembly, and delivery of data in real time. Object-oriented software development organizes both a problem and its solution as a collection of discrete digital objects authored or created using various software programming applications. Therefore, in educational technology we see the largest influence of object orientation on the design and development of software products for teaching and learning, including instructional software, knowledge management software, electronic performance support solutions, and learning object management systems.

When data are organized into discrete, distinguishable entities (objects), they are said to have an identity that consists of a name, attributes, and behaviors. Object-oriented design goes beyond the identification of objects to identification of classes of objects and their interrelationships, where objects can be things, persons, and even concepts. For example, a JITT system for an automobile manufacturer might include a class of objects that

(1) are components of the automobile, such as the bumper, chassis, headlights, and the like; (2) machines used in assembly, such as a microprocessor, robot, or other device; or (3) job classifications of employees, such as heat treat operator, saw operator, or seat assembly operator. Classes of objects are organized hierarchically according to sameness or differences among them, so that each broadly defined class has several more specialized classes, or subclasses. For example, the manufacturer might have four different styles of headlights, each representing its own subclass.

The key to object orientation is the distinction of behaviors. A behavior is an action or transformation that an object performs or to which it is subjected. Object subclasses can inherit behaviors, as well structure, from a superclass. For example, all parts that are outsourced might inherit on order as a behavior while all parts that are produced in house might inherit scheduled for production as a behavior.

The classification schema represents relationships among the attributes and behaviors of things, people, and concepts, such that when a user of an object-oriented JITT system poses a problem with specific attributes and behaviors, a solution (or limited number of solutions) can be intelligently delivered using the same set of attributes and behaviors. In this sense, JITT is performing the traditional support functions of technicians, technical manuals, and job aids, as well as the training functions of the traditional training course.

Although JITT has been and is now in use in many sectors of business and industry, more widespread use is uncertain for several reasons. Object-oriented JITT systems may be prohibitively expensive to design and develop for medium and small organizations. In addition, many educational technologists dispute that JITT facilitates learning but rather serves only advanced support functions. Finally, other critics are unconvinced as to its effectiveness as a learning tool over traditional classroom training. Questions regarding the efficiency, effectiveness, and true return on investment will need to be considered before any organization can confidently implement a JITT program.

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See also

Electronic Performance Support System; Knowledge Management; Learning Objects; Performance Support; Problem-Based Learning

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Knowledge Management

Knowledge management in business and industry is the increased value provided by the effective use of data and information assets. In the past, a business's value was calculated in terms of physical assets, but in today's information economy, information and data—the intellectual capital—are just as valuable as physical assets, if not more so. It has been said that competitive advantage in the future will reside with organizations and nations that are best able to (1) collect, index, and store data; (2) retrieve and derive useful information from analysis of data trends and patterns; and (3) use that information for timely, knowledgeable decisionmaking. The significant advances we have seen and will continue to see in data collection, indexing, storage, retrieval, and analysis are the result of advances in computing and telecommunications power, efficiency, and speed.

Knowledge management can be enabled through the use of information technology and software products. Educational knowledge management systems are often called content management systems, learning management systems, and electronic performance support systems. These systems are used in business, industry, government, and education today, and their use will grow as it becomes increasingly important that we become more capable of "knowing what we know."

Data are nothing more than discrete facts, whereas aggregating data to discern meaningful patterns and themes can create information. The ability to use information has historically been deterred or retarded by a lack of needed relevant information delivered to the right persons at the right time. Data-processing speed and capability today enable the classification, storage, and retrieval of information to the right persons at the right time for decisionmaking. For example, a knowledge management system used in aluminum manufacturing can be used to provide necessary information to a technician when a machine that is required to roll aluminum product breaks down. Instead of sending the technician to a two-week training session that covers all aspects of machine maintenance and expecting the technician to recall all that he learned when the machine breaks down six months later, the knowledge management system can provide only the right information to the technician at the time it is needed. Systems designed to accomplish data classification, storage, and retrieval have further enabled and advanced knowledge management. These systems record data, organize information, and store knowledge so that it can be found and used whenever and wherever it is needed.

As an educational technology resource, information systems are designed and deployed to assist organizations and individuals in learning and in exchanging knowledge by empowering them with critical knowledge accessed in just the right amount, at just the right time. For example, a knowledge management system can link production orders week by week, corresponding skill sets required, and skills sets available given sick leave and vacation schedules, and can provide the human resource manager with a profile of skill deficiencies for the upcoming week in production.

There are several factors to consider when designing, delivering, and evaluating knowledge management systems. Such systems must include tools (1) for authoring knowledge products and objects; (2) for delivering knowledge products, profiles, and objects; and (3) for managing the relationship between products and objects and their delivery when needed. Through the authoring, delivery, and management process, knowledge management systems store data about the organizational and individual knowledge requirements, existing knowledge and skill, learning, and content, as well as tasks and context.

Authoring capabilities in learning management systems are used to develop content. There is a disparity in the authoring functionality of the different products on the market. This capability ranges from the authoring of narrative documents, such as a text file, to animations, simulations, audio files, video files, and so on and the combination thereof. In addition to creating new content using any authoring tool, many systems include functionality for capturing content from other sources (such as other training materials, online resources, data from other systems, etc.), assembling this content, and publishing it to the learning catalog in the appropriate format, whether the format is a course, short learning module, document, job aid, or reference guide. In addition to preplanned authoring, these systems may also support real-time knowledge generation through collaboration between learners and tutors through discussion forums, document-sharing, and real-time virtual classrooms. Data collected in real-time situations can be archived and tagged as a data source for future content authoring. The goal of many of these systems is to reduce the costs and time associated with creating compelling multimedia content. Current thinking is that cost and time reductions can be realized through the authoring of small chunks of content that can be used in a flexible manner, as well as the mining of existing data banks for reuse of information. These systems are being developed with the functionality to author adaptive learning experiences and simulations through conditional navigation of author-defined branching logic. Author-defined branching logic describes the if-then conditions that dictate the user's learning experiences based on precoded branches, or options.

Delivery functionality has evolved rapidly in the last two generations of learning management systems. One of the simplest delivery functions is to list all of the resources available. However, with the integration of delivery and management, systems are now more capable of personalizing the delivery of learning based on emerging intelligent search capabilities. In-depth profile information can be used to narrow the search for the right resources by acting as a filter based on user preferences such as: (1) face-to-face, instructor-led, or self-paced learning; (2) asynchronous versus real-time online events; (3) time constraints; (4) events that have available spaces; (5) resources that match the budget; (6) training that has been reviewed favorably by previous students and/or content experts; (7) resources provided by preferred suppliers, and so on. In addition to intelligent searching, some systems have decisionmaking capability that will assist in the delivery of content to learners based on their prior knowledge and experiences, the requisite competencies (whether job-related or other user data), and knowledge gaps (individual skills profiles linked to organizational goals). Most systems support multiple delivery modes such as the Internet, intranets, CD-ROMs, or offline learning.

The management functionality in these systems is varied and significant. These systems can store the organizational goals, skill, and competency needs within the organization, as well as the skills and competencies possessed by the users within the enterprise. Using the current and required skill profiles, individual and organizational competency gaps can be readily identified and analyzed. Required competencies are recorded in a systematic way and then can be used as the basis for human resource planning, curriculum planning, and the analysis of training and developmental needs. Some systems store information about competencies, qualifications, and licenses that a person already has. This information can be viewable by individuals, managers, peers, subordinates, and so on. The information can be organized by the person's current job and/or by jobs to which they aspire. Individuals' skills can be linked to job requirements and to organizational goals. The system can act on this information by informing individuals of obligations and appropriate learning resources to get certified or remain certified. The capability to cross-reference learning resources to competencies means that managers and individuals can then automatically find learning resources that address an identified gap. Some systems take a proactive approach and assign courses directly to individuals or groups based on identified needs.

From a content management perspective, some of these systems include a robust content and/or learning object repository that allows content managers to search, share, repurpose, and store content and learning objects in a central location. This single, central repository eliminates duplicate learning content creation efforts and encourages a collaborative work environment where multiple people can work on the same module or course at the same time.

From a program management perspective, some systems assist in providing access controls and services. Controls can be advantageous when resources (such as seats in a course or budget) are scarce. Some systems allow enterprise-wide profiles, which are used to set control limits to resources for specific, manager-defined target groups. With regard to services, functionality exists to (1) provide a wait-listing service for classroom events; (2) obtain electronic approvals; (3) accept a wide range of payment schemes, including prepayments, credit lines, and pay-as-you-go; (4) track registration; (5) track time on task; and (6) track course completion and/or tests results. Some systems have functionality to help managers evaluate their training programs by tracking and aggregating statistics on demand, usage, completions, student satisfaction, and an aggregate measure of the learning that's been achieved. From a return-on-investment standpoint, some systems can keep track of costs, and if it incorporates competency management facilities, a training manager can plot how narrow that learning gap is becoming.

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See also

Analysis; Collaborative Technologies; Communities of Practice; Electronic Performance Support System; Just-in-Time Training; Performance Support

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Knowledge-Building Environments (KBEs)

Almost all of the innovative work in the learning sciences and instructional design today comes from the constructivist paradigm, in which knowledge is viewed as humanly constructed. When compared to conventional instructivist pedagogy, the various constructivist approaches appear to be fundamentally the same. Yet there is reason to believe that there are deep differences among constructivist approaches and their intellectual bases and that further progress will require that these differences be brought into the open. There is a difference central to the design of educational technologies in the so-called knowledge age. The difference is between designs for constructive work around available knowledge versus constructive work aimed at generating new knowledge. This distinction of old knowledge versus new knowledge is elaborated below in light of knowledge age challenges for education.

The ability of a society to generate new knowledge is coming to be seen as a major determinant of the health and wealth of nations (Romer 1993) and education as the foundation of that ability (Drucker 1994). “Knowledge-building” is the term used to focus on the new knowledge challenge. Two key points: Most educational technology, including modern constructivist technology, does not address the new knowledge challenges but instead reproduces approaches adapted to the acquisition of old knowledge; and environments designed for the creation and improvement of new knowledge—knowledge-building environments—are better suited to the new knowledge challenge.

The adage “there’s nothing new under the sun” reflects the fact that it is difficult to pinpoint the time when an idea first enters our culture; nonetheless, some ideas clearly entered before others, and many can be dated, if only approximately. The distinction between extant and new knowledge is becoming increasingly important to knowledge age considerations. The distinction between learning and knowledge-building captures this important difference. Learning is a process through which a person’s beliefs, attitudes, or skills change and grow. It encompasses all those means by which our cultural heritage is passed from one generation to the next. Knowledge-building, by contrast, involves the creation of new knowledge.

Throughout most of history, learning constituted an adequate objective for education, because knowledge was not thought of as advancing; it was thought to be in greater danger of deteriorating or getting lost. Perhaps not until the curriculum reforms of the 1950s did the idea become firmly established that knowledge is continually advancing and that the schools accordingly have a responsibility to keep students abreast of it. The knowledge age adds a new requirement: Students must learn how to contribute to the production of new knowledge. This is a radically different challenge for education—different from both the ancient challenge of cultural transmission and the more recent challenge of lifelong learning.

Knowledge-building that makes headlines produces ideas that are new to the world. However, authentic knowledge-building can also occur through the production of ideas that are new to the participating community. Much of the work of scientists, for instance, is devoted to *reconstructing* the work of their colleagues (Dunbar 1995). This reconstructed work then becomes community knowledge—a form of new information and shared intellectual property that other community members can all build on. This challenge of creating community knowledge and continually improving it is what distinguishes knowledge-building classrooms from classrooms in which learning (including "constructivist" learning) is the focus. When people set out to create knowledge, they are embarking on a different kind of enterprise from those who set out to learn. That difference is elaborated below, after a brief review of current learning technologies.

Old Learning Technologies and Modern Parallels

Old: one-to-one conversation and tutoring
New: e-mail, telementoring, intelligent tutoring systems

One-to-one interaction is regarded as an educational ideal. Efforts to realize this ideal through information technology have included intelligent tutoring systems and telementoring. Intelligent tutoring systems, like human tutors, are expected to respond flexibly to student inputs so as to optimize progress toward a learning objective. Telementoring involves one-to-one interchanges between tutor and student, as well. It typically relies on e-mail exchanges between an individual student and someone more expert in the domain (Neils 1997). Its success is highly dependent on the match between mentor and student, and it is difficult for benefits to spread beyond the dyad. Common to both old and new one-to-one approaches is their typically asymmetric character. The tutor or mentor, whether human or machine, is in charge and directs the learning process. The tutor attempts to understand or diagnose the learner's processes, but the learner is not afforded insight into the tutor's thinking. Within a KBE, by contrast, tutors and mentors join the community as expert learners, exploring ideas at the growing edge of their understanding. All members engage in self- and group assessment, with mentors extending their own knowledge and modeling the process rather than simply assuming diagnose-and-answer roles.

Old: small-group discussion
New: threaded discourse, online forums, bulletin boards

Small-group work has been the principal way of breaking the pattern in which all communication is mediated through the teacher. Substantial responsibility is transferred to students, and interactions can be quite productive. However, it often proves unmanageable unless the groups have definite and limited tasks; but this reduces the responsibility assumed by the students. Without a facilitator, there is a tendency for discussions to be dominated by outspoken students. Knowledge generated in small groups tends to be ephemeral, with no recording of it and no teacher to serve as the corporate memory; and what is produced in one group is not readily available to others. Threaded discourse, now a standard adjunct to course delivery systems, mirrors small-group discussion. Problems with threaded discourse parallel those of small-group discussions, with fewer of the advantages. The first entries set the discourse, with subsequent entries moving farther from the initiating goal, seldom establishing a higher-level goal than the first entry. And threads encapsulate ideas, eliminating potential cross-thread synergies. Revision is typically not permitted (to preserve the discourse in its original form), but this encourages a rambling discourse. The strict downward-branching format of threaded discourse discourages rising above to some more integrated framework. Participants typically have only two options—to branch downward from an existing entry, or to start a new thread. In KBEs, by contrast, conversations can move not only downward but also upward to a higher level of integration and horizontally to create connections across different threads and discourses.

Old: large-group lectures
New: broadcast media, online lectures, listservs

New media for large-group interactions actually reinforce rather than diminish centralized control, in that they increase the separation between the teacher in charge and the learners. Much of the popularity of these media arises, of course, from the fact that they do not fundamentally alter the character of educational discourse and therefore require no basic change. This is signaled by the common expression of "putting a course online"—implying, as is often the case, that it simply involves importing old material into a new medium. By contrast, KBEs provide a forum through which teachers and learners share responsibility for knowledge advancement.

Old: conferences
New: teleconferences; telepresence; streaming video

Computer-mediated conferences and video-enhanced meetings aim to reproduce the characteristics of small- or large-group face-to-face interactions. For geographically separated participants, this provides opportunities for a more personal level of social interaction and sharing. This can be valuable, particularly at the beginning and at critical junctures in collaboration. The term “telepresence” refers to the ideal of imbuing an online conference with all the experiential qualities of a face-to-face discussion. From an educational standpoint it also embodies the familiar limitations of the group and classroom discussions that it aims to reproduce. KBEs create more flexible and decentralized spaces for collaborative interactions.

Old: research project
New: computer-mediated projects

The school research project is a staple of education, seldom involving original research and instead drawing on available reference material. It is known in the educational literature for reinforcing a pernicious educational strategy called “copy-delete,” whereby researchers copy material from reference resources and delete irrelevant information (Brown and Day 1983). The result is a collage of copied material, reworded to avoid plagiarism. The Internet makes this knowledge replication strategy increasingly easy. At its worst, computer-mediated project-based work consists of similar cut-and-paste media projects; in others, students’ contributions are limited to filling in the blanks of electronic templates. Often the discourse is the weakest part of collaborative projects, focusing on concrete details of getting the job done and determining who will do what rather than advancing ideas. Within a KBE project work is more easily transformed into authentic knowledge-building. Participants contribute artifacts to a public forum, with the expectation that these artifacts will enhance the knowledge resources of the whole community and be continually refined by that extended community.

Old: field trips, laboratory exercises
New: simulations and microworlds

The field trip is the classic way to explore worlds that are not easily represented through school-based instructional materials. New knowledge media extend the range of experiences and concepts that can be brought into school, through video productions, simulations, and microworlds. Physics microworlds, for example, allow students to explore concepts such as force and momentum by applying “kicks” to objects under different conditions and testing results (see, e.g., White 1993). In well-engineered environments, explorations are designed to maximize opportunities for discovering the deep principles of the domain. Video productions can anchor instruction in real-world phenomena (e.g., the Jasper Woodbury series). Although computer-based explorations lack the immediacy and the “embodied cognition” of real-life exploration, they afford greatly enhanced opportunities for experimental probing and testing of conjectures. In order for these to coalesce into theoretical understanding, however, a more comprehensive constructive process has to take place. Over the years designers of anchored instruction and simulations have added prompting, discussion tools, and cooperative groups to their environments (White and Frederiksen 1998; Linn and Hsi 2000; Cognition and Technology Group at Vanderbilt 1997) in an effort to achieve greater depth and integration. The same problems of superficial and piecemeal learning occur, of course, with respect to real-life experiments and field trips. KBEs provide a means for learners to record their ideas as they explore these phenomena. Their ideas live alongside the simulation that is actually incorporated into the KBE, where it serves as a tool in a larger effort to advance knowledge.

The main thrust of current learning technologies has been to reproduce time-honored educational mechanisms, sometimes with improvements. “Constructivism” in this context refers to the extent of active versus passive involvement of students in the learning process. It does not refer to knowledge creation, as carried out in modern professions, the sciences, research enterprises, and innovation-driven companies. Supporting that kind of process is a challenge being addressed in the design of knowledgeware, and knowledge management literature, but it represents a new and unfamiliar challenge for educational technology—a challenge to be addressed through KBEs (Scardamalia and Bereiter, forthcoming).

New Technologies for New Knowledge

Knowledge-creating organizations generate community knowledge and continually improve it. KBEs support this process and extend the possibilities. Participants contribute ideas to community knowledge spaces, where these ideas are advanced through interactions with others. Contributed ideas become objects for continual testing, improvement, and linking to other ideas. As ideas develop, problems are reformulated at more complex levels, new information is contributed, the amount of knowledge that is presupposed increases, standards rise, and participants are challenged to create increasingly coherent wholes based on the diverse ideas contributed.

Continual idea improvement requires knowledge-building discourse. This discourse contrasts with threaded discussion. Threaded discussion typically follows the question-and-answer or opinion-and-response formats, both of which are more conducive to the acceptance or rejection of ideas than to idea improvement. As illustrated by the CSILE/Knowledge Forum®, a true KBE affords much more constructive work with ideas than does a simple threaded discussion environment: All entries can be built on directly or embedded in other notes, with automatic citation and links back to the original note; ideas are fortuitously brought into new discourses and new contexts through searches and collective design spaces that allow for new conceptual structures. More generally, ideas are kept alive through a variety of functions, and there is always the option, in any discourse, to move to a higher level of integration or to create connections across different discourses.

If we revisit the idea of telementoring, we gain a better idea of the advantages of having all participants creating and being responsible for community knowledge. To review briefly, telementoring matches a mentor/teacher with a learner, typically engaged in e-mail exchanges. Contrast this with telementors in the Knowledge Forum. The mentors are brought into the public, community forum in which the students are working. Even if the input is directed to a particular person, it is accessible to all community members. The mentor's advice is then read by a broader audience; the mentors themselves read each other's exchanges. Not only is advice more broadly received; mentors learn to become better mentors (O'Neill and Scardamalia 2000). Expertise is broadly distributed rather than residing in one-to-one interactions.

KBEs similarly alter the framework for project-based learning. Project participants contribute their work (plans, project responsibilities, summary of research findings, notes, multimedia productions, original texts, Internet resources, etc.) into a public forum. The evolution of the project—not just its endpoint—is available to all. And after a project is complete, the solutions and artifacts, and the discussions that surround them, remain available for extended work. In a KBE, "production values" are important, but idea advancement is more important. The project is not an encapsulated activity whose endpoint is a presentation: Rise-above dynamics support higher-level productions, with the output from one project serving as input to new, more advanced efforts. Database access and linking structures favor flexible, opportunistic meetings of participants, with discourses linked through one large discourse or a set of interlocking discourses, as users wish. This contrasts with the often highly regimented projects designed by others, with students in the implementation role rather than engaged in design as well.

From Learning Technologies to Knowledge-Building Environments

As already noted, discussion is increasingly being added as a layer on top of other kinds of learning technology such as simulations and microworlds.

This is a worthwhile enhancement, consistent with time-honored principles of good teaching, although there are indications that this added layer of work is often treated in a perfunctory manner by students (Guzdial 1997). A KBE may well incorporate or link to simulations, microworlds, and other applications relevant to work with ideas, but outputs from these applications are brought into the shared workspace, where they serve as objects of discourse to help advance the overall knowledge-building effort. Knowledge-building discourse drives the work rather than being an adjunct to it. The potential of KBEs for learning applications is suggested by experiments in which student work in a physics simulation or Jasper Woodbury problem is carried out within CSILE/Knowledge Forum, resulting in advanced problem-solving (Scardamalia, Bereiter, and Lamon 1994).

The largest body of data available from the use of KBEs comes from the CSILE/Knowledge Forum initiative. Positive results are consistently found in contexts where the social innovation—knowledge-building communities—is combined with the technological innovation—CSILE/Knowledge Forum. When the social practices of the classroom remain tied to traditional teaching-learning models, the changes are not as impressive. When knowledge-building communities and KBEs combine to produce self-organizing systems for creating new knowledge, results indicate significant advances in textual, graphical, and computer literacy, as well as in depth of inquiry, collaboration, and a host of mature knowledge processes (Scardamalia, Bereiter, and Lamon 1994). Such results suggest that it is helpful to distinguish learning from knowledge-building and that technology designed to support the distinctive social and cognitive dynamics of knowledge can make a valuable contribution to education.

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See also

Computer-Mediated Communication; Constructivism; CSILE/Knowledge Forum; Educational Systems Design; Jasper Woodbury; Research on Media and Learning; Telementoring

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L

Learner-Centered Environment (LCE)

Learner-centered environments describe an environment where learning is the focal point and learners are engaged in complex, hands-on activities that allow them to develop their understanding of the world around them. These activities may involve engagement in authentic research; use of technology for gathering information, communicating with experts, or developing understanding; and engagement in other real-world activities to support learning. The design of LCEs is based on the fourteen principles outlined by the American Psychological Association (APA). These principles provide a guide to thinking about learning based on brain development and learning research studies. The principles focus on how people of all different ages and ability levels learn effectively; the importance of motivational factors on learning; the influence of social interaction on learning; the importance of recognizing individual differences; and assessing learning and understanding. The guidelines not only offer a vision of a learning environment for students but also provide a framework for what it means to be a teacher. The best learner-centered environments also go one step farther by looking at how to support teachers in moving toward this new vision through learner-centered professional development. The one critical aspect common to all LCEs is that they focus on developing a culture of learning.

LCEs focus on individual students' abilities, needs, and interests, and labeling and tracking are not typically emphasized or deemed significant to a learner's ability. In an LCE, students are not sorted by teachers according to perceived ability; instead a student's efforts are encouraged as a means for moving as far as possible toward a learning goal. LCEs respect diversity through the belief that students are naturally motivated to learn and that students can take responsibility in their own learning processes. Each student brings a particular understanding of the world and particular background experiences to every learning opportunity.

LCEs are necessarily supported by a number of resources that until recently have been extremely difficult for schools to offer. For example, the Internet has opened a world of resources to the classroom, word processors have offered a tool that allows students to reword and revise their ideas easily, and computer-based simulations offer ways for students to see or experience things that they would normally not experience until they entered the workforce. Without the widespread adoption of technology by schools, LCEs would be nearly impossible to support; however, with technology they have become feasible and attractive to educators.

A learner-centered environment should offer a safe place where learners further their understandings through compelling, complicated, authentic inquiry into the world around them. Safety in LCEs is of two kinds. First, students are physically safe—the environment is made safe for students as they learn. If danger is naturally involved with the phenomenon they are examining (e.g., fire or certain chemical reactions), the teacher may choose to use demonstrations, videos, computer simulations, and other nonhazardous means for student exploration. For example, students learning to fly will use a computerized flight simulator many times before they ever pilot a real airplane. Likewise, an eighth-grader may experience what it is like to manage a paper plant through a simulation but would never be expected to run one in real life. The second safety is psychological—students feel safe to learn. Students as well as teachers recognize that making mistakes is part of learning and that mistakes can be learned through reflection. In the LCE, the student's evolving understanding and the processes the student is going through are more important than the right answer. Teachers may use a number of technologies to promote reflection and understanding, such as concept-mapping software to help students create visual maps of their understanding, collaborative tools to allow students to carry on discussions about their understanding, and word processors so that students may keep a journal that is editable over time.

The Fourteen Learner-Centered Principles

The fourteen learner-centered principles as described by the APA cover a broad range of learning-related issues. They are drawn from research on how people learn best, including research on thinking, memory, cognition, development, and motivation. The principles are concerned with those aspects of learning that are under the control of the learner. It is the job of educators and mentors to find ways of supporting students that are consistent with these principles.

The first six principles highlight the nature and goals of learning and introduce a number of issues that are critical to the learning process. First, learning should be intentional, that is, the learner must take responsibility for learning. To be successful at intentional learning, the learner must be able to integrate new knowledge with old. This means that new experiences should tie to old experiences in meaningful ways. For example, if we were to ask students to consider whether a new high school should be built at the base of a volcano, we might expect that students would draw on what they know about volcanoes or what they know about urban planning, depending on their past experience. Furthermore, we would expect that a graduate student in geology would have a very different view of the problem from that of a ninth-grade physical science student. However, both students could have meaningful learning experiences centered on this problem.

The first set of principles also highlight the need for the learner to develop strategies for monitoring his thinking and reasoning processes. That is, learners need to develop a variety of approaches for learning, such as different problem-solving and research strategies, as well as the ability to self-assess. In an LCE, it is the learner's responsibility to engage in this reflection.

Finally, the first set of principles states that learning is not an isolated task. Learning takes place in a context characterized by the tools available to the learner. A key similarity among all learner-centered environments is the creation of a culture of learning, that is, the creation of a place where students feel safe in trying new ideas, researching new topics, and asking difficult questions. LCEs are not punitive—they allow students to explore the world around them without fear of disapproval or ridicule from the teacher or peers.

The second set of principles highlights affective factors that influence learning. All three principles assert that motivation is critical to learning and that motivation is tied to emotions, beliefs, goals, and habits of thinking. A student's own definition of his abilities has tremendous impact on that student's ability to be a successful learner. In general, curiosity has a positive effect on learning, as does performance-focusing levels of anxiety, such as the anxiety related to trying something for the first time. However, high levels of stress, panic, or worry lead to lower levels of performance. Because of this, the LCE must encourage exploration and provide appropriate learning opportunities to a wide range of students. For example, in a math classroom a student who struggles with the concept of angles can explore angles using exploration software to rotate the angles and see their properties. At the same time, another student in the class who understands the concept of angles better may use the same tool to explore what happens when two angles are put together in different ways. Both students are exploring mathematics to make it personally meaningful, yet each is doing something slightly different.

Tightly tied to the notion that emotions matter is the notion that intrinsic motivation—a natural valuing of learning rather than a valuing because of an external prize or reward—is critical to learning. In fact, some research has indicated that extrinsic motivation (such as giving extra credit or computer time) can lead to a diminished intrinsic motivation because students begin to lose their natural curiosity when they begin to expect that they will be rewarded in some other way for their efforts. One of the keys to effectively using and promoting intrinsic motivation is to provide students with activities that are challenging, but not perceived as impossible, and to try to appeal to learner interests and/or allow the learners some control over what they learn.

The final motivation principle reminds us that motivation is directly linked to the amount of effort students put into their learning. Perseverance is critical to learning, particularly in open-ended or ambiguous situations. The next principle states that learners will learn best when they are in situations that are developmentally appropriate. Learners must be adequately challenged to maintain motivation while not becoming overwhelmed by the size or complexity of the learning task. A learner’s developmental readiness may be affected by a number of factors, including the student’s environment and the social support network.

The learner-centered principles also point out that learning is a social activity. We learn by communicating with other people. Because we construct understanding from experience, interacting with more people ensures having more experiences to draw from in developing understanding. Furthermore, by discussing hypotheses about how things work, learners are confronted with difficult questions that push their thinking farther than they would have been able to go alone. The learner is pushed farther by having to explain and support a position and by being challenged by views that do not match his own. This is a particularly promising area for technology use. Projects such as CSILE (Hewitt and Scardamalia 1998; Scardamalia et al. 1989) are supporting the development of tools that help students collectively formulate hypotheses, test them, and discuss the results with their peers and with others worldwide. By using these kinds of tools, the paths that were taken to achieve acceptable outcomes can be more readily seen and reflected upon by the learners. Finally, social settings allow learners to be the teacher. In a collaborative setting, there are times when each group member is the “expert” on a particular aspect of the learning.

The final principle deals with standards and assessment. It states that educators should set high and challenging standards for our students’ performance.

Assessments should include standardized measures, self-assessments, and performance assessments to provide the most support to the learner. Furthermore, in LCEs, assessment should occur not only at the end of a project or unit but also throughout. This will allow students to learn and recover from their mistakes.

The Learner-Centered Classroom

The learner-centered classroom is one in which students are actively engaged in inquiry-based projects. Often the students are doing a variety of different things simultaneously. For example, one group of students might be meeting to discuss a hypothesis they have about the project they are working on, while across the room another group of students is using the Internet to communicate with an expert in the area they are studying. Meanwhile, the teacher is actively moving around to support the students as they work. The teacher's role is that of coach and facilitator. She has four primary goals in her interaction with the students: facilitation of the students' solving their problem; promoting an environment of inquiry and collaboration through the modeling of questioning and listening skills; pushing the students in their understanding by asking higher-level questions about what they think and why; and ongoing assessment of the students' learning at all levels through the same questioning techniques. A true LCE will promote a student's construction of knowledge regardless of the subject matter. This occurs when teachers and curriculum developers ensure that the learning goals are relevant to students and can be related to their prior experiences. This can be achieved by asking questions that promote deeper understanding, providing lectures that explicitly help a group of students see certain connections, providing multiple experiences that allow development of understanding of a key concept, and working individually with students who are having problems making connections. Some of the tools that can be used to support these efforts include software allowing graphical representation of abstract concepts (e.g., using a graphing calculator program to show students a difficult calculus problem or using a physics simulation to explain how gravity and friction work with each other); communications tools that allow learning to extend beyond the boundaries of the physical classroom (e.g., e-mailing a scientist or having a keypal class in another country); and physical manipulatives that can help students use tactile methods to develop their understanding of abstract concepts (e.g., using blocks to teach subtraction).

Preparing Teachers

A critical success factor for developing LCEs is the development of the necessary skills teachers need to create an LCE. In the learner-centered classroom, teachers are required to teach in new ways. Their role is designer of experiences and questioning, not deliverer of information. They must focus on helping students develop strategies to make sense of the world around them rather than providing students with rules and truths to apply in different situations. Teachers must promote connections of previous ideas and ensure accurate interpretations and interconnection among understandings rather than focusing on discrete packets of subject matter. They must learn to use questions, demonstrations, lectures, simulations, and assessment as tools to support student learning, leaving behind more traditional notions of how teaching should look.

With all of these requirements, teachers must have a learning experience that immerses them in this kind of learning. Within the professional development community, there is a move toward creating a learner-centered approach to professional development. The National Partnership for Excellence and Accountability in Teaching (NPEAT) provides one of the best descriptions of learner-centered professional development in *Revisioning Professional Development.* According to NPEAT (2000), teachers should build a community of learners among themselves, work together to solve problems, become engaged in learning through reflection on their own efforts, and become avid researchers in search of solutions to their problems. In essence, teachers should treat teaching in the same way they expect students to treat learning. This requires a rethinking of what it means to teach and what it means to be a teacher.

Professional development has traditionally been offered to teachers in the form of workshops on interesting and timely topics. Teachers, even in our current culture of change, are regularly offered opportunities to learn certain software (such as a spreadsheet program), a particular teaching strategy (such as cooperative learning), or a particular approach to curriculum (such as a workshop helping teachers adopt a new textbook). However, these can be very segmented and disconnected from the classroom and the students. Learner-centered professional development happens in the schools and in the classrooms of the teachers and must be ongoing.

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See also

Constructivism; CSILE/Knowledge Forum

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Learning Circles

A Learning Circle (www.iearn.org/circles) is a group of six to ten classes of students who interact electronically to accomplish a shared goal. Each classroom in a Learning Circle contributes a project and participates in the projects of others to create a shared product—a circle publication. The networked interactive process begins with exchanging information and proceeds to proposing a project. Students then exchange work on one another's projects. The final task of each Learning Circle is for the group of schools to publish a booklet summarizing the projects or collecting their writings. This ends the Learning Circle and, if the teachers and students continue, it will be in a new Learning Circle.

The rationale for this model of network learning is based on constructivist theories of education (Piaget 1952), social theories of cognition (Bransford, Brown, and Cocking 1999), and shifts in nature of work in our society (SCANS 1991). The model of the teacher as the primary source of content or discipline information is changing to a model where the teacher establishes a setting for student construction of meaning using local and distant resources and experts. In Learning Circles, students trade investigative, research, and creative skills to complete a number of projects that are organized around a theme. Students learn how to observe, integrate, communicate their own ideas, and work with others to construct shared understandings of their world. This program of cross-classroom collaboration embeds learning in a social context that extends beyond the classroom and represents a departure from the traditional structure of teaching and learning.

Learning Circle teachers join a circle with a specific theme that defines the type of projects or activities that each class will sponsor for partners. For example, one class of students in a Places and Perspectives Learning Circle asked students to adopt the role of local historian, discovering and sharing information about the formation of their communities. Another classroom requested biographies of local heroes. Another popular project is to request plans for a three-day historical tour of their city. In Computer Chronicles Learning Circles, students express feelings about themselves, their world, and world issues. For examples, groups of students have requested opinions and news articles on issues like whale hunting, trash disposal, rain forests, racial, cultural, and gang violence, and the drug trade. Mind Works Learning Circle projects have a creative flair, like the one in which students ask peers to create everyday math problems that revealed cultural patterns or geographic conditions. Students designed math problems about ice fishing, skateboarding, ferry crossings, and planting cornfields. In some cases teachers create the themes for a particular session. For example, in 2000 we had millennium themes.

Participation in the early design of “computer pal” projects (Levin et al. 1984) as well as international theme projects (Levin et al. 1987) provided the context for the development of the Learning Circle as a way to organize international project-based collaborative learning (Riel 1992). The goal was to create a design that solved the puzzle of how to integrate international collaboration on projects with curriculum constraints of students and teachers working with widely differing curriculums. By making it possible for each school to control and direct one of the Learning Circle projects, and by structuring the project response work in concurrent small groups, it is possible to maximize project work related to the curriculum.

Learning Circles provide a structure—a team of teachers and students from classrooms located throughout the world—and a process—a sequence of phases—to promote international project-based learning embedded, at least in part, within the curriculum of each classroom.

The Structure

Learning Circles bring together six to ten classrooms, each of which is located in a unique location and with its own regional and cultural worldview. Currently Learning Circles are offered worldwide through the iEARN network (*www.iEARN.org*/circles); throughout South Africa, Jamaica, Ghana, Zimbabwe, and the Netherlands through a project called Global Teenagers (www.iicd.org/globalteenager); and in Spanish (Círculos de Aprendizaje; www.redescolar.ilce.edu.mx/redescolar/proyectos/circulos_aprendizaje). Classrooms are matched together on the basis of a curricular theme selected by the teacher to ensure grade-level compatibility and geographic diversity. Students from large urban settings have worked with students from remote rural areas. Students with a wide range of educational, physical, and social abilities have interacted with one another, ignoring educational labels, tracks, and small differences in age. The term “Learning Circles” invokes two metaphors—one for the role of the student (“Circle Time”) and one for the role of the teacher (“Quality Circles”).

Circle Time describes a period of the day when young students sit in a circle on a rug to share information about themselves, their families, or their ideas and experiences. In Learning Circles, older students use computer messages to share information with a circle of distant peers on projects requesting information about themselves, their school, their community, and their world.

Quality Circles is a description of participatory management arrangements in industry. Quality Circles are groups of workers who provide management plans for their work. Similarly, in Learning Circles teachers from distant classrooms form a resource team for working with all of their students. The collective knowledge of a small group of teachers from around the world on a given theme is an impressive resource for facilitating student learning.

Learning Circles represent a unique model for distant learning. It is not a single expert working with a number of distant students. It is instead a collaborative effort of teachers and students who respect the fact that knowledge is distributed; by sharing local expertise and worldviews from people located throughout the world, the way we think is changed in very important ways.

The Process

Learning Circles extend the practice of group investigation from within classrooms to across classrooms. Learning Circle interaction takes place over several months and is organized around the following sequence of phases:

1. *Forming the Learning Circle (weeks 1–2):* Teachers select a Learning Circle theme and are grouped with six to ten other classes at the elementary, middle, or high school levels. The teachers and students meet electronically, exchanging introductions electronically and through welcome packets prepared by students and sent though regular mail. The introductory tasks are organized to help students and teachers learn more about the schools and communities of their partners. They also provide a wealth of information about geography, time zones, climate, industry, current events, and life patterns that can be used to extend the classroom curriculum.
2. *Project planning by classrooms (weeks 3–4):* Teachers and students from each of the classrooms plan one of the Circle projects. They offer their plan to the Learning Circle for group comments. They, in turn, help shape the project plans of the other classes (student/teacher teams).
3. *Exchanging student work on projects (weeks 5–10):* Students work closely with students in their own classroom as well as the students in distant locations to carry out their learning activities. Students receive the guidance and encouragement of teachers in other locations and from one of the experienced Learning Circle teachers who volunteers

to be the facilitator. The mutual interdependence of teamwork is an effective way to motivate student work.

4. *Creating the publication (weeks 11–13):* Each classroom in the Learning Circle collects, analyzes, and arranges any materials that were exchanged on the project sponsored by their classroom. This report is combined with reports from the other classrooms and assembled into the collective Learning Circle publication documenting the teamwork that took place in the Learning Circle.
5. *Closing the Circle: sharing and evaluating the publication (week 14):* Each class sends its final project reports or anthology (either by postal mail or in a final print format), and they are collected at each school and combined to complete the Learning Circle publication. Students reflect on the process as the circle closes.

A central feature of Learning Circles it that each school takes the responsibility to (1) create a project; (2) direct the student responses from the others schools; (3) monitor the progress of their partners in completing the task; and (4) integrate the responses into a final report or anthology. This work will take proportionately more time than responding to projects of other students. It can be structured to align with the curriculum. The Learning Circle Teacher Guide (available online at www.iearn.org/circles/lcguide for anyone who wants to use this structure to support cross-classroom collaboration) recommends the following considerations as teacher-student teams design their project:

1. Request information that is likely to show interesting cultural and regional variation. Projects take advantage of the diversity represented in the Learning Circle by having students investigate the characteristics of their own environment in relationship to those of others.
2. Request project information that is reasonable in scope and can be completed without a large investment of classroom time. With five to ten projects in a Learning Circle, distant teachers and a small group of students should be able to respond to one project across one or two class periods.
3. Use the sponsored project to extend the classroom curriculum. Learning Circle projects are more effective when they integrate project work with other learning activities that take place in the classroom.
4. Collect project information that is of interest to a wide audience of students, teachers, parents, and others who read the Circle publication. The publication summarizing the collected information is a unique and current document. The student viewpoint as well as the information itself can be of great interest to other students and adults in the community.

The obligation incurred for requesting intellectual resources from other classrooms is an agreement to send similar resources to the other classrooms. But this activity does not have to involve all of the students or be limited to only students. Teachers and students have elicited the help of many people beyond the classroom, including the principal, city planners, museum docents, parents, and even the mayor to respond to issues raised by students in other locations. Students can be formed into groups so that, within one or two class periods with some homework, students can respond to all of the projects in a Learning Circle. Teachers with extremely tight curriculum constraints have had students from other classes work on the Learning Circle with their students or elicited the help of after-school computer clubs to complete the requests for some projects.

Collaborative Investigations

The sequence of activities in a Learning Circle is similar to that of group investigation models of classroom learning but extend these procedures *across* classrooms. For example, successful organization of group learning within the classroom means involving the coordination of the students, the development of a task, and procedures for individual and group roles and responsibilities (Sharan and Hertz-Lazarowitz 1979). In this model, a teacher divides the class into small groups to form the teams and identifies a specific task. Student teams work together to plan and carry out the task or parts of a large task. While some diversity of perspectives exist within the classroom, the teacher increases this by sharing different information sources with the groups, which prepare a report to present to the class for discussion and evaluation. The teacher works with the individual teams, giving them directions, and the teams report back to the teacher and class as a whole. While people on the same team work closely together, there is often little cross-team interaction. In some models of cooperative learning, the teams compete with one another, but in most cases each team presents its work to the whole class.

Besides the obvious difference involved in having the teams located beyond the school, there are two important ways in which Learning Circle interaction differs from the group investigation within the classroom. One is in the role of the classroom teacher, and the other is in the interaction between teams.

In Learning Circles, the teacher and students form a single team. Teachers work closely with students to plan their activities. This causes a shift in the power relationship in the classroom. The teacher joins the class as a learner and problem-solver rather than as an organizer and expert. No single teacher has complete control over all the projects. Without advance knowledge of what students and teachers in other locations will contribute to the process, they, too, can enjoy the unexpected learning opportunities that evolve from projects from distant schools. As events unfold on the world stage, one group is sometimes placed in a spotlight, interpreting local events that have global significance. The teacher becomes a more experienced learner and can model for students the process of finding the information or learning about a new issue. The teacher’s motivation in learning new content or finding out more about an evolving news story from direct reports of students demonstrates the value adults place on learning.

The second difference concerns patterns of communication. Learning Circles encourage more communication *across* the teams (classrooms) than is commonly found in the cooperative learning model. Each classroom plans a project and assumes the responsibility of creating a final report or publication to share with the group. But to carry out the project, students request the help of other circle classes. In return for that help, they offer to help other classrooms with their projects. So while each class of students works as a team on the project they proposed, they are contributing work to the projects sponsored by the other class teams in the Learning Circle.

The structure of asynchronous communication on networks makes it possible for students to interact with a number of groups at the same time without creating the chaotic situation that would result if this were attempted in the classroom setting. Each of the projects in the Learning Circle represents the collective work of all and is summarized in a report by the classroom that sponsored the project. This framework creates cooperative work within a team in a way that is similar to the cooperative learning framework, but it also constructs cooperative working patterns *among* the teams.

The Learning Circle facilitator helps with group organization, but since each team (classroom) has a very skilled person (teacher) helping to organize its contribution, there is less of a need for the strong centralized control that often characterizes classroom programs. In this way, electronic networks provide a new way to organize cooperative learning *within* and *across* classrooms. It provides a tool that helps students *and* teachers work collaboratively with peers in distant locations.

Several different studies document increases in literacy skills (measured on standardized tests) for students who participated in Learning Circles (Riel and Harasim 1994). Elementary, middle, and high school students, many of whom started below grade level in writing skills, reported increased confidence and skill as writers. These findings were consistent with findings for collaborative learning in the classroom (Slavin 1983).

The changes in teachers who participate in Learning Circles parallel the findings reported by other researchers for students in cooperative learning settings. Teachers, like students, acquire knowledge, learn new strategies from their peers, increase their confidence as an instructional leader, and develop social networks of people and resources for future use. For teachers, this form of communication makes it possible to be involved in collaborative teaching with other educators without having to leave the classroom or bring additional students into crowded spaces. The partnership in Learning Circles extends creative ideas, provides support for new challenges, and creates a vehicle for discussing school renewal strategies.

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See also

Computer-Supported Collaborative Learning; Constructivism; Knowledge-Building Environments

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Learning Objects

Learning objects are small chunks of learning or individual digital resources that provide a new way of thinking about learning content and delivery. Attempts to define this elusive concept have created controversy and vivid metaphors, ranging from LEGO building blocks to atoms to snacking. Learning objects promise to make the design and development of instructional material streamlined and cost-effective. They promise to make customized learning experiences available to every student. Once created and catalogued, learning objects are placed in a learning management system (LMS), and it is here that students engage with the material. However, the definitions and roles learning objects play in education continue to be controversial. To fulfill these promises of engaging and effective learning activities, learning objects must be portable, durable, reusable, and scalable. When they meet these criteria, learning objects play a key role in this shift of focus. They promise cost-effective development, high-quality materials customization of the actual material for each learner, and a competitive edge in distance learning market. But creating just-in-time and just-enough learning experiences for a diverse audience poses new challenges to education and the business world. “We are on the verge of being able to provide learning customized for each specific learner at a specific time, taking into account, their learning styles, experience, knowledge and learning goals” (Schatz 2000).

The first serious theoretical work on the idea of using assemblages of individual digital resources as the basis for instructional design was done by colleagues working on the TICCIT project at Brigham Young University when they developed the component display theory (CDT) in the early 1970s. By the early 1990s CDT evolved into instructional transaction theory, which utilized “knowledge objects” as the components of instruction. The term “learning objects” was popularized by Wayne Hodgins in 1994 when he named a CEdMa working group LALO (Learning Architectures and Learning Objects). A formal, foundational definition emerged in 2000 from the Learning Technology Standards Committee. “Learning objects are defined here as any entity, digital or non-digital, which can be used, reused or referenced during technology-supported learning” (LOM 1999). This definition was quickly challenged as being too broad to be of significance by David Wiley, a key scholar in the learning objects debate. He proposed a briefer definition (any digital resource that can be used to support learning) and insisted that the discussion must include instructional design theory with its focus on how these objects would be integrated.

Ongoing attempts to define learning objects are both imaginative and informative. A metaphor found frequently in popular literature compared learning objects with LEGO blocks. The colorful, familiar child’s toy succeeds because it is portable, durable, and sharable. An imaginative child can assemble diverse structures with LEGO blocks.

As the metaphor was applied to learning objects, they were seen as exhibiting the same characteristics: digital “bits” could easily be combined into a larger learning unit and shared across computer platforms and course management systems. An imaginative child could do it, suggests the metaphor. Wiley insists that the comparison implies many things about the design and development of quality education that are simply not true. Though any child may be able to create a colorful structure from LEGO blocks, not just anyone can quickly assemble a quality learning experience by cobbling together bits of this and that. He proposed the more sophisticated metaphor of the atom, believing that it honors the true complexity of developing quality instructional experiences.

It is because learning objects are generally understood to be digital resources that the focus of early learning objects research and development has been on maximizing reusability. Nondigital resources are "rival resources" that can be used by only one person at a time; that is, prospective consumers must compete for access or purchase multiple instances of the resource. Digital resources available on a computer network can be utilized simultaneously by many people and thus are considered nonrival resources. For example, if one person has checked a book out from the library, another person cannot use it—but they can both use the digital resources available on a website simultaneously. Much of the excitement around learning objects is due to the fact that learning objects are nonrival resources.

When combined, the nonrival nature of learning objects and their reusability in different learning scenarios make for educational resources that can be used in different learning environments by different individuals at the same time. This realization has led some to believe that learning objects can be the foundation of massive adaptive instructional systems capable of delivering individually tailored learning opportunities to large groups of people at the same time. For this same reason several universities and corporations have turned to learning objects as an economical solution to their online distance education programs. And though learning objects certainly provide the content foundation of such a system, creating appropriate learning architectures and intelligent systems capable of performing the desired individualization remains a challenge.

The creators of two digital collections of learning materials have designed imaginative techniques to create custom paths or journeys through complex, nonlinear subjects. As a result, two new metaphors emerged with the introduction of these collections. The first is the Harvey Project, an open access, worldwide collaboration in the fields of physiology, medicine, and related disciplines (www.harveyproject.org). Beyond simply collecting rich content, the Harvey Project creators designed a "beads and string" tool as a mechanism for allowing individual instructors to create a custom learning experience for the student. The instructor strings together learning objects with a clear scope and sequence, which can be followed in a nonlinear fashion by the individual learner. The navigational panel has a dropdown menu that allows nonlinear access to related learning objects.

Fathom, a commercial consortium effort that includes the British Library, British Museum, Columbia University, RAND, and the University of Chicago, among others, assembled a broad collection of online learning materials. The architects of Fathom designed the "trail" as a mechanism to assist the online learner in navigating the nonlinear wealth of their collection. A trail allows the learner to gather and then navigate the material efficiently.

In both instances, the learner's path through the material is facilitated by an organizing mechanism. The learning objects are presented in a structured, intuitive way that honors the learner's individual needs. The Harvey Project is open-access and discipline-specific. Fathom is a commercial educational enterprise. Both use databases populated with high-quality learning objects.

Businesses with a global reach and thousands of employees began an early investigation of learning objects, seeing in the concept of modularity an effective way to streamline training costs and keep employee knowledge up to date. From these investigations, several new variants of the learning object concept emerged. In 1998, Cisco launched an initiative to control the costs of its global training system. A Cisco white paper ("Reusable Learning Object Strategy") defines the field clearly for global businesses with steep training costs. The company's motivation was cost control: "Training departments were among the first groups to understand how reusable chunks of content could increase efficiency in course development and delivery, thereby reducing costs" (Cisco 1998). Its work is important because Cisco outlined a content development and delivery system that could impact higher education as institutions moved into the distance learning market. As businesses began to create corporate universities, another metaphor emerged, that of "snacking," which suggests on-demand learning. As defined by John Cone, vice president of Dell University, on-demand refers to a learning event, defined as one five- to ten-minute event that takes place within ten minutes of recognizing the need. The necessary information is provided: just-in-time, just-enough, just-for-you. In order to use learning objects, they must be stored so they can be located, sequenced, and delivered to the student.

Learning objects can more efficiently provide this customized, learner-driven content if the information is available within a learning management system. Such systems use powerful databases to profile learners first to determine such factors as learning style and previous knowledge. A sophisticated LMS will then offer the student units of learning, instructional modules, or courses that integrate well with previous knowledge. Embedded assessments will track the student's progress and facilitate later reentry into the learning material. The learner won't have to repeat four modules to get to the desired module five. In order for learning objects to function this way and to succeed in impacting education, these systems must meet the four criteria that have marked the commercial success of LEGO: portability, durability, reusability, and scalability.

- *Portability:* Learning objects work across computer platforms and across LMS products from various vendors.

  Durability: The learning object is stable and available over time, unlike many web resources that change and vanish unpredictably.

  Reusability: Cost savings are achieved when a costly but effective item is able to be reused in multiple contexts. To be used in many contexts, a learning object must be accurately tagged so that it can be located quickly and aggregated with other learning objects. The smaller a learning object is, the more often it can be used, but tagging small or granular learning objects is costly. So designers of systems and institutions wishing to break courses down into reusable chunks face a trade-off.

  Scalability: For learning organizations to take advantage of digital resources located across a global network, the digital repositories must be intelligently connected via internationally accepted standards. The issue of hosting and making available vast amounts of digital resources must be determined in such a way that small local learning-objects initiatives can become part of the worldwide learning environment.

The acceptance of learning objects as a key component of instructional design and delivery in the information age raises questions. Certain technical issues must be resolved before learning objects can impact education in the way their promoters envision. These issues include:

- *Quality assurance* for each learning object
- *Tagging* of learning objects to achieve efficient and effective searches
- *Portability* of learning objects across computer platforms and course management systems
- *Hosting* for determining who or what institution or government will host and/or store all these resources
- *Intellectual copyright* and compensation for individual or institutional creators

Furthermore, because many learning objects are nontextual (e.g., digitized slides, animations, video clips), locating learning objects within a digital library can be a daunting task without the help of metadata. Metadata are resource descriptors used to index a resource for later discovery, such as the resource's author, title, and date of publication. This information is similar to that used to catalog books in a library. By any measure, more resources have been expended in the creation of a standard set of learning object metadata descriptors than have been spent developing instructional theories around learning objects.

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See also

Component Display Theory; Just-in-Time Training; Self-Regulated Learning; Web-Based Instruction

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Learning Styles

Learning styles are the diverse ways in which people take in, process, and understand information. Educational technologies increase an instructor's ability to design and implement teaching strategies that address a variety of learning styles. Researchers often distinguish between visual, auditory, and tactile-kinesthetic learners. Visual learners learn best by seeing and respond well to illustrations and diagrams; students considered auditory learners prefer listening and favor lectures and discussion, while tactile-kinesthetic learners, stimulated by movement and touch, thrive in active exploration of a topic or situation (Felder 1993). Web-based technologies facilitate the use of multimedia; they help move learning beyond a primarily text-based and linear arena into the cyclical world of sights, sounds, creativity, and interactivity. Computer-mediated communications tools such as e-mail, discussion boards, and virtual chat provide opportunities for interaction collaboration and discussion both inside and outside of the classroom. Teachers, freed from the constraints of time and place, use technology to develop and deliver individualized instruction to a variety of learners (Kahn 1997). A number of online resources are available to help students and instructors identify their preferred learning and teaching styles; these include inventories, assessments, and questionnaires.

A more complex theory concerning the diverse ways people learn is Howard Gardner's theory of multiple intelligences (MIS). Gardner distinguishes between learning styles and MI, suggesting "an intelligence entails the ability to solve problems or fashion products that are of consequence in a particular cultural setting or community" (Gardner 1993, 15). He approaches MI from a biological perspective, believing each person has a different intellectual composition made up of the following intelligences: verbal-linguistic (speaking, writing, and reading), mathematical-logical (reasoning skills), musical, visual-spatial, bodily-kinesthetic, interpersonal, intrapersonal, naturalist, and existential (Gardner 2000). Humans possess all the intelligences in varying amounts and may utilize each one separately or jointly depending upon the learning situation (Gardner 1993).

Gardner (1993) recommends designing instruction and assessment that address the wide range of intellect present in the classroom. Often traditional instruction is geared toward verbal-linguistic and mathematical-logical intelligence, with instructors and designers failing to take into account the presence of other intelligences. Educational technology provides the platform upon which numerous instructional approaches can be developed and delivered in a timely and cost-effective manner. Table 1 identifies the attributes of each intelligence and provides examples of appropriate online teaching strategies to be used in an educational setting.

Examples of evaluation that remain sensitive to individual differences include portfolio development, journaling, and other types of reflective assessment (Gardner 1993).

Personality inventories and temperament sorters provide another dimension to the discussion on learning styles. The most widely used personality type indicator is the Myers-Briggs Type Indicator (MBTI), developed during World War II. A variety of academic disciplines and professional fields rely on results of the MBTI to provide direction on the development of collaborative learning and group activities. The Keirsey temperament sorter is another popular model of learning and has categories that correspond to the four pairs of MBTI preferences (Fairhurst and Fairhurst 1995).

Jennifer Gramling

Table 1: Attributes of Intelligence Leveraged by Online Technologies

Intelligence	**Description**	**Example of Online Teaching Strategy**
Verbal-linguistic	Preference for reading, writing, and speaking	Web-based research, computer-mediated communication
Mathematical-logical	Aptitude for numbers, reasoning skills	Problem solving, data analysis
Musical	Ability to produce and appreciate pitch, rhythms; learns well through song	Music and composition software, multimedia
Visual-spatial	Visual and spatial stimulation; learners enjoy charts, maps, and puzzles	Web-based presentations, object and document analysis, 3-D modeling
Bodily-kinesthetic	Good sense of balance and hand-eye coordination; handles objects skillfully	Virtual reality, interactive simulations, whiteboard
Interpersonal	Ability to detect and respond to moods and motivations of others; tries to see things from another's point of view	Collaborative learning, WebQuests
Intrapersonal	Uses self-reflection to remain aware of one's inner feelings	Online journaling, reflective assessment
Naturalist	Enjoyment of outdoors; ability to detect subtle differences in meaning	WebQuests, case studies, virtual field trips
Existential	Capacity to handle profound questions about existence	Computer-mediated communication, online journaling, authentic learning

Source: Created by the author

See also

Computer-Mediated Communication; Learner-Centered Environment; Multiple Intelligences; WebQuests

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LEGO/Logo

LEGO/Logo brings together the world of building blocks called LEGOs and the world of Logo programming into a single learning environment. The LEGO building blocks of today include not only the LEGO blocks of blue, red, yellow, and black but also the LEGO gears, motors, and sensors. When the LEGO building blocks are connected to the computer programming ability of Logo, a powerful problem-solving tool for children emerges. LEGO/Logo promotes the use of the computer as a tool for the development of critical thinking and problem-solving skills.

The use of computers to help students learn to think critically and solve problems originates from Seymour Papert, who in 1964 joined the Massachusetts Institute of Technology (MIT) to study the general theory of intelligence and how to make machines think. By 1967 Papert and a team of researchers had created the first version of the computer programming language Logo to support his study of artificial intelligence. Papert presented his idea in 1971 at a symposium at MIT called "Teaching Children Thinking." Papert proposed the use of computers by students to teach and in turn learn by teaching. This idea would lay the foundation for a lengthy partnership between MIT and Papert and the establishment of the MIT Artificial Intelligence Laboratory by Seymour Papert and Marvin Minsky. However, this very unorthodox idea would incubate for fifteen years, awaiting the arrival of the personal computer (Negroponte 1995).

Papert's idea for the development of Logo was greatly influenced by Jean Piaget's model of children as builders of their own knowledge. Papert noted that children seemed to be innately gifted learners who knew many things before they ever went to school. Based on this observation, Papert developed two fundamental ideas about computers as tools for thinking and learning. First, computers can be designed so that learning to communicate with them is a natural process. Second, learning to communicate with a computer can change the way other learning takes place. When children see the computer as a communications device in which verbal discourse is used to learn a subject such as math, children learn the subject as a living language. The technological aspects of the computer and the social processes of verbal communication interact in the construction of ideas, thinking, and learning (Papert 1980).

Papert asserts that children and teachers are often passive users of computers that ask questions, drill and practice the user, and move through the process at a predetermined pace. Both teachers and children feel inferior in their ability to use the computer as though the computer were “smarter.” With the development of the programming language Logo, a new, nonthreatening learning environment was created. In this environment the student becomes the teacher of the computer and creates a set of instructions in which the student must understand the knowledge to be taught to the computer, develop a set of instructions for the computer to follow, construct a program in which the tasks are carried out in the correct order, and evaluate the results of the program executed by the computer. Logo enables children and teachers to take control of the computer and actively engage in their own problem-solving activities (Burns and Cook 1986).

Papert’s work with Logo and the learning theories and educational strategies associated with Logo and the LEGO building blocks are commonly seen as constructivist in nature and state that knowledge is not given by the teacher to the student but is actively constructed in the mind of the learner. “Children don’t get ideas; they make ideas” (Kafai and Resnick 1996, 1). The theory of constructivism suggests that learners must be actively engaged with the development of artifacts, whether the artifact is the development of an essay or building a robot. Children continue to construct and reconstruct knowledge as the world changes around them. Although considered radical in the early 1980s, constructivism is widely accepted in today’s educational arena. The use of LEGO building blocks in combination with Logo programming in the classroom promotes the use of constructivist practice.

To continue their research concerning constructivism and Logo, Nicholas Negroponte and Papert conducted experiments in Dakar, Senegal, in which the Logo language and the Apple Computer were used to explore how children learn. While computers were foreign to their culture, the Senegalese children, like American children, enthusiastically embraced their use. Whether a child was more likely to be a visual, kinesthetic, or auditory learner, Logo allowed all children to flourish in the constructivist environment. From his research in Senegal and later in economically depressed regions in the United States, Papert has shown that the social context in which Logo operates is not culturally biased and could support thinking, learning, and problem-solving within a variety of cultures (Negroponte 1995).

Philosophically, Logo was designed to place the power of the computer in the hands of the user. In Logo, a few very simple commands can be learned quickly, thereby allowing the student or teacher to begin to use the computer quickly. Designed from the sophisticated artificial intelligence programming language, Logo allows the user to take simple words and numbers to complete complicated tasks. Logo is considered a procedural language in which instructions are placed together in groups called procedures. Whenever the computer is given the procedure name, the steps found within the procedure are executed. This allows the computer to store many procedures in its memory for execution and for multiple tasks to be completed at one time.

Logo is often said to employ the use of turtle graphics. The Logo turtle originally began as a dome-shaped robot that could be placed on the floor. It had a pen placed on its underside that would draw on paper placed on the floor as it was given instructions from the computer. Eventually the abilities and movements of the robot, now called a turtle due to its shape, were translated to the computer. Using a triangle (also called the turtle) in the center of the computer screen and commands typed on the keyboard, a series of lines and shapes could be drawn on the computer screen.

Increased use of Logo paralleled the development of the personal computer. A pilot project sponsored by MIT and Texas Instruments with the Lamplighter School in Dallas, Texas, in 1980 placed some of the first personal computers and Logo software into the hands of classroom teachers and students. A similar project at the New York Academy of School of Sciences and Community School Districts 2, 3, and 9 in New York City, along with the Lamplighter School, created a research base for Papert and his colleagues at MIT. Teachers were provided training in the implementation of Logo in their classrooms in both projects. The use of Logo continues in these schools today, and the Logo used in both projects advanced the development of the various versions of Terrapin Logo for Apple, IBM, and Texas Instruments computers. Logo Computer Systems Inc. (LCSI) was formed as the result of the research and innovation in the Lamplighter and New York Academy of School of Sciences schools. Seymour Papert remains the chairman of LCSI today. It was also during this period that Papert wrote *Mindstorms*, which inspired teachers around the world to examine the intellectual and creative potential of Logo in the classroom. Logo was translated to more than a dozen languages and implemented in Japan, Europe, South America, and Australia as well as the United States (Logo Foundation 2000).

LogoWriter, the next version of Logo, was introduced in 1990. LogoWriter contained word processing, multiple turtles, and a more intuitive interface. The LogoWriter turtles used newly developed “sprite” programming. Sprite programming allows for independent animated shapes or images at many points on the computer screen. A single turtle or multiple turtles are now able to change into different shapes, are animated, and move independently of each other rather than maintaining one shape during program execution. The integration of word processing into the Logo software encouraged the development of integrated math, science, and language arts lessons within the schools. LogoWriter became very popular for a short period of time. LogoWriter was developed specifically for the

Apple Computer; as DOS-based machines began to dominate the marketplace and schools, LogoWriter lost popularity (Logo Foundation 2000).

In 1993 LCSI introduced MicroWorlds in response to a new interest in Logo worldwide. MicroWorlds added drawing tools, a shape editor, and the ability to write music. MicroWorlds was seen as a way to encourage students to develop their own simulations, games, and multimedia projects. This new version of Logo supported multitasking and parallel processing, often demanded by teachers and students programming in Logo. Although multitasking was already available in Logo, MicroWorlds made it far easier for students. This same processing system is used in the current LEGO Dacta Control Lab (Logo Foundation 2000).

In the mid-1980s MIT researcher Michael Resnick spearheaded the development of a device that united Logo and the LEGO building blocks used by children. Resnick developed a control box that allowed the structures built with LEGOs to be attached to the computer by a series of wires. These wires carried a version of Logo instructions programmed on a computer to the LEGO motors and sensors. This allows the LEGO structure to move. This box became known as the LEGO Dacta Control Lab Interface. The development of the LEGO Dacta Control Lab Interface completed the marriage of LEGO and Logo and is the version of LEGO/Logo seen in many schools today.

With LEGO/Logo, students can create their own inventions by applying concepts of science, mathematics, design, programming, and engineering. Students learn to program using Logo to build robotic machines and devices using specially designed LEGO bricks. Students can build theories, design and develop robotic devices such as a Martian rover or robotic arm, and program these devices through the LEGO/Logo software. Students using LEGO/Logo internalize an understanding of concepts such as simple machines, compound machines, acceleration, friction, and their interaction in the real world. LEGO/Logo use also allows students to gain problem-solving, project-planning, and management skills. Problem-solving and discovery learning are encouraged when building hypotheses, designing and developing devices, and programming the software when using the LEGO/Logo materials. These student-designed inventions are then attached to the Control Lab Interface through a series of wires and manipulated through programming code entered by the student at a computer. When using the Control Lab Interface, the student-designed invention remains tethered to the computer, which does limit the ability of the device to travel any great distance. The software is available in Macintosh and PC versions for home and school.

Recently added to the LEGO/Logo learning strategies is the RCX brick under the official name of LEGO Mindstorms. The LEGO Mindstorms brick is similar to the programmable brick technology developed by researchers at MIT but uses software developed by LEGO to operate the RCX brick. The LEGO Mindstorms RCX brick allows students to create programs that are embedded in the brick. The brick and attached sensors move independently of the computer. The LEGO Mindstorms RCX brick contains a microprocessor inside. With the help of infrared technology, the computer transmits code to the brick to be carried out by the microprocessor within the brick. Students can produce robot-design activities and data-gathering experiments for use away from the computer. Released in 1998, the product is typically sold under the name LEGO Mindstorms in the public market at toy stores and is Windows-based. The school version of Mindstorms is called RoboLab and may be purchased for the Macintosh and PC platforms. Both are based on ubiquitous computing and visual representation of the programming language Logo.

LEGO/Logo Dacta Control and RoboLab instructional kits are tools that can be used to enhance the problem-solving skills of students. LEGO/Logo and RoboLab support successful design environments and learning environments. The materials provided in the LEGO bricks, Logo software, and RoboLab RCX brick provide outstanding design environments for students from several viewpoints. First, the students are placed in control of their learning environment by creating their own designs and experiments. Second, the LEGO/Logo materials offer multiple paths for learning, allowing students to design from their own life experiences. Finally, the use of the LEGO/Logo encourages a sense of community in which students work as teams, share information and design tips, critique each other’s designs, and learn from one another. Students acquire a sense of how real designers work on solving design problems. The creation of meaningful designs suggests that students are more likely to explore, and to make deeper connections to, the scientific concepts that underlie the activities. This idea is at the core of Papert’s theory of constructionism (Papert 1980; Resnick et al. 1988).

To encourage creativity in a wider audience, several museums have developed displays using the new MyBot microcomputer and LEGO building bricks to encourage problem-solving activities by children visiting the museum. MyBot, introduced by the Children’s Museum in Boston, contains a microcomputer and light and motion sensors that respond to a child’s actions.

MyBot supports the creative learning process in which children are encouraged to use playtime to build things, try out new ideas, and revise their approach. This philosophy of learning has been widely supported by teachers of preschoolers and elementary grades for years. This is a shift that reflects the recent understanding within the toy industry of how play helps children to learn (Lindsay 2000).

Worldwide use of Logo continues in various formats to this day. In Costa Rica the Ministry of Public Education and IBM Latin America have placed Logo in the hands of 50 percent of schoolchildren and have conducted extensive training with teachers. Latin America and Japan continue to increase the use of Logo within their school systems. In England, Logo is a required part of the national curriculum, and loyalty to Logo remains strong in Europe.

Today's home computer readily supplies the needed computational base for children to teach and to learn via LEGO/Logo. Learning by doing through simulations in the computer environment is becoming the norm. Children can build robots that simulate the devices used by the lunar and Mars rovers. Input devices attached to the computer can be used to gather information about the world in which these children live, allowing the abstract concepts of the world to become meaningful. Exemplifying Papert's views on constructivism, children can use LEGO/Logo programming and sensor devices to build a new environment for learning and explore the world in which they live. As in the past, LEGO/Logo continues to stimulate the critical thinking and problem-solving skills of children and prepare them for the future.

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See also

Constructivism; Papert, Seymour

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M

Mathematics and Technology (K-12 Education)

Technology used in the mathematics classroom can take many forms, whether it be calculator, spreadsheet, dynamic geometry software, statistical software, computer algebra systems, data collection probes, or interactive websites. These technology tools can enhance and extend the learning of mathematics for all students from kindergarten through college. In *Principles and Standards of School Mathematics* the National Council of Teachers of Mathematics (NCTM) identified the "Technology Principle" as one of six necessary principles for high-quality mathematics education. This principle states: "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM 2000, 24).

Technology makes accessible the study of mathematics topics that were previously impractical. Not only can technology help students process large computations and routine procedures quickly; it also provides the students with multiple representations of mathematical phenomena and allows students to organize and analyze large sets of real-world data. Elementary school students can investigate and conjecture properties of quadrilaterals using dynamic geometry software. By removing the computational constraints, topics such as recursion and regression have been introduced into middle school and high school curricula. These and many other mathematical topics were inaccessible to students before the use of technology. "As some skills that were once considered essential are rendered less necessary by technological tools, students can be asked to work at higher levels of generalization or abstraction" (NCTM 2000, 26).

Technology also enables students to explore mathematics topics in more depth and in more interactive ways. Technology “blurs some of the artificial separations among some topics in algebra, geometry and data analysis by allowing students to use ideas from one area of mathematics to better understand another area of mathematics” (NCTM 2000, 26). Many school mathematics topics can be used to model and resolve situations arising in the physical, biological, environmental, social, and managerial sciences. Many mathematics topics can be connected to the arts and humanities as well. Appropriate use of technology can facilitate such applications by providing ready access to real data and information by making the inclusion of mathematics topics useful for applications more practical (e.g., regression and recursion), as well as by making it easier for teachers and students to bring together multiple representations of mathematics topics. Technology also supports students to be more actively involved in mathematical learning. Writing a computer- or calculator-based program to compute a particular formula encourages the student to fully understand the underlying mathematics involved. Instead of being given a set of experiment results to analyze, technology provides a means for students to conduct simulations (e.g., tossing a coin) much more quickly. Collecting real-world data using probes bridges the gap between mathematics and a laboratory science classroom, fully engaging students in the learning process.

The use of technology in mathematics teaching is not for the purpose of teaching *about* technology but for the purpose of enhancing mathematics teaching and learning with technology. There is widespread agreement that mathematics teachers, not technological tools, are the key change agents to bringing about reform in mathematics teaching with technology (Kaput 1992; NCTM 2000). Yet preparing teachers to use technology appropriately is a complex task for teacher educators (Mergendoller 1994). The adoption of technology by teachers requires professional development that focuses on both conceptual and pedagogical issues, ongoing support in terms of “intensive start-up assistance and regular follow-up activities,” and a desire to change from within the profession (Waits and Demana 2000, 53). In addition, studies of teachers’ implementation of educational technology document that at least three to five years are needed for teachers to become competent and confident in teaching with technology (Dwyer, Ringstaff, and Sandholtz 1991; Means and Olson 1994).

There are many forms of technology used in a mathematics classroom. Some of the more commonly used technologies are listed below, with a brief description about each:

1. *Graphing calculators* by Texas Instruments, Casio, Hewlett Packard, and Sharp. These calculators have capabilities to input a function in algebraic notation, and the calculator provides additional representations

of the function in graphical and numerical (tabular) forms. In addition, most graphing calculators have advanced statistical functions to compute and graph a line of best fit through a particular set of data. Other features include financial mathematics applications, programming capabilities, and a random number generator.

2. *Spreadsheets* by Microsoft Excel, Lotus 1–2–3, ClarisWorks, and Corel Quattro Pro. Spreadsheets are computer applications that provide an easy way to sort, organize, analyze, and graph data. They, too, can compute the line of best fit through a set of data. Spreadsheets can also be made into interactive environments for students to simulate mathematical concepts, such as probability experiments and projectile motion.
3. *Dynamic geometry software* by the Geometer's Sketchpad, Cabri Geometry, and ShapeMakers. This software allows the user to draw geometric objects and explore mathematical properties by distorting size or shape while all mathematical relationships are preserved (e.g., parallel lines, midpoint, angle bisector, etc.). Taking an inductive approach to geometry, dynamic geometry software encourages students to discover and make conjectures based on their sketches before attempting mathematical proofs.
4. *Statistical software* by Fathom, SPSS, and add-ins for Microsoft Excel. This software allows the user to explore data-driven investigations in mathematics and statistics. Easily importing real-world data sets makes statistics more relevant and engaging to the students. Using Fathom, students can construct mathematical models using sliders as parameters. As students manipulate the sliders, everything in their document that depends on the value of the slider updates dynamically.
5. *Computer algebra systems* by Maple, Mathematica, and Derive. These programs efficiently perform most of the symbolic manipulation that was the focus of traditional high school mathematics programs. They also have the unique capability to display three-dimensional graphs. No longer should the study of algebra be limited to simple, contrived situations in which symbolic manipulation is relatively straightforward.
6. *Data collection probes* like Calculator-Based Laboratory and Calculator-Based Ranger by Texas Instruments and Venier Sensors. These additions to a graphing calculator or a personal digital assistant (the handheld devices known as PDAs) provide an easy way to collect real-world data. The different probes measure an array of environmental conditions over a given amount of time such as motion, temperature, light, pH, sound, force, and voltage. The measurements are collected and directly put into a designated statistical list of the

graphing calculator or PDA. Students then can use statistical features of the calculator or PDA to further study and analyze the data.

7. *Interactive websites* like NCTM Illuminations (illuminations.nctm.org/) and ExploreMath (www.exploremath.com). On these websites, users will find dynamic multimedia activities to be played on the web. Each site houses a large array of activities, and unlike computer software packages these activities address one or two specific mathematics concepts (e.g., fractions, parabolas, and complex numbers in polar form). These activities allow students to change certain parameters of the mathematical phenomenon, observe the immediate changes, and make mathematical conjectures based on the results.

Suzanne R. Harper

See also

Curriculum Integration; Mindtools; Probeware; Technology in K-12 Schools

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Message Design

Message design is an application of communication theory that explains the optimal relationship of a message's parts, details, composition, patterns, plan, and intentions, as well as the entire communication system, to ensure that the message sent by the source is effectively received. Traditional models of communication include the source, message, channel, interference (also called noise), and receiver. Although these models are often presented in a linear fashion, the communication process in reality is highly mutable and has no beginning or end. The communication process is irreversible, meaning that new communication efforts are the residue of previous interaction patterns, experiences, ideas, and feelings. These patterns, experiences, ideas, and feelings often function as a source of interference in the communication process.

Interference is noise between message source and message receipt. This noise affects a sender’s ability to predict how a receiver will receive and decode a message. Noise can stem from disjointed cognitions, attitudes, interests, beliefs, and motivations as they pertain to the source, message, channel, and/or receiver. For example, educational technologists who do not know how to craft an effective message for a specific technology (such as web delivery) or are not interested in how to do this will be more likely to create a message that includes extraneous details or is composed in a manner that is graphically confusing and difficult, thereby reducing the likelihood that the message will be received by the recipients as intended. As another example, recipients who are uncomfortable using the Internet (such as those with less experience) are less likely to successfully receive messages delivered through that channel. Their own discomfort and lack of knowledge about how to use the tool inhibits effortless use. The less experienced users are required to focus effort to overcome their lack of confidence and knowledge on how to use the medium—effort that should have been spent on the message itself and not the channel. The goal of message design is to reduce interference, thereby increasing the likelihood that the intended message will be received.

Message Design in Educational Technology

When planning instruction, educational technologists should consider that people respond more strongly to interpersonal communication than they do to mediated communication. However, humans respond most strongly to what some call “tangible communications.” Tangible communications refers to what producers often think are tangential or irrelevant messages delivered by the attributes of the communication. In other words, while we pay attention to what is said, we pay as much attention, if not more, to how something is said or who is saying it. Consequently, learners will respond to well-designed instruction better than poorly designed instruction regardless of the media, and learners will better attend to well-designed instructional messages than instructional messages that are poorly designed, some without regard to content.

Within the field of educational technology, message design is the process of manipulating, or planning for the manipulation of, a pattern of signs and symbols to provide the conditions for learning. Some theorists have distinguished between message design for instruction, which attends to those areas external to the learner, and message design for learning, which attends to strategies that activate internal controls that facilitate learning. For example, screen design (what information is included on a webpage and the layout) would fall under message design for instruction, whereas sequencing options (proceeding through instruction from beginning to end versus skipping around) and the amount of practice required would fall under message design for learning.

The physical aspects of message design typically include organizational strategies such as typographical cuing elements (e.g., the use of different fonts and font sizes) and directive cues or graphics (the use of arrows, bullets, and different colors), screen density (the amount of information on the screen), and the arrangement of information on one or more screens (structure, organization, and spaciousness). In addition to the physical attributes of the message, a variety of other message attributes affect the receiver during message selection, perception, comprehension, and recall, many of which are not under the control of the instructor or instructional designer.

Receiver exposure, attention, perception, and retention can vary greatly depending upon the persons involved, the nature and content of the message, the type of decision to be made, the circumstances, and the values that the learners and instructors believe to be relevant. Despite the many mutable variables that impact the intended recipient's ability to decode the message, there are certain guidelines that researchers suggest are important when designing messages that learners can inductively compose.

Selecting what content to include in the message can have an impact on whether a message is attended to, comprehended, and later recalled. Researchers have found that consumer-oriented messages are more effective for gaining the attention of the recipient compared to producer-oriented messages. A consumer-oriented message is a message that demonstrates clear instrumental utility to the intended recipient. Messages are more likely to get the attention of the intended recipient when they come from someone similar to the recipient. When the content of the message is affective, then messages are more likely to get attention when they come from someone who is trustworthy. When the content of the message is cognitive, receivers are more likely to pay attention to the message when it comes from someone with perceived competence.

When the goal of communication extends beyond gaining attention to comprehension, then educational technologists need to be concerned with minimizing cognitive dissonance. The theory of cognitive dissonance is based on the principle that people prefer and understand cognitions or beliefs that are consistent with each other and with what they already know, believe, value, and do. Another strategy for increasing comprehension is frequency and repetition. It is suggested that repetition with variation is better that repetition without variation. In other words, learners comprehend more when an idea or concept is repeated often but with slight variation. So if someone wants to teach a group of learners about risk assessment concepts, varying the focus from threats to vulnerabilities to consequences helps convey the larger concept. Furthermore, for technology-mediated instruction, short, concentrated bursts are more effective than longer, less concentrated messages. This is partly a function of the physical organization of content mentioned earlier, as well as the nature and type of content included in the message.

A key principle of all of the processes, tools, and systems that comprise educational technology is learning, and learning requires communication. As information technology research and development continue to expand our technical capabilities of education, the role of message design in educational technology will become even more important if educational technology is to reach its potential and place in our educational systems.

Melissa J. Dark

See also

Analysis; Communication Theory; Human-Computer Interaction; Instructional Communications; Usability

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Mindtools

"Mindtools are computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher order learning" (Jonassen 2000, 9). Mindtools are a departure from traditional computer use such as drill and practice, tutorials, and other applications in which learners have little to no input into the process. Mindtools facilitate meaningful learning and critical thinking. Meaningful learning refers to learning that is active, constructive, intentional, authentic, and cooperative, and critical thinking refers to thinking that yields multiple solutions, encourages analysis, synthesis, and evaluation, presents complex situations, involves self-regulated learning, and fosters nonalgorithmic solutions. Mindtools are efficient for use in schools because they can be used across the curriculum and are typically less expensive than other applications. To be considered a Mindtool, a tool must be, among other things, computer-based, readily available, generalizable, affordable, and easily learned. David Jonassen, the pioneer of Mindtools, identifies five categories: (1) semantic organizational tools; (2) dynamic modeling tools; (3) interpretation tools; (4) knowledge construction tools; and (5) conversation tools.

Semantic Organizational Tools

Databases and concept mapping tools are included as Mindtools in this category. Databases are, in essence, electronic filing cabinets that enable information to be stored, organized, and retrieved. Concept mapping tools allow for visual representation of interrelated concepts and were designed to represent knowledge as structured in the human mind. Both encourage students to construct their own knowledge by visually organizing information in ways that make sense to them. Once this organization is complete, students can begin to make inferences, draw conclusions, solve problems, hypothesize, and engage in other higher-order thinking activities. One example Jonassen uses to illustrate the use of databases as a Mindtool involves elementary students creating a database of the countries they studied throughout a school year. Students created and organized the categories of information related to the social, political, and economic factors they would need to compare and contrast countries. Once the database was complete students were able to search it in a variety of ways and make connections that would have not been possible had each country been studied in isolation. Students made hypotheses about the relationships between economic indicators and literacy rates, income levels and educational levels, and populations and population densities, for example.

Dynamic Modeling Tools

Spreadsheets, expert systems, systems modeling, and microworlds are included as Mindtools in this category. Spreadsheets are electronic ledger systems with the ability to display, edit, and manipulate data in a variety of ways, including graphical representations of numeric data. Expert systems are programs designed to simulate the reasoning of experts via artificial intelligence. Systems models are computer-based models that show causal relationships among components in a system. Microworlds are exploratory learning environments that students can control via a programming language called Logo. Each application helps students represent dynamic, causal relationships and construct simulations to model such relationships. One example of a dynamic modeling tool given by Jonassen involves a simulation of a fish tank. Within this simulation students can manipulate variables including the type of fish, water temperature, type of food, amount of food, amount of water, and frequency of cleaning. Students are able to hypothesize the relationship among such variables in a system and are able to more easily grasp the interrelated nature of the variables within a system.

Interpretation Tools

Intentional information searching tools and visualization tools are included as Mindtools in this category. Intentional information searching tools refer to searching tools (web-based and others) used in a way that requires students to be intentional, self-regulated learners. Visualization tools enable students to visually interpret and express information, often making difficult concepts and abstract ideas more concrete through visual material. Both encourage students to locate and interpret information, to understand ideas and concepts, and to construct new knowledge based on what they have found and what they already know. One example given by Jonassen involves the use of visualization tools to help students understand the microscopic and complex atomic interactions involved in chemical bonding. Visualization tools enable students to go beyond the static diagrams in textbooks to view, measure, manipulate, and see multiple representations of these bonds.

Knowledge Construction Tools

All hypermedia applications, including desktop publishing programs, HTML editors, and multimedia development tools, are included as Mindtools in this category. Knowledge construction tools encourage students to construct something tangible that enables them to more thoroughly understand a concept or idea. Examples of this category include student-created kiosks that are used for authentic purposes, student-created presentations given to peers or community members, webpages designed to deliver multiple perspectives on an issue, and HyperCard stacks created in a nonlinear fashion to demonstrate scientific or mathematical concepts.

Conversation Tools

Synchronous and asynchronous conferencing tools are included as Mindtools in this category. Synchronous tools enable real-time communication and may include MOOs, Internet relay chat, videoconferencing, and shared whiteboards. Asynchronous tools enable communication regardless of time and place and may include newsgroups, listservs, discussion groups, and e-mail. These encourage students to construct knowledge within a social context and to learn from peers in a collaborative, dialogic fashion. Examples of this category include videoconferences with subject-matter experts, newsgroup discussions with students from another state or country, and e-mail communication with authors of books students are currently reading.

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See also

Constructivism; Curriculum Integration; Knowledge-Building Environments; Technology in K-12 Schools

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MOOs and MUDs

MOOs and MUDs are chat facilities that teachers use to engage students in collaborative, real-time online conversation. These environments employ synchronous communication, requiring participants to be online at the same time, and they can employ either local area networks (e.g., computer laboratories where only students within the classroom can participate) or wide area networks (such as the Internet). MUDs (multiuser dungeons) were created and thrived within a social context; they provided an online environment for role-playing games and other textually based interactions. A decade into the playfulness of MUDs, programmers began adding descriptions that vividly defined separate rooms within MUDs, innovated the online language to allow for actions and emotions, and programmed objects that could be created and shared by participants. Although the standard MUD featured dialogue only between participants, the MOO (MUD, object-oriented) allowed people to demonstrate emotions, show actions, create and employ functional items, and invest in the creation of a cyber-reality of the online world. MOOs employ all of the chat functionality of MUDs while investing deeply in the online environments themselves.

The principle guiding MOOs and MUDs is that the interaction is synchronous. Therefore, it is possible to consider any online chat utility a MUD—AOL's instant messaging utility, the chat feature of any educational software, text messaging via cellular telephones, or any other application that requires users to be together online and writing to each other within a common virtual space. Educators have been drawn to the immediacy of textual interaction that synchronous communication provides, finding significant promise in the social learning that chat environments foster. As the history and educational theory of MOOs and MUDS suggest, the promise of synchronous environments lies in their inherently social nature.

History

The first MUD was built in 1979 by students Roy Trubshaw and Richard Bartle at Essex University in Colchester, England, as a textual environment for multiple users to play role-playing games online. For ten years, MUDs flourished on college campuses for gaming and socializing over the Internet. In 1989, inspired by the social interaction MUDs offered, James

Aspen, a graduate student at Carnegie-Mellon University, created TinyMUD, a simple application that served as a MUD client. This made it easier for participants to meet and chat and give personal metaphors to the online space outside of the role-playing games previously associated with MUDs. From that point, internet-based synchronous conferencing evolved as social environments and, eventually, as learning environments (Haynes and Holmevik 1998).

Importantly, the social came before the educational. Trent Batson’s (1988) articulation of electronic networks for interaction sparked teachers’ curiosity for bringing students into casual, social chat environments to collaborate. Synchronous conferencing was an invigorating possibility for teachers not because it was designed for educational use but because its use necessarily implied collaborative knowledge-making for those who participated in it. Synchronous messaging allowed multiple voices to be represented equally and concurrently, and educators adopted it in the context of social constructionist theories of learning (Hawisher 1992). In the same year of TinyMUD’s birth, a group of graduate students at Texas Tech University, led by Fred Kemp, developed the Daedalus Integrated Writing Environment (DIWE), a classroom software package that combined e-mail, word processing, question-and-answer, and its most talked-about and used feature, Interchange. This synchronous conferencing feature stood out so much from among the other features that teachers often took DIWE and Interchange to be the same thing; by the early 1990s the Daedalus group began including special articles in its biannual journal *Wings* on the importance of using the other features along with Interchange. By the mid-1990s, nearly every commercial courseware environment followed DIWE’s integration of a synchronous conferencing utility. For educational classroom software, synchronous conferencing was becoming an increasingly essential feature.

In early 1990 Berkeley student Stephen White expanded upon TinyMUD’s abilities to demonstrate descriptions of rooms and began creating objects to inhabit those rooms. This object-oriented MUD, which White called “Alpha Test MOO,” was significant for providing environment inhabitants the ability to create a sense of place by creating objects and rooms. By the end of that year, White handed the project over to Pavel Curtis at the Xerox Palo Alto Research Center, who developed the first and most populated MOO—LambdaMOO (Curtis 1998). Though LambdaMOO was a purely social environment, educators began building educational MOOs within a year: Amy Bruckman, as a graduate student at MIT, built MediaMOO for research into educational MOO use in 1992; the Weizmann Institute of Science constructed BioMOO in 1993 as a distance-bridging tool for international professionals in biology; and Jeanne MacWhorter designed Diversity University, a place for cross-curricular learning online (Haynes and Holmevik 1998).

Educational Theory

Teachers and scholars who talk and write about the use of MOOs and MUDs in the classroom attest to a kind of democracy that the synchronous online conference brings. For example, teachers often say that students who seldom or never speak in face-to-face settings seem to actively participate online. Being online *forces* students to contribute to discussion (having a presence there necessitates language production, since language is the only thing that exists online) and makes it *inviting* to contribute. Because so many more students actively participate within online sessions, much more discourse and interchange happens (as a process), and more learning is documented on the transcript of the discussion (the product). Teachers within synchronous online environments agree that the environment supports greater levels of student participation and higher amounts of discourse during classroom activities.

Part of the high levels of activity in the synchronous online classroom is certainly due to the fact that most students find the activity fun. The casual dialogue between people online creates an environment that is fertile for social interplay, and this playfulness can lead to productivity. The fun inherent in synchronous conferencing is at the heart of its success as a pedagogical tool. It is the “expanded social context” of synchronous conferencing, wherein students generate “a realm of active dialogue that supports the playful, creative expressions of the self,” Leslie Harris (1995) explains, that encourages students to feel “alive and powerful, and therefore highly motivated and highly creative.” This is the power of social interaction and the power of fun—motivating students to create language and knowledge, to interact, to intellectually spar, to converse productively. Teachers who appreciate fun between students within learning activities are usually those who appreciate what synchronous conferencing brings to the classroom; those who are not comfortable with some silliness during class are often the ones who find online classroom sessions unproductive.

Synchronous communication’s reliance on language-based social interaction between participants immediately points toward theories of the social construction of knowledge supported by theorists such as Mikhail Bakhtin (1929), who explains that language exists in and only in social contexts. And nowhere can language and knowledge more clearly be seen as a product of social interactivity than in the MOO and MUD, where the directions of conversations, the rules and conventions of speaking, and entire notions of reality are in continual question and revision, dependent upon what participants decide to do and say online. When teachers bring classroom activities online, they provide a learning environment that is fertile for students’ conversations to literally create the knowledge shared among them.

The enhanced collaborative nature of synchronous online conferencing equates to a new form of democracy between students, teachers, and tutors.

Eric Crump (1998) proposes that teachers who attempt to concoct a peer relationship with students in the traditional classroom do so artificially. The teacher has an obvious and omnipresent hierarchical status above the student, and therefore, in Crump's terms, "community" cannot truly exist. He suggests that speaking online creates an environment that welcomes collegiality among links in the hierarchical chain and that the environment rejects bureaucracy.

The impact of an explicitly collaborative approach to social construction can be demonstrated by review of Juli Burk's (1998) critique. Burk, a feminist and theater scholar, argues that the original gaming MUDs, which devised a narrative structure and imposed upon its players a theme, purpose, and identity online, shared with Aristotle's notion of the theater (and Shakespeare's manifestation of the theater) a tendency to subjectify women (who ultimately serve as a metaphor for students) as "players." These forums tended to position a "hero involved in a quest that demands an obstacle inevitably identified as feminine" (Burk 1998, 233). The feminine was made a goal, an end, but never a voice or driving force of the narrative. Ultimately, through the "narrative itself, women are coerced into consenting to the patriarchal definition of femininity that upholds its oppressive power relations." However, Burk claims that as MUDs moved away from set themes and narratives and social MOOs began offering individuals the ability to create their own voices and build the online space itself, the environment allowed the feminine to break from an idle, played-upon/preyed-upon role to a self-determining one. Burk claims that "MOO-dependent elements . . . represent new possibilities for the feminist subject: constructing gender identifications, a multiplicity of subject positions, and an opportunity for agency on the part of the audience" (Burk 1998, 247).

Importantly, this democratized learning environment puts the control and authority of knowledge creation in the hands or words of students and out of the hands of a central authority figure (the teacher). All participants become at once teachers and learners, informants and informed—provider, receptor, and collaborator on a body of knowledge being evolved through deliberative conversation. Add to this the literal building capabilities that MOOs allow. Standard MUDs appear as little more than computer windows in which many participants are able to post messages, sometimes allowing participants to manipulate the color, size, and font face of their text, other times allowing nonstandard characters, like expressive facial characters (emoticons). But MOOs are structured around actual geography, consisting of rooms that feature detailed descriptions (sometimes including graphics and multimedia), objects that can be manipulated and used, exits and entrances, furniture, and a limitless number of characters. Furthermore, MOOs allow participants not only to speak but also to “emote” and develop personality through implied actions, gestures, feelings, and thoughts.

Juli Burk suggests a similar function of the MOO’s features, drawing an extended comparison between online participants’ ability to create their personae by describing and developing “character objects,” and dramatic performers’ tendencies to “develop their characters.” Burk postulates that the nature of creating a character on the MOO is similar to establishing a character onstage and that the freedom to do so is ultimately liberating for students. However, not all students actually *use* the extended features of the MOO while online, choosing to only chat with others; some students regularly interact with the environmental features; and others ignore the environment and simply talk. Some studies (English 1998, 1999) suggest that there is a distinct connection between interacting with the MOO environment and becoming confident and ultimately productive there. That is, as students employ objects, use furniture, emote, and interact with the environmental features of the MOO, they begin to find a “grounding” there, they begin to feel at home and finally master the space. By establishing a comfortable relationship with the environment, students become more capable of engaging in productive work, learning from the interaction that happens online, and leading fruitful discussions.

Interface Innovation

More than twenty years after the first MUDs were developed, more than 500 Internet-based MUDs are open to the public (Turkle 1995); there are nearly 100 educational MOOs and MUDs (Galin 1998). Nearly every college and university owns and supports software that features synchronous conferencing. Contemporary MOOs feature not only text but also complex imaging and web-browsing built into the interface, offering vivid pictures and multimedia for representation of rooms, objects, and characters. For example, the EnCore Xpress MOO interface employs a web-based interface, allowing characters, rooms, objects, and features to employ multimedia components—graphics, sound, and video. When logging on to LinguaMOO, the first MOO that employed EnCore Xpress, users are offered a graphical representation of the entire MOO.

The user types messages in a small window and views all discussion directly above. When a student clicks on a person, object, room direction, or one of the navigational buttons, a multimedia representation of the appropriate response results.

The MOO interface developed by TappedIn, a nonprofit organization dedicated to helping educational professionals develop online projects, communities, and conferences, divides the screen into several sections for discussion, navigation, and environment interaction.

When logged into this interface, users can click on the top row of buttons to access web-based information about TappedIn events and help information, and the second row offers information about rooms, characters, and objects within the MOO itself. The large graphical window (labeled “you are here”) displays the room the user is in, and the objects within that graphic are linked to the objects themselves; clicking on an object will display the object and its features, and clicking an exit will take the user to the new location. The window to the right allows users to view the people within the current room and the objects there. The bottom half of the screen is dedicated to textual conversation. Incorporating graphics, linking, and multimedia into the MOO interface allows students to envision the learning metaphors within the environment.

Innovations in MOO and MUD interfaces continue to allow students to become more confident and comfortable online. And in turn, confidence allows students to excel within the social online environment.

Joel A. English

See also

Computer-Mediated Communication; Cyberculture and Related Studies; Simulation and Gaming; Virtual Reality

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Multimedia Educational Resource for Learning and Online Teaching (MERLOT)

MERLOT is an international cooperative for high-quality online resources to improve learning and teaching in higher education. The cooperative connects higher education systems, consortia, individual institutions of higher education, professional organizations of academic disciplines, and individuals to form a community of people who strive to enrich the teaching and learning experience. MERLOT is a free web-based resource where faculty and students can easily find digital learning materials with evaluations and guidance for their use. MERLOT enables faculty to effectively and easily choose and use the best online learning materials for students, compatible with their own teaching methods and the learning goals of their academic program. Faculty, students, staff, and administrators are invited to join this cooperative endeavor and shape the educational resources to serve their needs.

The guiding vision of MERLOT is to be a premier online community where faculty, staff, and students from around the world share online learning materials and pedagogy. Its mission is to improve the effectiveness of teaching and learning by expanding the quantity and quality of peer-reviewed online learning materials that can be easily incorporated into faculty-designed courses.

MERLOT resources are delivered via an online catalog of thousands of web-based learning materials for a wide range of disciplines that are designed to be integrated into larger courses. MERLOT does not store the actual learning materials on its servers but simply provides the links and descriptions of the materials. The learning materials are organized by subject for easy browsing of the collection. Searching is available over a variety of dimensions, such as type of material (simulation, tutorial, reference, etc.). Most of the materials run inside a web browser. Each catalog record of learning material can also have links to sample student assignments for using the materials, peer reviews of the materials, and comments by members of the MERLOT community. These annotations provide users with the pedagogical context for choosing, evaluating, and integrating the online materials into teaching and learning. MERLOT also contains profiles of people who are the users and contributors of the materials within MERLOT. The member directory contains contact information, academic areas of expertise, and a portfolio of contributions to the MERLOT collection.

Almost all the information contained in MERLOT has been added by users of MERLOT. Users write the descriptions of the learning materials, learning assignments, comments, peer reviews, and member profiles following web-based forms. To contribute materials to the MERLOT collection, a user must become a MERLOT member, which is free and easy to do. MERLOT has also created discipline-based editorial boards whose responsibilities include expanding, organizing, reviewing, and generally managing the collection of learning materials and support resources. Each year, the MERLOT project plans to add editorial boards in new discipline areas.

To ensure that learning materials addressing significant theoretical or research issues are contextually accurate, pedagogically sound, and technically easy to use, MERLOT conducts a peer-review process. Materials must pass a preliminary review before they are selected for peer review. This process is modeled on the discipline-based peer review of scholarship and research. MERLOT's peer-review process also provides a mechanism for professional recognition of faculty developing and using instructional technology. MERLOT has a second and parallel review process that complements formal peer reviews. Individual MERLOT members can provide observations and evaluations on the learning materials within MERLOT.

Users do not have to be a member to use the MERLOT search engine. Finding good and relevant online teaching/learning materials is the first step in engaging a faculty's use of technology, and keeping the barriers as low as possible is a goal of MERLOT. Users have simple search and advanced search options as well as browsing by subject category through the collection. Simple searching is a free text search in selected fields in the material records (title, author, description, and subject). Advanced search enables users to select a wide variety of fields and conditions to limit their searches. Searches result in a listing of the materials in MERLOT, and the default ordering of the listing places items with the highest peer reviews at the top, followed by items with the highest user ratings.

MERLOT has created discipline community websites, which are subsets of the MERLOT collection focused on specific disciplines. Searching and browsing here returns results only within that discipline. These communities also represent the subject areas in which MERLOT editorial boards conduct peer reviews of materials. MERLOT has recently created special interest community websites such as MERLOT-CATS (Community for Academic Technology Staff) and MERLOT-TWO (Teaching Well Online). MERLOT-CATS focuses on sharing tools, methods, and expertise among academic computing support staff. Authors of online materials will find useful tools and techniques here as well. MERLOT-TWO is designed to aid faculty and faculty development professionals in planning for successfully using online resources in teaching and learning.

MERLOT represents a partnership of more than twenty systems and institutions of higher education. Each institutional partner provides MERLOT $25,000 per year and significant in-kind contributions to support faculty and staff collaborations. MERLOT also has campus members who provide $6,500 per year, and sustaining partners who provide $50,000 per year. California State University, which created MERLOT in 1997, continues its leadership of and responsibilities for the management, planning, and operation of MERLOT's processes and tools, in part supported by the yearly fees. MERLOT also develops alliances with professional societies and other digital libraries to work collaboratively on projects, grants, and outreach.

In addition to access to peer-reviewed online resources, MERLOT provides a variety of services to ensure its effective use. The annual MERLOT international conference provides many opportunities for professional development using academic technology in higher education. The MERLOT faculty development workshop provides institutional partners an intensive training program for staffs to learn how to implement MERLOT at their campuses. MERLOT also conducts a variety of planning and training meetings for its project directors' council, editors' council, and advisory board as it continuously shapes its future.

Gerard L. Hanley

See also

Learning Objects; OpenCourseWare; Web-Based Instruction

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Multiple Intelligences

The theory of multiple intelligences, developed by Howard Gardner in 1983, challenges the unitary view of intelligence that is based on the IQ test. Gardner’s theory claims that there is not one underlying mental capacity but rather a variety of intelligences. He defines intelligence as the “ability to solve problems or fashion products that are of consequence in a particular cultural setting or community” (Gardner 1993, 15). Gardner’s theory provides a guide for teachers and instructors at all levels to reach more types of students by exploring alternative teaching and assessment strategies that consider multiple intelligences. Educational technologies provide a variety of means to expand the horizons of traditional teaching and learning tools and to help teachers address multiple intelligences in instruction. According to Gardner, there are eight intelligences: (1) linguistic; (2) logical-mathematical; (3) visual-spatial; (4) bodily-kinesthetic; (5) musical; (6) interpersonal; (7) intrapersonal; and (8) naturalist.

Linguistic

Linguistic intelligence relates to a strong ability to read, write, and communicate with words and includes proficiency with phonics (speech sounds), syntax (grammar), semantics (meaning), and pragmatics (appropriate use of language in a variety of settings). Linguistic intelligence is highly valued in traditional school contexts. Those with strong proficiency in linguistic intelligence include poets, comedians, journalists, orators, and lawyers.

Educational technologies provide avenues to help those with linguistic difficulties. For example, students without the motor skills necessary to write or type can record their thoughts through the use of a speech synthesizer. Likewise, students who find the writing process laborious can more easily edit their work through the use of word processors. Other educational technologies such as multimedia development tools enable students to communicate in a variety of forms. For example, students can enhance a traditional report or presentation with images, charts, sound, and movies. These technologies expand communicative abilities and allow for the nonlinear presentation of thoughts and ideas.

Logical-Mathematical

This intelligence relates to a strong ability to reason and calculate, to think in a logical manner, and to understand abstract relationships. Logical-mathematical and linguistic intelligences are the most valued intelligences in traditional school contexts. Those with strong proficiency in logical-mathematical intelligence include computer programmers, financial analysts, engineers, accountants, and detectives.

Educational technologies such as spreadsheets and graphing calculators enable students to focus on concepts and to see mathematical relationships in graphical and numerical format. Computer programming, including Logo for young children, supports the development of logical thinking.

Visual-Spatial

Visual-spatial intelligence relates to a strong ability to perceive, transform, and modify visual and spatial information. It is often referred to as the ability to think with pictures. Those with strong proficiency in visual-spatial intelligence include architects, photographers, strategic planners, and sailors.

Three-dimensional models of structures, including buildings and molecules, help students with this intelligence understand complex concepts previously presented only in one-dimensional diagrams in textbooks. Such three-dimensional models also enable those with this intelligence to manipulate and build their own models. Likewise, higher-level multimedia development tools enable the creation of animated maps that show events like the paths of Civil War infantries or worldwide weather patterns. Oftentimes, these maps are located on the Internet, enabling teachers to bring them into the classroom as supplements to traditional text-based, lecture-based instruction.

Bodily-Kinesthetic

This intelligence relates to a strong ability to use the body to solve problems and to coordinate neural, muscular, and perceptual systems. Those with strong proficiency in bodily-kinesthetic intelligence include athletes, dancers, choreographers, surgeons, and builders.

Simulations, particularly virtual reality simulations, can be used to address this intelligence by providing a safe environment for practicing skills such as surgeries, frog dissections, and airplane flights. Other technologies such as digital video technologies can be used to help athletes, dancers, and others with bodily-kinesthetic intelligence perfect their skills by carefully analyzing each component from a variety of angles and in a variety of speeds.

Musical

Musical intelligence relates to a strong ability to communicate, create, and understand meaning from sound. It involves the ability to recognize pitch, keep rhythm, and recognize timbre, or sound quality. Those with strong proficiency in musical intelligence include musicians and composers.

Educational technologies, including sound synthesizers and MIDI devices, provide more capacity to create musical pieces than ever before. Likewise, the availability of music on the Internet enables teachers to bring in historical elements through music. For example, there is an entire website devoted to songs of the Civil War that teachers can easily integrate into a lesson.

Interpersonal

Interpersonal intelligence is often referred to as social intelligence and relates to a strong ability to work effectively with others, recognize and make distinctions among others' feelings, and display empathy and understanding. Those with strong proficiency in interpersonal intelligence include facilitators, therapists, counselors, and religious leaders.

Educational technologies such as newsgroups, listservs, discussion boards, and chat rooms enable students to communicate with a more diverse population and possibly enhance their interpersonal intelligence. Likewise, the creation of webpages enables students to share themselves and learn about others. Some simulation software programs also address this intelligence by focusing on ways to resolve conflicts among individuals and groups.

Intrapersonal

Intrapersonal intelligence relates to a strong ability to be self-reflective, distinguish among one's own feelings, assess one's accomplishments, and review one's behavior. Those with strong proficiency in intrapersonal intelligence include philosophers and novelists.

The Internet is full of journals and diaries of historic figures, political leaders, and ordinary people that students may study. Participation in some types of Internet-based discussions may also enable students to develop more intrapersonal intelligence.

Naturalist

This intelligence was later added to Gardner's original list of seven intelligences and relates to a strong ability to recognize flora and fauna, make distinctions among natural things, and make productive and useful decisions regarding natural processes and events. Those with strong proficiency in naturalistic intelligence include botanists, biologists, environmentalists, and farmers.

Internet-based resources provide a means for those with naturalistic intelligence to do extensive research, communicate with others in different geographical locations about common events, and share their findings on a large scale.

It is important to emphasize that these intelligences typically work in combination. For example, a dancer needs to have both bodily-kinesthetic and musical intelligence to be successful. Some may also need interpersonal skills if they dance in teams and intrapersonal skills if they interpret characters. The theory was designed to recognize multiple intelligences, not to suggest each intelligence is mutually exclusive from the others.

Kara Dawson

See also

Behaviorism; Cognitive Psychology; Constructivism; Learner-Centered Environment; Learning Styles

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N

Netiquette

Netiquette refers to the rules of online etiquette that guide users while working, communicating, and utilizing resources in an online environment. The purpose of netiquette is to help create procedures of civility in a virtual environment. It is important for technology users to understand the basic premise of netiquette. Failure to do so could result in unintended insults to others, miscommunication, or exclusion from online forums and activities. Netiquette is an excellent example of a new skill or concept that students will need in order to succeed in a world influenced strongly by the role of technology. These principles and guidelines should be discussed in school and modeled by teachers and school policy.

Most netiquette guidelines are based on commonsense principles and are similar to the etiquette in place in the real world. Other specific recommendations are unique to the virtual world. Examples of commonly found guidelines include:

1. Apply standard rules of politeness to the online world. It is important that common polite practices are applied to an individual's behavior online. It is important to always think before you type.
2. Refrain from sending, posting, or publishing offensive material. Aggressive outbursts or insults are known as "flames" and can carry as much hostility as the spoken word.
3. AVOID USING ALL CAPITAL LETTERS while corresponding via e-mail, in chat rooms, or within posting environments—it appears that you are yelling.
4.

When involved with a listserv, send information only to the account that is relevant to the majority of the members. If you have a need to personally converse with an individual, be sure to e-mail her directly.

5. Respect the privacy of other people. Try not to disseminate personal information without the knowledge and permission of the individual.
6. Be concise with e-mail messages. Try to create a message that conveys a point without an excessive amount of writing.
7. Utilize relevant subject lines in e-mail messages. It is important to give the recipient of your message an indicator of the content by supplying an accurate subject line with all e-mails. This procedure helps others to file messages appropriately and to manage their time more efficiently.
8. Keep your signature simple and informative. Signatures can be a valuable source of information. However, an unusually long signature can take away from the focus of the message and add unnecessary weight to the mail.
9. Refrain from sending spam, e-mail hoaxes, and chain letters. These forms of communication are annoying to the recipients and are a waste of time. In addition, the repetitive forwarding of e-mail addresses can lead to the unwanted dissemination of personal information.
10. Share ideas with new users in a friendly manner. If you encounter a new user who is in need of a few tips, share your netiquette wisdom in a neighborly manner.

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See also

Acceptable Use Policies; Cyberculture and Related Studies; Internet Safety

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O

Online Learning Communities

Online learning communities have many of the same characteristics as campus learning communities. Online learning communities, with no physical locations and boundaries, extend beyond campuses, regions, and countries. Online learning communities are virtual spaces where students can meet and aggregate to create a sense of community among isolated learners. In online learning communities, students can focus on learning tasks and work cooperatively and collaboratively on projects. During their interaction with peers, instructors, and experts from the field, students pose questions, test ideas and hypotheses, share and exchange experiences, and solve problems. Online learning communities differ from learning communities in that they are virtual and are created for the purpose of learning and teaching.

Members of an online learning community are connected through shared interests, beliefs, and activities. Members come from classes, degree programs, different universities, colleges, and organizations. They are linked via technology tools such as e-mail, asynchronous discussion or conferencing tools, synchronous chat programs, and video conferencing programs. Sometimes members are brought together via a learning environment supported mainly by course management systems. (See Figure 1.)

Physical Chemistry On-Line (PCOL), for example, is an online learning community dedicated to the study of physical chemistry. Members of the online learning community are from universities across the United States. PCOL provides online modules for use in the physical chemistry curriculum. These modules, usually ranging from four to six weeks, engage faculty

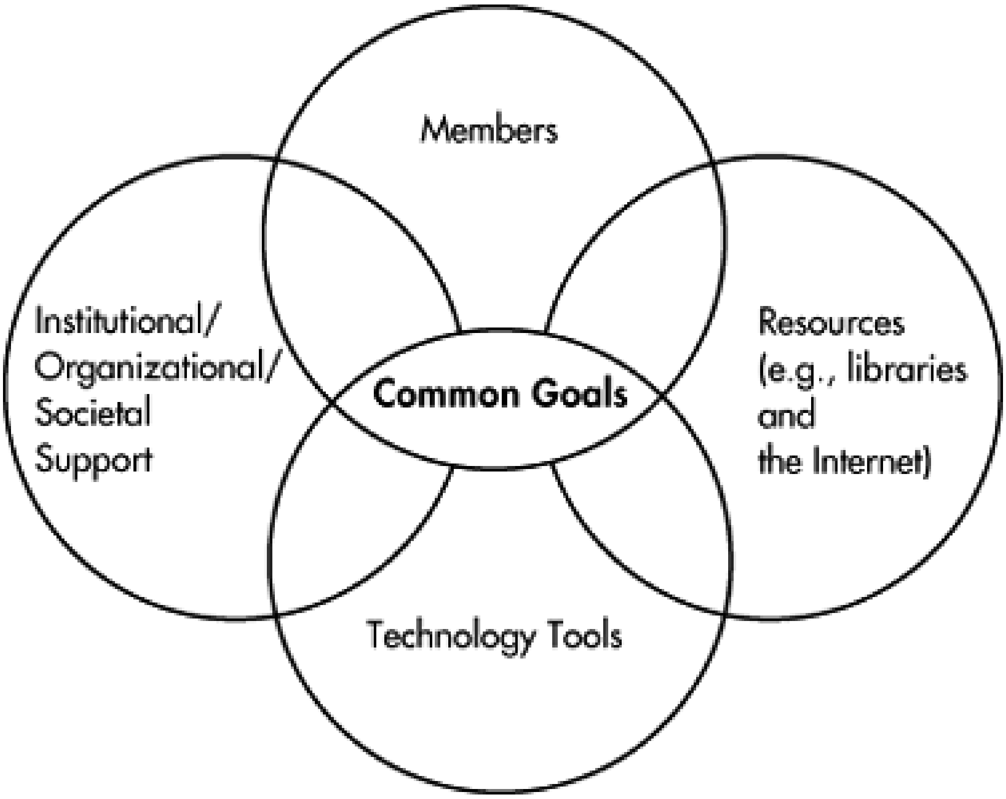

Figure 1:

Online Learning Community

Source: Created by the author.

and students from geographically dispersed institutions in collaborative teaching and learning activities. The learning modules focus on context-rich scenarios and require using e-mail, discussion boards, and the World Wide Web for communication and information distribution.

Online learning communities connect academic campuses and corporate, public, and private sectors. These communities encourage cognitive and social interaction among members. Three types of interaction usually occur in an online learning environment: with instructors (or experts), with content materials, and among learners.

Online learning communities develop in stages, which are characterized by varied levels of interaction among the members and varied types of activities (Salmon 2000). In the initial stage, members identify needs, common interests, and goals for their online community. In the socialization stage, members get acquainted. In the interaction stage, members share experiences, information, and resources, tackle problems collaboratively, and construct knowledge. To sustain an online learning community, it is important for members to recruit new members, to generate new collaborative tasks/projects, and to develop new issues for discussion. The stages highlight how the focus of an online learning community can vary across times and reflect a progression in the quality and intensity of interaction among members.

The relationship among members of an online learning community is dynamic. Roles of instructors and students emerge from interactive community activities and change according to learning needs. The environment of an online learning community provides an alternative method for organizing teaching and learning; roles of both instructors and students shift in various ways. In this context, teaching and learning become more student-centered. Instructors in online learning communities (see Collins and Berge 1996) are more likely to:

- Plan and structure the syllabus and learning materials while remaining flexible and sensitive to students' needs.
- Promote a student-centered learning environment by encouraging students to set their own objectives within the overall goals of a course and by introducing rich resources rather than enacting one-way delivery of prefixed instructional materials.
- Facilitate/mediate learning by engaging students in cooperative and collaborative tasks/projects via networked electronic technologies along with other media.
- Incorporate strategies for establishing a social presence online and building a sense of learning community.
- Play multiple roles suited to instructional needs (e.g., a guide/mentor/peer/learner).
- Embrace many roles in daily teaching practice—pedagogical, social, managerial, and technical.

The instructors actively engage in community activities, interact with students, assess understanding, and provide guidance for learning.

Students in online learning communities, as compared to isolated online students, are more likely to:

- Take a more active role in their learning.
- Become problem-solvers rather than just memorizers of facts.
- Utilize a variety of technologies in their learning.
- Engage in role-playing and gain skills in collaborative projects.
- Spend more time interacting with others online rather than sitting alone reading instructional materials and working on problem sets.

In addition, students decide what to learn, how to learn, how to participate in community activities, and how to interact with materials, instructors, and peers.

To ensure the effectiveness and success of an online learning community, it is useful for members to replicate what generally makes learning communities thrive (Rheingold 1993). In addition, the success or failure of an online learning community is associated with the quality of the social interaction and the extent to which members develop a sense of community. When evaluating an online learning community, it is essential to look at several dimensions (Goodsell Love and Tokuno 1999), which include student collaboration, faculty collaboration, and curriculum coordination. At the same time, it is important to consider the technical aspects of online learning. Guidelines for evaluating online learning communities include issues related to interaction, collaboration, resource sharing, pedagogy, and technology:

- *Student involvement:* How does the online learning community facilitate and foster student interaction and collaboration?
- *Faculty involvement:* How do faculty cooperate and collaborate on instructional materials, curriculum development, and strategies for teaching, learning, and evaluation?
- *Curricular coordination:* To what extent are courses integrated within a curriculum?
- *Resources:* How are resources shared by students, instructors, and other members of the online learning community?
- *Philosophy of teaching and learning:* To what extent do members of an online learning community believe in and engage in student-centered teaching and active learning?
- *Technology:* How do technology tools support interaction and collaborative learning and teaching activities without adding extra burdens to members of an online learning community?

Various methods are available for collecting data about these issues. Interviews, surveys, observation, learners' self-reports, and instructors' self-reports can provide data for assessing an online learning community. It is worth emphasizing that there is no single or simple way to evaluate an online learning community. For the evaluation to be reliable, valid, fair, and useful for further improvement of an online learning community, it is critical to think carefully about the purposes of evaluation, to examine various aspects of the online learning community, and to use a combination of data collection methods.

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See also

Collaboration and Negotiation Tool for Case-Based Instruction; Collaborative Technologies; Communities of Practice; Computer-Mediated Communication; Computer-Supported Collaborative Learning

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Open University

Open University in the United Kingdom is one of the largest distance education institutions in the world, utilizing the dimension of educational openness in its innovative structure. Since its founding in 1969 by the British prime minister Lord Harold Wilson, Open University has been a leader and a model for other distance education institutions. Its organizational structure, teaching methods, and approach to the instructional design of courses have proven successful over the years, and it is recognized as a prototype for distance learning institutions throughout the world. Established by royal charter, Open University admitted its first 25,000 students in 1971 and since then it has enrolled more than 2 million in its programs and degrees. Currently, Open University has more than 200,000 students, of which 140,000 are taking undergraduate-level courses and another 45,000 are registered for postgraduate degrees. Open University’s unique system and integrated combination of media and methods support open learning for adults and about 9,000 disabled adults with special needs.

The creation of Open University as a model of openness in education has presented a major challenge to the traditional organization of teaching and learning. Openness in relation to an educational mission is a process of learning that is unencumbered by barriers and suggests a continuum of access and opportunity. This dimension of openness has been used to democratize education and provide equal access and opportunities to those whom traditional ways of education and learning have been “closed by various barriers—entrance requirements, time constraints, financial demands, geographical distance, and much more subtly, social and cultural barriers, as well as those of gender” (Paul 1993, 115).

The founding vice chancellor of Open University, Walter Perry, points to three ideas that influenced the teaching methods and structure of Open University, sometimes referred to as the “University in the Air.” These three ideas were: the need for reform in part-time education available to adults; the growth of educational broadcasting; and the political attempts to increase egalitarianism in education (Perry 1977). Though some critics decry marketing of distance learning as a political act or the industrialization of education, some reply that the accessibility dimension in distance learning was prompted by social policies rooted in a spirit of educational egalitarianism, particularly at Open University. Open University created educational opportunities for a generation of people who, after World War II, had not undertaken any higher education or completed secondary schooling. The entrance policy and course structure were designed to enhance educational access to adults by removing barriers such as admission requirements and the constraints of place and time.

Since the 1960s, technology, such as broadcast TV and radio, has played a crucial role in the rapid development of distance education as Open University began offering courses to the public through broadcasting mediums. Teams of content specialists and instructional designers rigorously developed course programs, and the British Broadcasting Company (BBC) has been central to the success of the Open University. In 1993, for example, BBC transmitted nearly 550 Open University radio programs on Radio 3 and Radio 5. There were 1,542 Open University TV programs on BBC 2 (Open University 2002). The planning committee at Open University selected specially constructed teaching materials integrated with TV and radio broadcasts for instructional use. Students were assigned correspondence tutors and required to attend short residential summer schools with the opportunity to meet their counselor and other students (Perry 1976). Tutor-marked assignments provided a mechanism for individual feedback. Student guidance and support were provided through a comprehensive system of course materials and formats, including study guides, textbooks, audiotapes and videotapes, correspondence tutors, counselors, summer schools, and self-help groups. A key aspect of Open University’s support system for students is the use of regional and local support centers. Teaching and counseling support is provided by thousands of tutors and counselors through a network of more than 300 local centers and thirteen regional centers.

Open University uses a team approach to design and produce courses. This course team was a result of a vision to encourage interdisciplinary production of courses and research and to vest the nature, content, and teaching of each course in the university itself rather than individual departments. The team approach brought academics from a number of disciplines, providing the creation of multidisciplinary courses with expert knowledge suitable for the needs of adults working in isolation (Perry 1976).

Each course team consists of three groups of academics, educational technologists, and BBC production staff. The academics are responsible for the content, the educational technologists for advice on course design and materials development, and the BBC staff for production of the radio and TV programs (Perry 1976). The design of printed materials at Open University was unique and innovative; in fact, the University has originated a new form of educational publishing. Open University's use of educational technology, the course team approach, the regional staff, and part-time tutors were significant innovations and successful, which led many distance learning institutions to adopt Open University's form of educational publishing, teaching methods, and organizational structure.

In addition to teaching materials, Open University has made considerable effort to build activities and projects such as home experiment kits into courses. Open University encourages self-study and independent learning to ensure that students take control of their own learning. Using multiple approaches to learning and giving students a choice demonstrates that Open University founders and course teams recognize that students have varying learning needs and styles.

Since the late 1980s Open University has been transforming itself to utilize the potential of fast-growing information technologies for learning. The university experimented with its first computer conference in 1986, a pioneer effort for the time. Currently, about 160,000 students and their tutors utilize online technology for communication and teaching and learning activities. The university held its first virtual commencement in 2000 to confer degrees on twenty-four master's students from countries all over the world (Walker 2000).

Open University has broken traditional barriers to education by allowing any student to enroll regardless of previous educational background or experience. Most students are aged between twenty-five and forty-five, with roughly equal numbers of men and women; the median age for graduation is in the middle thirties. About three-quarters of students remain in full-time employment throughout their studies. Open University students represent 22 percent of all part-time higher education students at United Kingdom universities (Open University 2003).

Since 1992 Open University has been accepting undergraduate students from European Union countries. Open University also operates in partnerships with institutions in many parts of the world, making its teaching materials available in English and in translation. Open University has approximately 28,000 overseas students and 42,000 students in collaborative partnership teaching programs with institutions in Central and Eastern Europe, the Middle East, and the Far East.

Open University aims to have an international presence with alliances and partnerships throughout the world. In an effort to break into the U.S. distance education market, Britain's Open University opened a branch in the United States in 2000. However, the venture did not survive the expenditures and low enrollment numbers and announced its closing in two years (Michael 2002).

Selma Vonderwell

See also

Distance Education; Virtual Universities; Western Governors University

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OpenCourseWare

In 2001 the William and Flora Hewlett and Andrew W. Mellon foundations announced they would be funding MIT's OpenCourseWare initiative. The OpenCourseWare project's goals are to (1) provide free, searchable, coherent access to MIT's course materials for educators in the nonprofit sector, students, and individual learners around the world; and (2) create an efficient standards-based model that other universities may emulate to publish their own course materials (MIT 2002a).

The OpenCourseWare Frequently Asked Questions on the Creative commons website further states:

> The idea behind MIT OpenCourseWare (OCW) is to make MIT course materials that are used in the teaching of almost all undergraduate

> and graduate subjects available on the Web, free of charge, to any user anywhere in the world. MIT OCW will advance technology-enhanced education at MIT, and will serve as a model for university dissemination of knowledge in the Internet age. This venture continues the tradition at MIT, and in American higher education, of open dissemination of educational materials, philosophy, and modes of thought, and will help lead to fundamental changes in the way colleges and universities utilize the Web as a vehicle for education. (MIT 2002b)

The context and history of the OpenCourseWare project can be traced back to the 1983 announcement of the foundation of the GNU project housed within the MIT Artificial Intelligence Lab. The purpose of the GNU project was "to write a complete Unix-compatible software system called GNU (for Gnu's Not Unix), and give it away free to everyone who can use it" (Stallman 1983). Formation of the Free Software Foundation, a tax-exempt charity for free software development, followed in 1985 (FSF 1998). The idea of technology-facilitated sharing was coming of age.

When Linus Torvlads, then a student at the University of Helsinki, released the initial version of his Linux operating system in 1991, he licensed the software using the GNU General Public License. Although many people liked the basic idea of free software as espoused by Stallman, some thought his zeal was giving the movement a bad name. At a February 1998 strategy session, Eric Raymond and others created an alternative label, "open source software," that retained what they liked about free software and rejected some idealistic baggage (OSI 2002).

Later in 1998 the OpenContent project was launched and announced the first open content license, working on the premise that nonsoftware content—specifically educational content—should be developed and shared in a spirit similar to that of free and open software (OC 1998). The notion of free and open content quickly gained popularity. In 2000 Stallman announced the GNU Free Documentation License (Stallman 2000); in 2001 others announced the Creative Commons project (CC 2002); and by 2002 OpenCourseWare had come to MIT, returning to where the idea of technology-facilitated sharing had been pioneered twenty years earlier.

While intellectual property laws seem to be proliferating, peer-to-peer system users are illegally sharing proprietary content with each other, and secure digital content in the form of e-books is being hacked and compromised, OpenCourseWare offers an alternative view of the future of educational technology and the instructional content to be delivered thereby: a future in which less time, money, and energy are spent worrying about digital rights management and stopping pirates, and more time, money, and energy are spent getting students in touch with high-quality educational content. When empowered students begin to ask “Why are we paying $100 for a computer science textbook by some guy we never heard of when comparable resources are available from MIT for free?” all teaching and learning are bound to change.

David Wiley

See also

Courseware; Cyberculture and Related Studies; Web-Based Course Management Systems

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Open-Ended Learning Environment (OELE)

Open-ended learning environments enable and support exploration and experimentation; problem-solving, critical thinking, and multiple perspectives are essential processes in these environments (for a detailed description of OELEs, see Hannafin et al. 1994). OELEs are learner-centered; the instructor plays the role of facilitator and is not the focal point for learning. Individual experiences and contexts are emphasized as learners cultivate cognitive processes to support understanding. The development of strategies and processes are focal points for demonstrating understanding (Land and Hill 1997).

OELEs coordinate the application of a variety of tools and resources for use in addressing situated, authentic problems, and technology is often used as a mediator of the process, providing learners with electronic means to search vast databases of resources and manipulate variables and concepts (Hannafin, Hill, and Land 1997). Yet at their core OELEs support student-centered understanding—the learner is at the center of the environments both in terms of decisions for using the available resources and as the party with the primary responsibility for learning. As such, OELEs have relied heavily upon theoretical views from constructivists, who assert that understanding is best achieved when it is individually created or constructed by the learner. OELEs support learner-centered construction with opportunities to relate new knowledge to personal experiences from a problem-based, activity-intensive orientation. Technologically based tools and resources are used as means to support the constructive process.

OELEs provide interactive, complimentary activities that revolve around problem-based contexts and support individual sense-making processes. OELEs are comprised of several key characteristics that enable them to support divergent student needs and establish the conditions for enriching thinking (Hannafin et al. 1994). Several of these key characteristics include the following: (1) use of meaningful, complex contexts; (2) provision of tools and resources; (3) learner reflection and self-monitoring; and (4) social, material, or technological scaffolding.

Use of Meaningful, Complex Contexts

One common characteristic of OELEs is the use of broad, problem-based contexts that form the adhesive for all conceptual activity. Problem-based contexts serve three primary purposes: (1) to orient learners to the activity; (2) to provide a guide for applying what is known and evaluating what is not known; and (3) to assist learners in connecting formal concepts to everyday applications of them.

Scenarios, or cases, for instance, are often used to guide learners in exploring the complexities of a topic. Such contexts often focus on everyday problems (e.g., environmental pollution for studying chemistry concepts; swimming pools for studying buoyancy and water displacement; real patient cases for learning about radiology). Everyday problems are used to increase the likelihood that learners will readily identify how concepts can be *applied* in a given setting. Complex contexts are used as a way to assist learners in thinking about the content in ways that are consonant with a community of practice (e.g., chemists, physicists, nurses). OELEs strive to mirror the holistic thinking practices of experts within boundaries accessible to novice learners.

Complex contexts provide an anchor for making sense out of discrete pieces of information. Rather than memorize or learn content in absence from an applied context, information is learned as a result of *needing to know it* in order to solve the problem. Researchers at the Cognition and Technology Group at Vanderbilt (Hmelo, Gotterer, and Bransford 1997) describe problem-based approaches in medical schools (e.g., teaching learners to use hypothesis-driven approaches). Once hypotheses are generated, data are searched and selected that confirm, formalize, and/or refute the hypothesis. Consequently, new data or information becomes meaningful as its potential for *use* is evaluated in light of a driving context and hypothesis. OELEs use complex, meaningful contexts to assist learners in building formative theories and to then search for new information to confirm, elaborate, or refute the hypothesis.

Provision of Tools and Resources

OELEs use tools and resources to assist learners in accessing sources and perspectives related to the content under study. Often a range of resources is provided to serve as repositories of information (e.g., CD-ROMs, encyclopedias) that can be brought to bear to solve a particular problem. For instance, problem-based approaches for medical school training may incorporate databases of resources such as patient X-rays, disease diagnosis references, and patient histories. Students using a microworld (a simulation of a real-world context) on physics concepts may access resources about formal concepts such Newton’s laws, or a database of student perspectives regarding how the concepts manifest in everyday life (e.g., hitting a baseball, skiing downhill, slowing down in a car).

Environments can also be designed to facilitate the *construction* of resources by learners. For instance, leading researchers in student-centered design (Harel and Papert 1991) describe how students can learn about fractions by designing and constructing educational software for teaching younger children about fractions. The use of resources, or opportunities to construct resources, provides a rich environment for extending understanding.

Tools for constructing and manipulating understanding are used to promote learning that is more concrete and capable of being tested. Tools, such as spreadsheets and word processors, provide opportunities for user-centered activity. In learning environments, tools help learners to manipulate features and processes. Some tools, such as those found in simulations and microworlds, allow learners to manipulate concepts by varying parameters and/or physical models. For example, computerized tools can be used to select text for electronic notebooks, create hyperlinks between sources of information, and perform calculations.

Learner Reflection and Self-Monitoring

The student-centered learning process hinges upon the learner’s ability to monitor learning needs and to place into action planning and evaluation approaches. OELEs typically emphasize activities that induce and facilitate reflection on the learning process. For example, the CSILE environment (see Scardamalia et al. 1989) is designed to facilitate metacognitive thinking through the use of prompts to generate questions, hypotheses, or theories. By virtue of their design, OELEs require complex thinking skills and a variety of strategic and evaluative processes. For this reason, OELEs guide learners in using these techniques by embedding the reflective requirements of the activity into the environment itself.

OELEs often require the creation of end-products that make learner reasoning overt. It is not enough, for instance, for a learner to simply manipulate variables in a microworld or develop hypotheses without understanding *why* they are relevant. Instead, OELEs require learners to communicate what they have learned through the development of “artifacts” that reflect both the product of their understanding and/or the underlying argumentation. Project-based approaches, for instance, often revolve around the creation of learner-generated multimedia products. Thus a preservice teacher learning how to incorporate technology into the curriculum might develop an example lesson indicating how she would use technology in the classroom. Accompanying this product might also be documentation regarding how it solves an identified problem and how technology is an instrumental part of the solution. Consequently, reflective activity is supported through en-route as well as end-product requirements of the activity. En-route reflection is necessary for learners to ask driving questions, identify “needs to know,” and implement strategic plans during the open-ended learning process. End-product reflection is necessary to justify or argue what has been constructed.

Social, Material, or Technological Scaffolding

OELEs rely on the learner to direct the learning process, formulate goals, and interpret events within the environment. Social, material, or technological support is also provided to assist learners in the knowledge construction process. Many OELEs, for instance, utilize teacher-student and student-student interactions to model, or scaffold, reflection and performance. In such environments, teachers and students coach, model, and share strategies within a problem context. Such scaffolding emphasizes the sharing of sense-making processes and the progressive negotiation of meaning.

Technology is also used as a way of scaffolding performance. Technology-based environments often “provide models, opportunity for higher level thinking, and metacognitive guidance . . . in a learner’s zone of proximal development” (Salomon, Globerson, and Guterman 1989, 620). That is, technology is used in ways to support understanding that would be difficult, if not impossible, to support otherwise. For instance, visualization tools used in microworlds such as Geometer’s Sketchpad and Interactive Physics allow learners to construct models or objects and rotate and manipulate them in order to test their parameters. According to Salomon, technological tools can scaffold opportunities for learning by altering both the experiences available to learners and the cognitive requirements of the learning task.

Implications

Although the opportunities afforded by OELEs for enhancing learning are substantial, considerable challenges arise in their creation and implementation. OELEs come in many varieties (simplistic and focused; complicated and limitless) and can be manifested in several settings (face-to-face instruction, distance learning environments, computer-assisted instruction, etc.). Like most learning situations, well-designed and-developed OELEs have the ability to empower, liberate, and expand the orientations of participants. At the same time, OELEs are demanding and can be disorienting, even unsettling, for those engaged in such environments. The learners, as well as the instructor, are placed in roles not traditionally held in formal learning environments; furthermore, the processes associated with these environments (problem-solving, critical thinking, etc.) are ones that demand considerable work by all participants. As pointed out by Donald Norman (1988) in *The Psychology of Everyday Things*, designing and developing learning environments that empower the user, are intuitive and self-evident, and are inclusive in orientation is a formidable challenge. Yet we have evidence that these learner-centered environments are powerful ways to learn, making the creation and implementation of OELEs well worth the effort.

Janette R. Hill
Susan M. Land

See also

Active Learning; Computer-Supported Collaborative Learning; Constructivism; CSILE/Knowledge Forum®; Knowledge-Building Environments; Learner-Centered Environments

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Papert, Seymour (1928–)

Seymour Papert is the inventor of the Logo computer language, the first effort to facilitate complex thinking skills in young children through manipulation of computer-based technologies. He is also one of the early pioneers of artificial intelligence and is internationally recognized for his views on how computers can change learning.

Papert was born and educated in South Africa. After studying mathematics at Cambridge University, Papert studied at the University of Geneva, where he worked with Jean Piaget. Later he started to work at the Massachusetts Institute of Technology (MIT). He focused his work on how children think about and learn mathematics. He believes that mathematics helps one understand how children think and learn in general. He believes that children should be given opportunities to explore and find out what is right or wrong rather than being told so. Indeed, he thinks that children need easy yet powerful tools to help them construct mathematics. He thinks that learning is not a product of structured and predetermined exercises but a process of exploration. Papert has always had a good vision and foresight, and most of his ideas were originally regarded as fantasy. For example, he was speaking of personal computers in the 1960s and today advocates that every child should own a laptop computer. The former has long been a reality, and Papert made the latter possible in Maine.

Papert probably gained some of this great insight from his experiences abroad. He was educated in South Africa and Europe and worked in developing countries as well. The move from South Africa to MIT, a technology frontier, enabled him to use his wide array of experiences to the advantage of children. These experiences led him not only to gain a refined perspective of how children think and learn but also to develop conceptual tools to enable children to learn better. Papert did most of his work at MIT, where he cofounded the Artificial Intelligence Lab as well as the Media Lab. He mentored several graduate students who also are renowned scholars with paramount contributions to the field. David Perkins, professor of education at Harvard University and codirector of Project Zero, and Idit Harel, founder and CEO of MaMaMedia Inc., are two such names.

Seymour Papert has received several awards, including a distinguished professorship at the University of Maine, the Marconi International Fellowship Award, the Lifetime Achievement Award of the Software Publishers' Association, and the Smithsonian Computer World Award for Leadership in Education. His best-known books are *Mindstorms: Children, Computers, and Powerful Ideas; Perceptrons: An Introduction to Computational Geometry; The Children's Machine: Rethinking School in the Age of the Computer; The Connected Family: Bridging the Digital Generation Gap; Constructionism;* and *Constructionism Research Reports and Essays, 1985–1990.* To see an expanded list of Papert's work, visit www.papert.com/works.html.

Currently he lives in Maine, where he works at the Learning Barn, piloting new methods of learning that he developed. He also works at the Maine Youth Center, helping at-risk teenagers' education using computers. He serves on the advisory boards of MaMaMedia Inc. and LEGO Mindstorms. He participates in the editorial board of the *Journal of Science Education and Technology* and the MIT Epistemology and Learning Group.

Sebnem Cilesiz

See also

Constructivism; LEGO/Logo

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Performance Support

Performance support is the integration of tools, information, data, and learning and communication aids that help workers maintain a level of performance desired by an institution or individual. According to Gloria Gery (1991), the goal of performance support is to “skew the bell curve,” enabling workers of varying skill levels to achieve the same desired level of performance quickly (Elswick 2001). Performance support often includes the provision of job aids on demand. Organizations are increasingly adopting this learn-as-you-go approach, enabling workers to get the help they need with a minimum of delay (as opposed to waiting to attend a course) or reliance on an overabundance of external resources (as opposed to the use of multivolume reference materials).

Some common examples of performance support tools include the wizards and assistants in software applications (task-specific, show-me help); document templates found in word-processing software; and personalized buying assistance found on websites. Although these are all computer-related examples, performance support can take other forms, such as printed job aids (e.g., checklists and quick-start guides).

The Relation to Performance Improvement

The definition of performance support suggests several assumptions. By stating that a level of performance is “desired,” we assume that an institution or individual has determined the gold standard for performance and articulated that standard. In addition, by using the word “maintain,” we suggest that the desired level of performance has been attained and the worker simply needs the means to continue. Furthermore, the wording suggests that those organizations providing performance support know what specific means or interventions the worker needs. (Although the term “worker” is used here, implying an employment situation, it is meant to also apply to a person attempting to perform a task for individual benefit.) These assumptions require looking at the outcomes of another process: performance improvement.

Performance improvement is a process for achieving desired institutional and individual results. The goal of performance improvement is the achievement and sustainment of high-quality task completion. Results are achieved through a process that considers the institutional context, describes desired performance, identifies gaps between desired and actual performance, identifies root causes, selects interventions to close the gaps, and measures changes in performance (Caiola and Sullivan 2000).

The performance improvement process, within the framework shown in Figure 1, comprises a series of steps that help an organization or individual define desired performance and identify the factors that contribute to or prevent achievement of that standard. The steps in the performance improvement process are listed below:

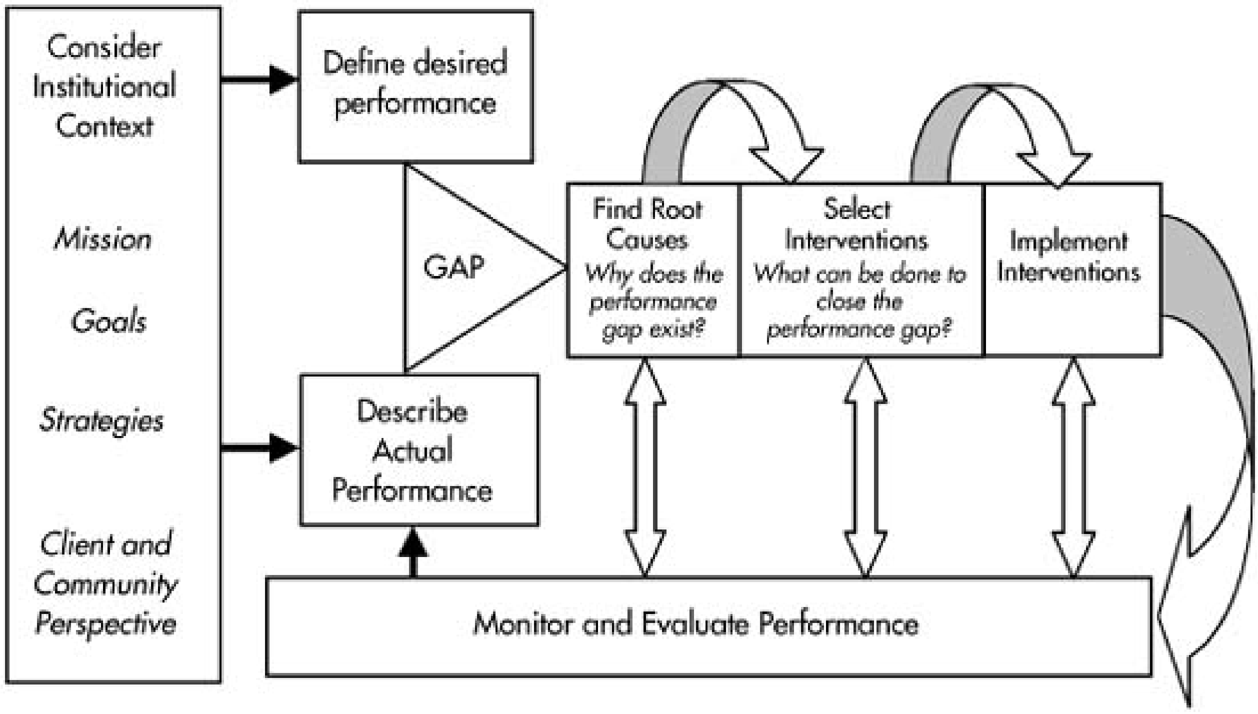

Figure 1:

Performance Improvement Framework

Source: Created by the author.

- *Analyze performance:* Conduct a performance analysis to identify any gaps between actual and desired performance.
- *Find root causes:* Conduct a root cause analysis to determine the reason for performance gaps.
- *Select interventions:* Select and design interventions to address the causes of performance gaps.
- *Implement interventions:* Introduce interventions in performance of work.
- *Monitor and evaluate performance:* On an ongoing basis, determine the effectiveness of interventions to raise performance and adjust the interventions as needed.

At the point in the process where interventions are selected and designed, the line between performance improvement and performance support begins to gray. The interventions selected may involve the development of tools, knowledge bases (databases capturing expert knowledge), and learning and communication opportunities that close performance gaps as well as support the desired level of performance in the long term. Increasingly, organizations are relying less on training alone to address performance challenges and more on integrated solutions. One term that has grown to be used almost synonymously with performance support is “electronic performance support systems,” an approach that offers just such an integrated solution.

Electronic Performance Support Systems

An electronic performance support system (EPSS) is an electronic environment available at the time and place a worker needs it to perform a task; it contains an integrated set of job aids, from expert advice to information and tools. These aids are designed to provide individualized assistance and require a minimum of external support for effective use. The goal of the EPSS is to enable a worker to get started quickly in performing a task.

EPSSs are rarely a single computer application. They are usually a combination of systems, with features such as hypertext (the linking of one module of text to another), embedded animation, hypermedia (the linking of media types such as audio and video with text and other resources), and communication vehicles (such as instant messaging, electronic bulletin boards, and e-mail discussion lists). According to Theo Bastiaens (1999), EPSSs generally include four components: *tools* to use in performing a job; *information* to help do the job correctly; *advice* to aid completion of complex tasks; *training or learning* to extend the employee's knowledge and skills. These components entail varying degrees of interactivity with the user. Figure 2 shows an example of EPSS components arranged as a continuum, ranging from those more purely providing information and tools to those components requiring extensive interaction with the user to effect learning or problem-solving.

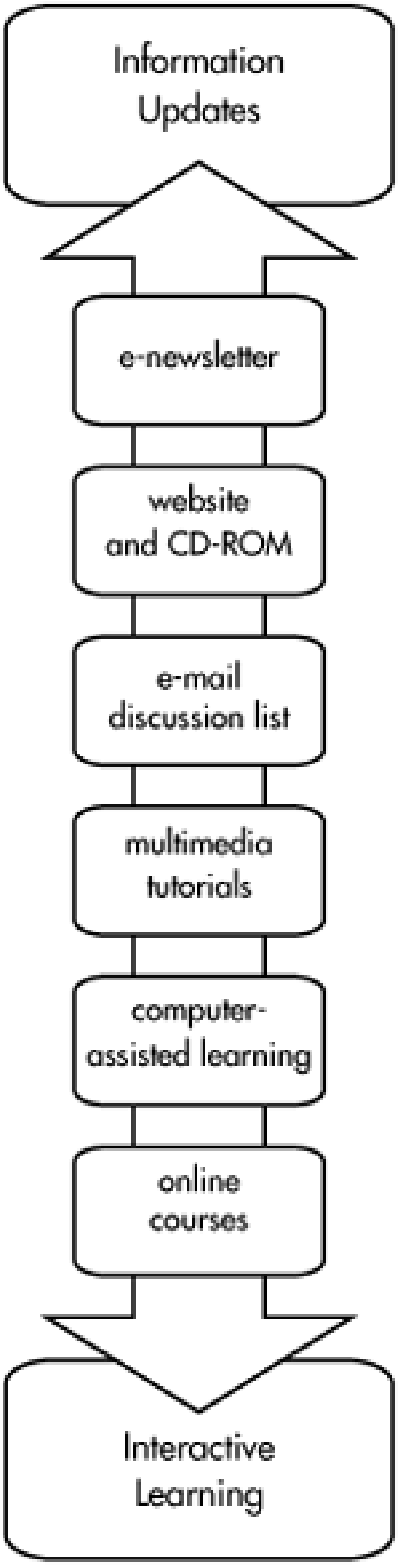

Figure 2:

Continuum of Electronic Performance Support

Source: Created by the author.

The following is an example (based on the suite of Performance Support Services developed by JHPIEGO Corporation, an affiliate of Johns Hopkins University) of how the components in Figure 2 might be used. Workers receive an e-mail newsletter to alert them of upcoming learning activities and tips and techniques for performing their jobs. A technical support website includes modular information that has been distilled from a large body of knowledge and is specific to the job duties and profession of the workers. For international sites with poor Internet connectivity, the website content is also distributed on CD-ROM.

Moving closer to the interactivity end of the continuum, e-mail discussion lists on technical topics enable workers to obtain peer support and expert advice on job challenges. Short, multimedia tutorials, distributed on a website and CD-ROM, allow for quick knowledge updates on new topics and contain hypertext links for exploring supporting material. Larger in scope, computer-assisted learning packages enable self-paced learning and incorporate monitoring and feedback in the form of pretest/posttest and in-progress reviews. Online courses incorporate many of the other components (information, communication, advice, learning materials) in an integrated learning environment.

Performance-Centered Design

An effective EPSS starts with a performance-centered design (PCD). PCD brings the focus of software design back to supporting the tasks of users rather than exploiting the capabilities of machines. PCD incorporates elements from human-factors engineering (design of technology for effective human use), usability analysis, and total quality management (Howell 2001). When a system reflects PCD, providing the right amount of information at the right time so that tasks can be completed efficiently results in performance support. PCD may include features that allow users to customize an interface to reflect their preferred work style (as long as the number of choices is not overwhelming) and choose the amount of help they wish to receive while performing a task.

Knowledge Management versus Performance Support

Often knowledge management is also raised in the context of EPSS functions. Knowledge management refers to harnessing information, data, and human institutional memory through information technology in such a way as to provide an organization with a competitive advantage and the capacity to adapt to environmental change. The difference between knowledge management and performance support lies in the goals: Knowledge management focuses on the overall goals of the organization, whereas performance support is targeted at high-quality task completion by an individual worker. Although an EPSS can incorporate elements of knowledge management, the goals are different.

Trends in Performance Support

With an increasingly mobile workforce and the desire to extend support to remote regions of the world, the delivery mechanisms for performance support are being rethought. Organizations are beginning to explore how support can be delivered on smaller devices such as handheld computers (personal digital assistants) and tablet PCs.

The need for mobile support also applies to settings where use of a desktop or laptop computer is impractical. For example, a physician in an emergency room may think of ten questions on patient care during the course of a shift but only remember four questions by the time he can access a desktop computer. Providing quick-reference information on a handheld computer that can be carried in a pocket enables the physician to obtain answers to patient care questions at the point of care. Take the same physician and locate him in a rural part of Africa with unreliable telecommunications and electricity, and provide a handheld, battery-operated computer with satellite access to the Internet, and performance support is taken to a new level.

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Richard L. Sullivan

See also

Analysis; Electronic Performance Support System; Human-Computer Interaction; Just-in-time Training; Knowledge Management

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PLATO®

The PLATO® Learning System (Programmed Logic for Automated Teaching Operations) is an open, modular, standards-based system that includes instructional software in core curricula for kindergarten through adult use, assessment, instructional management, curriculum planning, lesson plans, web-based resources and tools, and professional development. The system is browser-based and can be delivered via the Internet, intranets, local area networks, and CD-ROM. The more than 3,000 hours of instructional software available uses a wide range of instructional models, including problem-based simulation and game architectures, tools and resources for exploratory use, tutorial lessons for teaching declarative and procedural knowledge, application practice, and group communication. Various components of the PLATO system are designed for individual study and testing, small-group collaborative learning, and large-group instruction. Application models include mastery-model self-paced learning (in classrooms or via distance learning); individualized instruction for enrichment or review; support of problem-based curricula; individualized standards-based assessment; prescription; progress tracking and reporting; curriculum planning; and a range of systemic change initiatives that use technology as a point of leverage. The PLATO system serves more than 3 million users per year worldwide in K-12 schools, colleges, adult education centers, and industry.

Today's PLATO system, built over the years by PLATO Learning Inc., is the largest descendent of the PLATO mainframe system, originally developed at the Computer-Based Education (CBE) Research Laboratory at the University of Illinois under the direction of Donald Bitzer. Initial research started in 1959 with funding from the National Science Foundation (NSF), and the PLATO technology was patented in 1960. The system evolved to PLATO IV by 1968.

As one of two major CBE projects funded by NSF in the 1960s and 1970s, the PLATO mainframe was host to a broad range of groundbreaking research and development in computer-based learning, assessment, gaming, online communities, programming languages, and hardware technologies. Thousands of hours of software were written on the system by hundreds of authors on campuses worldwide. The ERIC index includes nearly 900 references to the PLATO system from that era, including much of the basic research on computer-based learning, tutorial dialogs, instructional games and simulations, and online assessment.

The global online community of PLATO users was the progenitor of today's global Internet-based communities. In 1973, under the direction of Paul Tenczar, David Wooley developed the NOTES system on PLATO. Originally developed to report bugs and courseware development (through a system called TERM COMMENT), by 1976 it evolved into a powerful threaded chat system (Group Notes, or GNOTES) that supported hundreds of discussions on a wide range of topics. A descendent of this system is today's LOTUS NOTES. Also in 1973, Doug Brown designed the Talkomatic (later TERM TALK) system to provide real-time terminal-to-terminal conversation among users. In 1974 Kim Mast developed an e-mail system called Personal Notes (PNOTES)—eight years before the ARPANet specification that is the origin of today's Internet e-mail. Many of the online social conventions familiar today, such as the use of emoticons, evolved on PLATO.

The authoring language of the PLATO mainframe system was TUTOR, written by Paul Tenczar in 1967. TUTOR was designed to have the power of a general-purpose language such as BASIC or PASCAL, but it had additional capabilities to support instructionally important features such as interactive vector graphics and real-time online transaction processing capabilities such as free-response answer analysis and feedback. The majority of subsequent computer-based instruction authoring systems show the influence of TUTOR, such as today's AUTHORWARE system by MacroMedia. Similarly, the functions of computer-managed instruction were developed in PLATO's CMI system. Its influence is still felt in today's management systems and specifications such as Instructional Management System.

The PLATO mainframe and its community also spawned much of the original work on computer gaming, including online multiplayer games. Users worldwide were influenced by their time spent playing Star Trek (an “Adventure” game), EMPIRE (perhaps the first multiplayer game), SPASIM (the first first-person shooter game), Flight Simulator (a 3-D real-time flight simulator with views of horizon, airport, and enemy), and Oubliette (a Dungeons & Dragons–type game). Many of the authors of these games went on to found the commercial computer game industry.

The PLATO mainframe project also spawned a number of important hardware and system innovations. Best known is the plasma flat-panel display, originally developed by Bitzer and Gene Slottow in 1964 as a way of allowing random-accessed full-screen displays without costly video memory or high bandwidth. The display’s descendents are now found in high-end television and computer displays. Less well known are innovations in system design that allowed connection and communication by hundreds of simultaneous users—over modems running at 300 bps or slower!

PLATO played a major role in the creation of the commercial e-learning industry. PLATO was licensed by Control Data Corporation (CDC) in 1976. CDC invested aggressively in PLATO, and the system grew by 1985 to more than 100 mainframes worldwide. Most were interconnected, creating a truly global computer-based learning community. Subsets of PLATO were implemented on a proprietary stand-alone computer, the TI 99, and the IBM-PC. In 1989, PLATO Learning Inc. (originally TRO Learning Inc.) acquired most of CDC’s PLATO assets. The original courseware is still marketed by the NovaNet subsidiary of Pearson Learning Technologies. CDC rechristened the system CYBIS and subsequently licensed it to VCampus (originally UOL Publishing).

Rob Foshay

See also

Computer-Assisted Instruction; Courseware; Intelligent Tutoring Systems; Simulation and Gaming

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Probeware

Probeware is educational hardware and software used for real-time data acquisition, display, and analysis with a computer or calculator. Probeware is also known as microcomputer-based labs; when used with a calculator, it is known as calculator-based labs. By connecting probes to a computer running suitable software, students can observe data displayed in a variety of formats as it is being collected. When used in an inquiry-based learning context, this capacity can significantly increase and speed learning. Probeware has been used widely in science, mathematics, and technology education.

The probeware hardware consists of probes that use sensors to convert physical properties into an electrical signal. The electrical signal from a sensor usually requires that an electronic interface be used to convert the signal into a format to be read by computers. More than forty kinds of probes are used in education, although temperature, light, and distance probes are most common.

Software used with probes can usually represent the data from the probe as a number, dial, or graph. There is great educational value in having students see the display change in real time, that is, as soon as the physical input changes. In this way, learners quickly associate the physical change with the way the representation changes. Some software can also be used to analyze the data as soon as it has been collected. For instance, the user may want to fit data to a function or filter out noise.

Probeware software frequently also includes support for probe calibration. The software uses a calibration equation to relate the raw values it reads from the sensor to a physical value such as temperature reported as degrees Celsius. The process of calibration adjusts this equation to increase its accuracy. This is necessary because not all sensors are identical, and most actually change their sensitivity, or “drift,” over time. Inexpensive sensors, which are frequently found in education, are more likely to drift. Calibration generally involves placing the probe at several known values of the physical property that the probe measures. For instance, a temperature probe might be placed in freezing and boiling water because those temperatures are known.

The use of probeware in education has been hindered by misunderstandings of its appropriate educational role. The most common misconception is that probeware can harm student learning by reducing the amount of exposure to hands-on learning. As with any technology, probeware can be used well or poorly, but with appropriate instructional design probeware actually increases student learning by supporting an inquiry process. Quality use is not, however, an automatic consequence of using probeware; good instructional strategies and designs are necessary. Good approaches that use probeware still leave it to the student to decide what to measure and how to interpret the results. Frequently, the role of probeware is to lessen the drudgery, allow students to focus more on the experiment, and increase the amount and range of experimentation students can undertake.

Another misconception about probeware is that it is an incomprehensible blackbox. There is no way, the argument goes, that students can possibly understand everything that is happening in an experiment that uses probeware—so how can they believe the results or learn from them? The combination of sensor, electronics, computer, software, and even the monitor is a blackbox that students should not even try to understand. The point is that for students to use probes effectively all they need is to understand the relationship between input and output; it is educationally sound to treat everything between as a blackbox. Students can learn quickly, for instance, that an increase of temperature at the sensor causes the line to go up on a graph on the display. They do not need to know how the display works to use this representation for exploration and learning.

The Cooling Curve Experiment

The cooling curve experiment, first demonstrated in 1978, illustrates how probeware can improve student learning by reducing the amount of clerical work required and increasing student interaction with the experiment and reflection about the results.

The experiment involves a substance like mothballs that melts between room temperature and 100 degrees Celsius. A sample of the warm liquid substance is placed in a test tube that is immersed in water that is cooler than the melting temperature. As the liquid cools, its temperature drops quickly to the melting temperature and then stays constant—plateaus—until all the liquid turns to solid. Then it continues cooling. This experiment is important because it illustrates that heat and temperature are different; at the plateau, heat is being extracted, but the temperature remains constant because the latent heat of solidification provides the heat transferred to the surrounding liquid.

Using a thermometer to measure the temperature of the mothballs, students typically take an entire lab to gather the temperature data of a single cooling experiment. They must plot the data later, often days afterward. They often fail to understand the connection between features on the graph and the properties of the substance that is cooling. Having never seen a normal cooling curve, they often fail to understand that the plateau observed during a liquid-solid transition is special. Consequently, the key observation—that the plateau represents the evolution of latent heat—is completely missed.

Because the temperature sensor can be tiny and respond quickly, the sample can be smaller when probeware is used. This means that one cooling experiment can be completed in a few minutes. There is ample time to do a normal cooling curve without a phase change and then compare that to a curve with a phase change. Furthermore, students can see the temperature graph evolving as the experiment is under way. They see the solid start to appear as snowlike particles at the beginning of the plateau and complete solidification at the end of the plateau. They can speculate about the reasons for the temperature being constant while the experiment is under way. A second sensor can be used to measure the temperature of the surrounding water to verify that it was cooler and extracting heat, although the temperature of the mothballs remains constant.

Ultrasonic Motion Detector

One of the most important probeware developments occurred in 1983. While on leave from his physics teaching at Whitman College, Jim Pengra first connected an ultrasonic camera focusing module to a computer to measure distance continuously. The interfaced module generates an ultrasonic pulse and then measures the time until its first echo. The computer can convert that time into the distance to the nearest object in front of the module. The module can make these measurements twenty or more times per second, giving very detailed data about the distance to a moving object. The computer can calculate the object's velocity from the change in distance, and its acceleration from the change in velocity. Any of these quantities can be plotted in real time.

A student moving in front of the ultrasonic detector can see a graph of his position, velocity, or acceleration against time. Students as young as fourth grade can learn to interpret these graphs in very little time. Studies of high school and college students' understanding of the relationship between these three quantities has shown substantial gains that are greater than any combination of lecture, problems, and traditional labs (Thornton and Sokoloff 1990).

New Directions

Probeware continues to be refined, gaining increased flexibility while becoming less expensive. One important current development has been the use of probeware with calculators and handheld computers. This not only reduces the cost of the computer; it makes it feasible to extend experiments outside the lab and classroom.

Current developments in probeware are also expanding the ways data can get from sensors into computers. Smart probes contain a microprocessor that converts the sensor signal directly into a computer-readable format that can be plugged directly into a computer. They use standard serial inputs, USBs, or computer-specific ports. There are ongoing experiments with wireless probes that communicate over infrared or microwaves, as well as sensors that connect directly to the Internet and can be read anywhere there is an Internet connection.

Robert Tinker

See also

Handheld Technologies; Science and Technology (K-12 Education)

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Problem-Based Learning (PBL)

Problem-based learning utilizes ill-structured problems to facilitate student learning. Ill-structured problems typically require more information than initially given to solve, have no correct sequence of steps to get to the necessary information or solve the problem, are dynamic in nature because the possibilities change with the addition of new information, and require that decisions are made in the absence of absolute certainty. PBL integrates knowledge of content and skills, context, collaboration, and learner-centered responsibilities to create a constructivist learning environment for students and may take a variety of forms.

In one of the most common implementations of PBL, students are provided with a description of an event or scenario that is relevant to learning goals. For example, students studying to become teachers may analyze videos of teachers in their classroom or law students may analyze courtroom scenarios. PBL may utilize real problems or situations that have occurred in the past, that are occurring in the present, or that are carefully fabricated to portray real life. Students can compare their solutions to those made by others, act on their solutions in the case of current problems, and/or compare and contrast their solutions with peers and experts. The best-known application and most thorough use of PBL is in medical schools, but PBL has also been used in education, law, business, and architecture.

Strategies for Using PBL

Problem-based learning may be used for a variety of reasons and may reflect differences regarding what is to be learned, how it is to be learned, and who the learners are. Five strategies have been identified related to using problems in instruction (Duffy and Cunningham 1996):

1. *The problem as a guide:* This approach involves the use of the problem as a way to focus learner attention. This strategy is typically focused and directed and includes assigned readings designed to clarify the case and transfer predetermined content knowledge. This use is similar to providing guiding questions before assigning a chapter for homework.
2. *The problem as an integrator/test:* Used following assigned readings so that students can apply what they've read to the problem. This strategy is designed to facilitate knowledge transfer and expose misconceptions and remediation needs. This is similar to using review questions at the end of a reading assignment.
3. *The problem as an example:* Used to emphasize a particular point or principle from assigned readings.
4. *The problem as vehicle for process:* Used less as a vehicle to teach prespecified content and more as a vehicle to facilitate critical thinking skills, self-regulated learning, and collaboration.
5. *The problem as a stimulus for authentic activity:* Used as a mechanism for facilitating transfer of concepts, knowledge, and skills to other situations. Thus skills are developed in the context of the problem.

Steps in PBL

The first three strategies represent a more traditional way of approaching the use of problems in instruction, whereas the last two strategies deviate from traditional instructional practices and require alternative teaching strategies. A teacher using these more sophisticated strategies typically guides students through five recursive steps when implementing problem-based learning (Wilson and Cole 1996):

1. *Problem formulation:* Students explore the situation, generate important facts, note additional information needed, identify the problems, and generate hypotheses.
2. *Self-directed learning:* Students collaboratively generate a list of things needed to test the various hypotheses and make a plan for how to obtain and explore this information.
3. *Problem reexamination:* Students combine their initial thoughts with what they've learned through the self-directed learning process.
4.

*Abstraction:*Students compare and contrast the problem they are working on with other problems, thus setting the stage for knowledge transfer.

5. *Reflection:* The class debriefs on the experience, shares solutions, and identifies areas for improvement in self-learning and collaborative learning.

During this process the teacher serves as a facilitator or coach rather than as a transmitter of knowledge. She asks students guiding questions, verbalizes internal knowledge, encourages students to justify their solutions, ensures that all members in the group are engaged and participatory, and helps them recognize weaknesses or inconsistencies in their thinking. By serving in this role the teacher encourages active learning, critical thinking, problem-solving, collaboration, and student responsibility in the learning process. However, such instruction requires a teacher well versed in the PBL methodology, content, and context of the problem who is willing to devote instructional time to the process.

Using Technology to Facilitate PBL

Technology-based programs that use groupware, the World Wide Web, hypermedia, and databases have been designed to reduce some of the cognitive overload associated with PBL. These programs provide a means to organize a searchable archive of potential solutions, collect and analyze similar cases, facilitate student communication outside of class time, allow students to access a wider variety of resources, enable coding and compiling of student notes, and allow the teacher to more effectively and efficiently monitor individual and group projects.

Resources Related to PBL

Center for Problem-based Learning (www.samford.edu): Samford University is redesigning core areas of its undergraduate curriculum to include problem-based learning. This initiative is funded as part of an endowment grant from the Pew Charitable Trusts and includes five schools: arts and sciences, business, education, nursing, and pharmacy. The center's website also provides a searchable database that allows users to locate uses of problem-based learning in undergraduate institutions around the world.

Illinois Mathematics and Science Academy, Center for Problem-based Learning (www.imsa.edu/team/cpbl/center.html): This center was created by the Illinois Mathematics and Science Academy and is funded by the Harris Family Foundation and the Hitachi Foundation to research and disseminate PBL strategies to K-16 teachers. The center's website includes examples of how PBL is being used in K-12 educational environments as well as many resources for those interested in further exploration.

Problem-based Learning Clearinghouse (www.mis4.udel.edu/Pbl): The PBL Clearinghouse is sponsored by the University of Delaware and provides a collection of problems and articles to help educators interested in using PBL. The clearinghouse also provides teaching notes and other supplemental materials to assist educators with implementation. All problems in the archives are peer-reviewed and classroom-tested prior to inclusion.

Kara Dawson

See also

Active Learning; Constructivism; Open-Ended Learning Environments

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R

Rapid Prototyping

Rapid prototyping is an instructional design methodology in which designers work with clients to quickly build a series of prototypes for instruction in order to experiment with and evaluate a variety of instructional designs before committing to a single instructional approach for further development. The use of rapid prototyping for instructional design was proposed by Steven Tripp and Barbara Bichelmeyer in 1990 to address the inefficiencies and costliness inherent in the design process of instructional systems design (ISD), the traditional instructional design model that outlines a linear, sequential five-step approach to instructional design involving analysis, design, development, implementation, and evaluation. The rapid-prototyping method was adapted from the discipline of software engineering, where it has been successfully used for the design and development of software programs and computer systems. In the recent past, numerous complementary instructional design processes have been introduced that extend the concepts and approaches of the rapid-prototyping method, including: iterative design, participatory design, user-centered design, collaborative prototyping, context-sensitive design, and usability testing.

In instructional design, rapid prototyping is the process of building a variety of models of an instructional system in order to support the design and development of the full and complete instructional system. In the rapid-prototyping methodology, a brief analysis of learner needs and instructional context is completed, then development and evaluation activities are conducted as parallel processes through the creation of prototypes.

The rapid-prototyping process brings the instructional designers and the potential learners together as they determine which design features of the various prototypes will be kept and which will be discarded. Through the rapid-prototyping process, initial prototypes evolve into final instructional products.

The first activities of rapid prototyping are similar to traditional methods of instructional systems design, in that they involve the assessment of instructional needs and analysis of the content of instruction in order to produce a tentative statement of instructional objectives. In rapid prototyping, this first statement of objectives is simply a rough outline of knowledge, skills, and attitudes to be acquired by learners, and this initial outline of objectives serves as a communication tool allowing designers and learners to evaluate various prototypes. The rapid-prototyping process continues with the parallel processes of prototype construction (the design of prototypes) and prototype utilization (research and evaluation of prototypes). Throughout the rapid-prototyping process, a successive progression of prototypes is developed. Prototypes begin as rough, fuzzy sketches of the basic elements of an instructional product. Initially, low-fidelity prototypes are created in order to generate a clear understanding of design problems. These prototypes are used iteratively and gradually evolve into high-fidelity prototypes, with the last prototype rendering a model of the proposed instructional product. These parallel processes of prototype construction and prototype utilization continue until the instructional designers and users develop a full understanding of the needs for instruction, the content and activities of instruction, and the context of the instructional environment. In the rapid-prototyping process, understanding the parameters and constraints of instruction does not occur prior to the design process; rather, this understanding occurs as a result of the activities of design. The process of coupling design with evaluation through rapid prototyping allows a designer to incorporate theory when designing products and to study the application of theory when conducting evaluation, so that product development and evaluation serve effectively as parallel processes of instructional design.

Rapid prototyping is characterized by the active involvement of users throughout the entire process of instructional design and development. Prototypes are collaboratively created by designers and users, with users engaged in instructional design activities and instructional designers acting to facilitate the design process. The instructional designer actively involves the user as codesigner and decisionmaker throughout the process, during which users and designers work as peers to simultaneously discover the problem and the solution through the use of prototypes. Instructional designers and users share control and responsibility for the realization of the goals of the design project; in this way users assume the role of collaborative inquirers with designers.

Rapid prototyping is an instructional design methodology capitalizing on the capabilities of software development tools that allow for rapid construction and modification of instructional products. Rapid prototyping became a practical instructional design methodology as a direct result of the availability of digital technology and advances in computer capabilities, because the digital environment provides two features that are requisites for rapid prototyping: modularity and plasticity. *Modularity* is a feature that allows for a segment of an instructional unit to be added, removed, or modified without severely disrupting other segments of the instructional unit or the unit as a whole. Some popular computer software programs for word processing, spreadsheets, and webpage design provide modularity that supports rapid prototyping. *Plasticity* refers to the ability to change aspects of a unit of instruction with only minor time and cost penalties. Historically, plasticity was difficult to achieve with instructional media such as textbooks, video, and audio recordings because making revisions was tedious and costly once a prototype was created. But again, computer software programs that are now standard tools for the design and development of instruction provide the high degree of plasticity required for rapid prototyping. The advanced design and development capabilities of computer software programs have made it practical for instructional designers to synthesize and modify instructional elements quickly and efficiently and, therefore, have made rapid prototyping a feasible instructional design methodology.

The introduction of rapid prototyping as an alternative instructional design process was a response to designers' dissatisfaction with the traditional model of instructional design, which is dominated by its systems approach. In the traditional model, commonly referred to as instructional systems design, the designer works through a sequential process of design activities, beginning with analysis, moving to design, followed by development, leading to implementation, and culminating in evaluation of the instructional product. First, the instructional designer engages in several types of analysis activities, including needs analysis, learner analysis, task analysis, and context analysis; the analysis phase is completed when the designer has a clearly identified set of instructional goals and objectives. Upon completion of analysis, the instructional designer moves into the design phase, during which templates for various instructional elements are created. During the development phase, all materials are produced according to the specifications prescribed in the templates. Once the development phase has been completed, the instructional product is implemented with the target audience. After the initial implementation, a formative evaluation may occur during which the designer makes needed changes to the instructional product. After full implementation, summative evaluation is conducted to measure the success of the instructional intervention.

The rapid-prototyping approach is not to be confused with the formative evaluation stage of the ISD model. Whereas rapid prototyping is an instructional design strategy concerned with exploring alternative design options, formative evaluation is a task of instructional design that is concerned with ensuring the effectiveness of an instructional product related to the goals for the product. Whereas rapid prototyping is an iterative process of development and evaluation, formative evaluation is a task in which instruction is evaluated in order to improve its effectiveness. Whereas evaluation occurs throughout the rapid-prototyping process, formative evaluation is conducted only when a relatively complete instructional product is available, functioning to some degree as a pilot test of the product.

Critics of the ISD model claim that it takes a long time, that it's expensive, and that it doesn't reflect the real world of instructional design. Rapid prototyping overcomes these limitations by addressing two major features of ISD: the emphasis on control and management of the instructional design process, and the lack of a concrete instructional product until late in the development process. Rapid prototyping counters the ISD model by replacing an overabundant design process with a minimalist design method, by replacing low-fidelity instructional design with high-fidelity product design and development, and by replacing lack of learner involvement during the instructional design process with active learner engagement. Rapid prototyping was, therefore, introduced as a process that could solve efficiency problems of instructional design while increasing the effectiveness of instructional products.

The rapid-prototyping methodology acknowledges a distinction between the natural sciences and what Herbert Simon (1981) called "the sciences of the artificial," or the design sciences, such as engineering, architecture, and instruction. Natural scientists and designers engage in different approaches to problem-solving, in that natural scientists solve problems using a systems approach based on the method of scientific inquiry, whereas designers generally solve problems by focusing on desired solutions and by using processes that are nonlinear, that are nonhierarchical, and that involve the development of partial and interim solutions on the way to a final solution. Rapid prototyping is based on Donald Schon's (1988) characterization of design activities as uncertain, unique, and often conflicting. Rapid prototyping is therefore a process of reflection in action, during which designers work to turn vague ideas into clear solutions. Rapid prototyping acknowledges the complexity of design by considering multiple design solutions, rather than trying to minimize the complexity of the design problem by using a rigorously systematic process such as the ISD model to create a single best solution. Instead, rapid prototyping allows and encourages the creation of alternative and even contradictory designs, out of which a negotiated prototype emerges. Rapid prototyping places synthesis before analysis through the creation of models or prototypes that provide a tangible and dynamic look at an evolving solution or even multiple alternative solutions to the problem in order to better detect the user's requirements. Rapid prototyping is important, because often users are not able to readily and fully grasp their needs and requirements without this visualization process.

Rapid prototyping has been posited as an appropriate instructional design strategy for at least three types of situations. In instructional situations that involve complex factors such as communication problems, cognitive processes, or management skills, where there is no well-defined body of knowledge to guide designers and prediction is problematical, rapid prototyping may be appropriate because it deemphasizes the need to predict solutions. In cases where traditional instructional design methods yield unsatisfactory results because the methods are incomplete, rapid prototyping may be appropriate because it accounts for the situated nature of knowledge. In new situations where there is not an abundance of experience from which to draw, rapid prototyping may be appropriate because research is conducted concurrently with development; therefore little formal research is needed in order to begin a project, and much information can be gathered from research conducted as learners use prototypes.

Rapid prototyping offers several advantages over traditional instructional systems design approaches. First, it encourages and requires the active participation of product users in the activities of design. Second, it makes allowance for the natural reaction of users to change their minds during the design process by incorporating iteration and change into design and development activities. Third, it facilitates users' understanding of their requirements for instructional products by engaging them in the implementation of various prototypes. Fourth, errors can be detected early. Fifth, prototyping can increase creativity through quick user feedback. And sixth, prototypes accelerate the instructional development process.

On a cautionary note, rapid prototyping may lead to a tendency toward informal design methods that introduce more problems than they eliminate. This weakness can be minimized if instructional designers keep in mind that prototyping is not a design-by-repair philosophy; nor does it eliminate the need for front-end analysis of human performance issues. Instructional designers who engage in rapid prototyping need to be careful not to prematurely commit to particular design solutions. Finally, designers should resist the temptation to add bells and whistles in subsequent prototypes, as this leads to creeping featurism and instructional products that are stylish but do not address the substance of the instructional problem.

In April 2000, ten years after the introduction of rapid prototyping as an alternative approach to the discipline of instructional design, an article was published in *Training* magazine attacking the ISD model. The article identified four problems with ISD: It is a slow and clumsy process; the process does not represent the real activities of design; it produces bad solutions; and it does not address the situated nature of reality. As evident from the description of rapid prototyping given above, these criticisms of the ISD model are not new and, in fact, have been addressed to some degree by the rapid-prototyping model as well as by other instructional design models that have extended and adapted the approach of rapid prototyping, such as iterative design, participatory design, context-sensitive design, and usability testing. As long as ISD is the dominant instructional design method in the field, it is likely that similar attacks will continue. It may, then, be valuable to remember that the most appropriate measure for the evaluation of rapid prototyping, and all other instructional design approaches, is whether the process is useful in creating an instructional product that effectively and efficiently addresses the unique characteristics and requirements of the instructional context.

Barbara Bichelmeyer

See also

Analysis; Evaluation; Human-Computer Interaction; Instructional Design; Usability

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Research on Media and Learning

Research on media and learning (also called media comparison studies) generally refers to research studies that compare the relative achievement between groups who have participated in instruction on similar subject matter using different media. Media comparison studies often occur when a new technological innovation is embraced by the educational community. Media comparison studies use methodologies that are based on a premise that single-shot experiments can reveal something about the cumulative effects of media on learning. For example, the focus of an experiment might attempt to determine which medium—online instruction, computer-assisted instruction, instructional video—produces the highest level of achievement when compared to face-to-face instruction. A long standing debate over the scientific merit of media comparison studies has ensued in the field of educational technology. One side of the debate says that media research is erroneously interpreted when it suggests that learning benefits are derived from a particular medium. The other side counters with the argument that media can be distinguished by its characteristic capabilities and that these processing capabilities of a medium complement or facilitate learning. A review of the literature on research on media and learning yields conflicting results, and the results of media comparison studies may be considered problematic by many in the field of educational technology.

Historically, media comparison studies were conducted along the lines of media type. Media comparison studies grew out of research conducted on the educational use of film and television from the 1940s to the mid-1960s. As different types of media began to be used for educational purposes, a large number of comparison studies were conducted for various media, especially instructional video and computer-assisted instruction. More recently, media comparison studies have focused on distance education and comparisons of online instruction with face-to-face or classroom instruction.

A methodological trend in media research was the meta-analytic study. Meta-analysis is a statistical technique used to summarize the findings of other research studies. Meta-analytic procedures yield effect sizes that are converted to a percentage of a standard deviation allowing comparisons among final test scores using a number of different treatments. A series of meta-analytic studies of media research, particularly research related to computer-assisted instruction, was conducted by James Kulik and colleagues at the University of Michigan.

Early on, researchers were cautious and sometimes skeptical about the results of media comparison studies and argued that comparisons of different media on learning might not be useful because they focused on the medium itself. For example, in 1968 Keith Mielke, a leading researcher on the effects of television on children at the time and later a senior research fellow with the Children's Television Workshop, questioned the assumptions used by media comparison studies by describing a hypothetically perfect experiment in which a unit of instruction is presented to two groups of students that have been randomly assigned. A teacher presents a lesson to the first group and no discussion is allowed while another group in another room views the lesson over a television screen as it is presented live to the first group. Mielke predicted that with this experimental design there would be no difference in learning because the only operating variable was the mode of transmission, and he questioned the value of such an approach to research. Yet media comparison studies often followed a similar methodology, assuming that somehow the medium used for the delivery of instruction somehow affected learning outcomes—and usually yielding results of no significant difference.

During the early 1980s Richard E. Clark, a former student of Mielke's and a professor of educational psychology at the University of Southern California, ignited a debate about the impact of media and technology on learning by taking the position that media do not influence learning under any conditions. He clarified this challenge by explaining that media and technology were merely vehicles that deliver instructional methods, and it was instructional methods, the teaching tasks, and student activities that accounted for learning. Clark compared the delivery of instruction using a particular medium to a truck that delivers groceries, noting that a medium no more influences learner achievement than the grocery delivery truck causes improvements in nutrition. Clark claimed that all the benefits attributed by research to media such as computers or video could be explained by the teaching methods they supported. Clark maintained that media research should focus on questions about specific teaching and learning methods, not on questions about the media.

Clark argued that there was compelling evidence for the confounding of variables in media research that he reviewed and disputed the meta-analytic findings of Kulik and others. Clark claimed there was clear evidence of consistent confounding in comparative research involving computer-assisted instruction. Because media such as computer-assisted instruction generally required a greater effort to design the presentation than the comparative media, Clark concluded that the confounding variable was the instructional design. The computer did not possess any intrinsic value for increasing learner achievement, so the effectiveness of computer-assisted instruction of other instructional media was a function of its instructional design. Clark proposed that the main contributions of research on media and learning were primarily economic and efficiency benefits.

Gavriel Salomon, a professor of educational psychology at the University of Haifa in Israel, and Clark distinguished between research *with* media and research *on* media. In research *with* media, media were simply the conveyance or delivery system for instruction, whereas research *on* media examined particular media variables. Research on media and learning was erroneously interpreted when it suggested that learning benefits were derived from a particular medium. Salomon and Clark suggested that most media research could be classified according to one of the following categories of research objectives:

- To obtain knowledge about the effectiveness of a chosen medium (comparison studies);
- To increase understanding of how media function and the psychological effects of certain media; and
- To enhance educational practices through improved media (evaluation studies).

As cognitive views of instructional and educational psychology began to replace behaviorist views, there was a shift in the focus of media comparison studies. In a cognitive approach to research on media and learning, the focus is on the interaction of media attributes with cognitive processes that influence learning. Researchers (Gardner, Howard, and Perkins 1974) introduced the theory of symbol systems (Goodman 1968), which proposed that the modes of presentation of a particular medium could be purposefully examined. Specifically, symbol systems were defined as representations of the mental operations that constituted the core of cognition and were acquired through the culture of an individual by one's external representations. Salomon advanced the notion of symbol systems in media research by proposing that media as well as the human mind used symbols to represent, store, and manipulate information and that some of these symbol systems used for human cognition may be acquired from the attributes of certain media.

Robert B. Kozma, professor of education at the University of Michigan and a scientist with SRI International, challenged Clark in the debate about the impact of media on learning. Kozma used symbol systems theory to bolster his counterargument. He described symbol systems as sets of elements such as words or picture components that were interrelated within each system by syntax and were used in ways specific to the corresponding fields of reference. For example, words and sentences in a text were used to represent people, objects, and activities and were structured in a way so as to form a story.

According to Kozma, information was not only represented in memory but also processed. Although symbol systems alone were not sufficient to describe a medium and its effects on cognition, Kozma maintained that media can be distinguished by characteristic capabilities that were used to process or operate on the available symbol systems. These processing capabilities of a medium complemented or facilitated those of the learner. Medium and method have an integral relationship, and Clark's separation of these components was unnecessary and undesirable according to Kozma.

Kozma claimed that any particular technology is not irrelevant, but the technology may be well or poorly suited to support a specific teaching-learning methodology, and there may be a choice of technologies for carrying out a particular teaching task. He argued that both medium and method are components of the instructional design and that within a particular design the medium enabled and constrained the method while the method drew on the capabilities of the medium. Therefore, when learning was influenced by a method or design, it was in part because of the medium's capability to complement a learner's prior skills and knowledge.

Kozma recommended refocusing research on media and technology from questions about the impact on learning to questions about ways for using the capabilities of interactive technology to influence learning for particular students with specific tasks in distinct contexts. Kozma suggested conducting research that identifies those technologies best suited for supporting the best methods of teaching and learning. He recognized that although interactive technologies may be essentially delivery vehicles for pedagogical dimensions, some vehicles are better at enabling specific instructional tasks than others.

Kozma proposed a theoretical framework for research on learning with media in which the learner actively collaborated with the medium to construct knowledge. According to this view, learning was an active, constructive process, and the learner strategically managed the available cognitive resources to create new knowledge by extracting information from the environment and integrating it with information already stored in memory. Kozma concluded that the processing capabilities of computers influenced the mental representations and cognitive processes of learners.

The implication of this debate for modern theories of learning and instruction is in the influence of the processing capabilities of the media on the mental representations and cognitive processes of learners. As the emphasis of media research shifted from teaching to learning, the methodologies attempted to identify the particular design features of a particular medium or the possible instructional variables that facilitated learning.

Both Clark and Kozma presented important ideas in this debate, and educational technology researchers and practitioners should understand the problems intrinsic to research on media and learning.

A half-century of media comparison studies for the most part have indicated no significant differences. The effects of technology on teaching and learning are not easily measured. The impact of technology and media interventions in instruction may best be understood by examining the contexts in which they are embedded. For example, the methodologies associated with research on media and learning could provide descriptions of existing practice and the qualitative changes that occur in technology-enhanced learning environments. Furthermore, research on media and learning should reveal effective implementations of media, explore the effects of media attributes on cognition, and identify instructional design elements and strategies facilitated by technology. As the focus of educational technology has shifted from learning *from* media to learning *with* media, research on media and learning has progressed toward examining how the processes of teaching and learning and cognition are influenced by technology to form effective contexts for learning.

Steven Mills

See also

Association for Educational Communications and Technology; Clark, Richard E.; Computer-Assisted Instruction; Cone of Experience; Instructional Technology; Television and Learning

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S

School Reform

School reform refers to a process in which elementary and secondary schools change their curricula, methods of instruction, and/or means of operation in order to improve instructional services for children and youth. Although school reform can occur without the presence of technology, instructional technology is sometimes employed as the justification as well as the catalyst for school reform.

School reform appears in many forms. The reform may be primarily curricular, as in whole-language approaches to teaching reading. The reform may be directed at particular instructional approaches, as in discovery learning or mastery learning. It can be classroom-based, school-focused, or systemwide. Team teaching, site-based decisionmaking, and the Baldrige National Quality Award Program are illustrations of reform efforts across these levels. School reforms may begin within a school system, even with an individual teacher, or they may be imposed from the outside by state departments of education or by local interest groups.

School reform is often prompted by factors in society that lie outside the school's control. In the late 1950s and early 1960s, competition with the Soviet Union led to demands that schools improve because many U.S. citizens feared that the Soviets were leading the United States in space exploration; somehow U.S. schools would have to do better preparing students in mathematics, sciences, and foreign languages. During the late 1960s and 1970s, public concern for civil rights led to greater interest in multiculturalism and in providing a basic education for all children. In the 1980s and the 1990s, worry about the U.S. competitive position in world trade led school critics to demand changes that might lead to a better-educated workforce in the United States.

What is apparent is that U.S. schools are always in one stage of reform or another. They are either beginning a reform, are in the course of reform, or are just concluding a reform. Reform has become a tradition in U.S. schools. Despite this fact, schools are remarkably similar to the way they were a century ago. Today buildings are more modern, teachers are better educated, and instructional materials are more varied and colorful, but the curriculum and the ways teachers teach have remained largely the same. What accounts for this stability over time?

School reforms that gain public attention and are attempted nationally have often been launched by people who work some distance from actual classrooms. College and university professors are frequent sources of school reform proposals. Some are in the business of developing theories about how to improve schools. Business leaders and politicians also promote remedies for schools. Businessmen believe that management practices that have proved successful in business might also bring improvements to schools. Because school budgets are one of the largest public expenditures, and because states and communities compete with each other to attract firms that strengthen their economies, politicians understand that political success may be measured in part by the success of schools within their jurisdictions. These reform advocates offer proposals for change, but they depend upon others—especially classroom teachers—to implement them. There is a vast distance between thought and deed.

The schools we have, the ones that reformers want to change, are largely a consequence of the social and economic conditions at the beginning of the twentieth century. School attendance requirements, child labor laws restricting the kind of work that children could perform before age sixteen, and massive immigration combined to transform schooling from an opportunity for the few to an expectation for most. Too few well-prepared teachers were available to handle the numbers of students crowding into the schools. What was needed was a system that would ensure that all children would be properly educated whatever level of education their teachers might possess. Such a system required careful supervision of classrooms, detailed curriculum guides, and textbooks that would contain all of the information that teachers needed to pass along to their students. The solution was found in the U.S. industrial system. Educators began to seek ways to ensure a uniform product and to operate schools in the most efficient manner. Schools were redesigned to take advantage of the technology of that time.

Technology has always been an important part of schooling; it is only that until recently the technology employed has been rather simple, mainly textbooks and chalkboards. From time to time there have been attempts to change the technology of schooling. Each has appeared with great fanfare and optimistic promises by its advocates. In the 1920s radio was expected to have a major impact on schooling. In the 1930s the technology was film; in the 1950s television was touted as the solution to instructional problems in schools; and in the 1960s it was teaching machines. Until the 1990s two pieces of technology, the VCR and the overhead projector, held the most secure place in schools. Both had the advantage of being relatively inexpensive, and they supported traditional instruction without placing heavy demands on the instructor. The overhead projector enabled teachers to display information from the front of the class without darkening the room. The VCR served the same purpose that the film projector used to play in classrooms with much less effort on the part of the teacher.

Computers and their associated devices and software have become the latest technology to penetrate schools, and their advocates believe that in time they have the power to reform schools. Computers began to be used in significant ways in the 1980s, and in the 1990s computers came into their own inside the classroom. Cost, complexity, the lack of compatibility across models, lack of technical support, and ill-prepared teachers limited their penetration initially. Although nearly every school can claim that it has made computers available to teachers and students, the fact is that computers have been placed primarily in special labs where students can use them whenever their class is scheduled for the lab. Some school officials may report that the ratio of computers to students in their schools is, for example, 1:5, but what this ratio makes clear is that no student has unrestricted access to a computer. Certainly, except in the most unusual situations, students have more access to textbooks than to computers, and the majority have better access to computers at home than at school. Indeed, if one seeks the place where computers are most frequently used in schools, it is typically in the business office of school systems. School systems use computers to manage records, process payroll and other expenditures, and prepare reports. Computers have done more to transform the business side of schooling than they have the instructional aspects.

One major reason for the limited impact of computers on schools is that school officials have been uncertain about the purposes to be served by this tool. The computer was first introduced as a new part of the curriculum. For example, those students preparing to be secretaries needed to learn keyboarding. Learning to program computers seemed to be an attractive option for a limited number of vocational students. Computer literacy for all students was easily defended. If students were to live in a society where computers were to play a large role, it was important to understand how they work and to be able to do some tasks with computers.

Later educators began to assign instructional tasks to computers that seemed repetitious and boring for teachers. Instructional learning systems seemed the answer to helping students master basic reading and mathematics skills that involved considerable repetition. Furthermore, computers were able to keep careful records of student progress and to design lessons that were tailored to each student’s progress. More recently, computers have been viewed more as a tool to support instruction rather than as an object of instruction. This has shifted the focus of computer use in schools to the integration of technology across the curriculum. The practical implications of this change is to put computers in classrooms rather than restrict their use to special laboratories; to insist that all teachers gain competence in the use of computers rather than charge only special teachers with teaching students how to employ computers; and to increase the number of computers in schools in order that students have ubiquitous access to computers whenever they are needed. It is too soon to judge whether this move will lead to substantial changes in instruction. Computers can be used to support traditional approaches to teaching and learning or to support more innovative approaches. The answer to how computers will be used for instruction is not to be found in the machine but in the intentions of individual teachers.

What has been missing in the discussion about the role of computers in education are visions and plans about ways that new electronic technologies can contribute to transforming the way schooling is delivered in the United States. In contrast to business, where debate is frequent about whether computers can, will, or should change the way commerce is conducted, most educators assume, correctly or not, that schools will largely function much as they have in the past except that they will have computers to make instruction more interesting and more effective. Only in higher education is there lively debate whether online instruction, for example, poses a threat to traditional means for delivering undergraduate and graduate education. For the present it appears that if electronic technologies transform U.S. schools it will be as a result of an evolutionary process rather than an abrupt, radical one.

In part, the absence of visions regarding the capacity of technology to transform schools is due to a lack of interest in technology by leading school reform advocates. Some of the most prominent reform advocates of the 1990s paid little attention to ways that computers and other electronic devices could be used in schools to advance their visions of improved schooling. It is not that they considered and rejected the role that computers could play; rather, their visions of what schools could and should become were driven by other factors, and technology seemed largely irrelevant to them. At the same time, instructional technology had its critics, including some prominent educators who cautioned educators about accepting blindly the claims of technology advocates and reminded people of the unfulfilled claims made on behalf of earlier technologies. Others argued that educators should be skeptical about technology and look carefully at the motivations of business and public officials that urge its use in schools. Such critics may have inhibited the transformation impact that technology could provide schools.

There are exceptions to the reluctance of school reformers to accept technology. Some who have been active in the school reform movement for years believe that the business of schools is to design and deliver intellectually demanding work for students (Schlechty 1997). If schools do their job well, student learning will follow, and schools' traditional dependence upon print media provides poor preparation for students to succeed in a world increasingly dominated by the random assumptions of electronic media (Schlechty 1997). In short, however a school is organized and whatever its curriculum may be, unless technology is at the core of how schools work, students are likely to be miseducated for the world in which they will live.

Recently, the most compelling force on behalf of school reform has been the growing interest in national and state standards. The development of standards is an outgrowth of a desire by public officials and community leaders to hold schools accountable for their work. They argue that the public needs to know what the schools are trying to teach; through a system of tests linked to standards, the public can learn if schools are achieving what they are expected to accomplish. Because education is mainly the responsibility of states, each state has been developing academic standards for each grade level and for each subject in the curriculum. And though control lies at the state and local levels of education, national organizations have created standards that are intended to provide guidance for the states. Thus various professional associations have provided leadership by establishing standards for such subjects as mathematics, science, history, and social studies.

The process of establishing standards has also taken place with regard to the role of technology in education. For example, the CEO Forum on Education and Technology is a partnership between business and education leaders who are committed to assessing and monitoring progress toward integrating technology in U.S. schools. In 1997 the CEO Forum published a chart that was designed to allow schools to conduct a self-assessment in order to gauge their progress toward technology integration. The CEO Forum hopes its standards will be adopted by individual states. The International Society for Technology in Education (ISTE) has published *National Educational Technology Standards for Students: Connecting Curriculum and Technology*. This book sets technology standards that students should meet at each grade level. It also provides curriculum integration ideas for teachers at each grade level and for each subject area. ISTE is also at work on technology standards for teachers. If state departments of education adopt ISTE standards for students and teachers and hold schools accountable for meeting these standards, it appears likely that the role of technology will increase in schools. These standards may or may not be connected to school reform generally.

It appears that school reform will continue indefinitely. It is also likely that the use of technology will increase in schools. What is not apparent is whether technology will be joined to school reform to form a bond that results in new and better schools.

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See also

Campus Computing Project; Diffusion of Innovations; Educational Systems Design; Technology in K-12 Schools; Technology Planning

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Schramm, Wilbur (1907–1987)

Wilbur Schramm is widely recognized among communication scholars as the founder of the field of communication as an academic discipline and as one of systematic inquiry. He was among the earliest scholars to realize the potential of mass media to influence people's lives—their attitudes and behaviors—as well as to serve as instructional tools. He studied the effects of media in both formal and informal learning contexts. As an academic, his career spanned four decades, beginning with the publication of his first major work, *Communications in Modern Society* (1948), and ending with *The Beginnings of Communication Study in America*, the manuscript discovered upon his death in 1987 and published posthumously in 1997. Schramm conducted research on mass media and instructional technology on four continents, wrote more than thirty books, and held honorary degrees from institutions around the world. He served as a consultant to many developing countries, designing strategies to use mass media systems to improve national economies. He conducted a series of field experiments around the world, designed to assess the effectiveness of media systems in distributing educational content to mass audiences.

Schramm earned his doctorate in English in 1932, but he took a leave from teaching literature at the University of Iowa to do wartime service as educational director in the Office of Facts and Figures and the Office of War Information from 1941 to 1943. While in Washington, he was intrigued by the work of social scientists engaged in mobilizing the American public in support of the war effort. His interest in the use of media to manipulate public opinion and to mobilize behavior set the agenda for the remainder of his academic career. When he returned to Iowa after the war, he shifted his academic interests from literature to mass media and accepted an appointment as director of the journalism school. For Schramm, this appointment marked the beginning of his career as a communication scholar.

His first contributions to the field, *Communications in Modern Society* (1948) and *Mass Communications* (1949 [1960]), collections of essays analyzing the significance of mass media in people's lives and their role in influencing public opinion, served as the first textbooks for communication research scholars. They included scholarly research from sociology, anthropology, economics, psychology, and political science. These early readers quickly established the field of communication research as an interdisciplinary field with its roots firmly grounded in the social sciences. A later collection of readings gathered by Schramm as a training manual for the U.S. Information Agency, *The Process and Effects of Mass Communication* (1954 [1971, 1974]), became a classic text for communication scholars. This publication, judged by many to be Schramm's most important book, remains a basic handbook of seminal research on the subject of mass communication.

Another reader that Schramm organized to make research around a common set of themes and issues accessible to the first generation of communication scholars was *The Impact of Educational Television* (1960). This book set the stage for Schramm's programmatic research agenda on the potential of mass media to educate the public. An ambitious original research effort to test many of his hypotheses about the role of media and their potential to educate and inform the public appeared in *Television in the Lives of Our Children* (1961). This classic study integrated findings from eleven distinct research projects conducted by Schramm and colleagues from 1958 through 1960. These studies, taken as a whole, began to explore the complex processes in which television influenced children's lives.

In 1962 Schramm organized another collection of essays, *Educational Television*, on the role of television. In the foreword, he outlined the purpose and significance of the publication, noting that the essays were collected to serve as a tool for everyone—researchers, television producers, audience members—in order to understand the potential of, and the barriers confronting, educational television. In his exhaustive review of the literature, he emphasized the increasing importance of television as an instructional tool.

In 1963 Schramm published *The People Look at Educational Television* with colleagues Jack Lyle and Ithiel de Sola Pool. This study reported the results of extensive interviews at nine representative stations, addressing a series of questions regarding the impact of educational television: who watches it; whether the audience is significant; how educational television fits into the mass media landscape; what educational television means to its audience; and the future of educational television. Throughout the study, Schramm and his colleagues noted the potential of television as an educational medium despite the emerging dominance of entertainment content. Following these broad-based studies from the early 1960s, Schramm's interest in the educational applications of television became increasingly focused.

The inquiries into the rapid expansion of domestic educational television built a foundation for Schramm's emerging international research agenda. He became increasingly interested in the link between educational applications of mass media and economic development. His work in *Mass Media and National Development* (1964) and *Communication and Change in the Developing Countries* (with Daniel Lerner, 1967) outlined his theoretical orientation, assumptions, and research model. Research projects emerged from this approach in Japan, India, Thailand, Samoa, El Salvador, and Indonesia; Schramm and his students launched a series of systematic inquiries designed to test the model, using mass communication systems for development purposes.

Schramm presented an extensive review of the literature that emerged from this research tradition in *Big Media, Little Media* (1977). This thoughtful assessment of the potential of media for educational purposes in a wide array of social, economic, and cultural contexts noted that media systems can certainly be effective teachers but that the extensive body of research on big media (e.g., satellite systems) and little media (e.g., radio) suggests important qualifications and limitations. Schramm's review is concerned with the relationships among cost, productivity, inputs, and outcomes in assessing the effectiveness of instructional technology applications. As he concluded, no one medium can provide a magic solution: "The trend now is to think of a combination of media able to do different things and contribute to learning in different ways. In no effective distant-teaching project is one medium given sole responsibility" (Schramm 1977, 276).

Kathy Krendl

See also

Communication Theory; Distance Education; Instructional Communications

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Science and Technology (K-12 Education)

Science and technology education have enjoyed a meaningful partnership for nearly a century. The work of scientists embraces an array of technologies, and major accomplishments in science are often accompanied by sophisticated applications of technology. Although it has long been a topic of instruction for its own sake, technology—specifically, digital technology—has demonstrated the potential to support national and state goals for improving science education in K-12 education. This potential grows from the way digital and telecommunication technologies expand access to information and increase the ways in which students and teachers can interact—with information, with each other, and with a variety of people who offer new avenues for learning. For some complex science topics, technology can help students gain conceptual understandings in ways that were never possible before.

One example of a complex topic in science education is the concept of scientific inquiry. Teaching “science as inquiry” is the cornerstone of the National Science Education Standards (National Research Council [NRC] 1996), which fueled a nationwide effort to design instruction and assessments to meet this challenging goal. New forms of technologies, such as computer probes, handheld computers, and web resources, are connecting students to the environment, students to experts, and students to each other in ways that scaffold the higher-level thinking needed to participate in and understand science as inquiry. Many new technologies offer capabilities that are intrinsically interesting in and of themselves. Often these capabilities become the focus of instruction regardless of how these features might best be applied for educational purposes. Because the temptation to use technology merely for its own sake is so strong, thoughtful consideration must be applied to determining how contemporary technologies can best be used to enhance subject matter–focused educational goals in science education. The following guidelines for appropriate use of technology in science education are intended to provide assistance in designing instruction and to guide applications of technology to support science education reform (Flick and Bell 2000):

- Technology should address worthwhile science with appropriate pedagogy.
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- Technology use in science instruction should take advantage of the unique features of technology.
- Technology should make scientific views more accessible.
- Technology use in science instruction should develop students' understanding of the relationship between technology and science.

Appropriate Pedagogy

Much has been learned about effective science instruction since the emergence of science education as a field in the 1950s. Teaching science for understanding, instead of for rote memorization, requires students to be active participants who are engaged in asking questions, observing and inferring, collecting and interpreting data, and drawing conclusions (American Association for the Advancement of Science 1993). In essence, science teachers should provide students with opportunities to *do* science, in addition to learning the facts and concepts of science. Appropriate uses of technology should support these goals of effective science instruction and should not be developed merely because technology makes them possible. Technology should be used to enhance student learning of worthwhile science concepts and science methodology. Activities involving technology should make appropriate connections to student experiences and promote student-centered, inquiry-based learning. Indeed, the use of technology in science teaching should support and facilitate conceptual development, process skills, and habits of mind that make up scientific literacy, as described by state and national science education standards. "Student inquiry in the science classroom encompasses a range of activities that are scaffolded by the teacher" (NRC 1996, 33). Teachers scaffold student engagement in inquiry by providing opportunities for, observing, collecting data, reflecting on their work, analyzing events or objects, collaborating with teacher and peers, formulating questions, devising procedures, deciding how to organize and represent data, and testing the reliability of knowledge they have generated.

For example, rather than merely reading in a textbook that the timing of seasons differs in the Northern and Southern Hemispheres, students can go to the World Wide Web and download temperature and precipitation data from multiple geographic locations. After graphing this data in a spreadsheet, analyzing the trends, and comparing data from the hemispheres, students can draw some conclusions, as well as formulate new questions to explore.

With planetarium simulation software, students can quickly and easily explore questions about the relationship between lunar phases and the moon's orbit around the earth, or learn about variations in the sun's position in the sky, as they make observations from around the globe. Rather than being *told* an explanation for the seasons, students can use planetarium simulation software to learn for themselves the key principles from their own simulated observations.

Taking Advantage of Technology’s Unique Features

Studies have clearly documented the value of technological capabilities for enhancing the presentation of complex or abstract content, such as computer visualization techniques (Baxter 1995; Lewis, Stern, and Linn 1993). Technology in science classrooms should take advantage of the capabilities of technology and extend instruction beyond or significantly enhance what can be done without technology. For example, probeware can be used to gather continuous temperature data over long periods of time for inquiry into local weather patterns, and motion detectors can be used to explore concepts of acceleration and velocity. Digital microscopes are finding their way into classrooms, allowing students to easily capture still and video images of microorganisms, as well as capturing time-lapse photographs of beans sprouting, salt crystals forming, and butterflies emerging from their chrysalises.

A concurrent concern with using technology in the science classroom is that the novelty and sophistication of modern technologies might distract or even mislead students from understanding science concepts that are the target of instruction. Two questions that educators should consider when selecting educational technologies include: “Do the capabilities of this technology application support or detract from learning?” and “Is this technology application being used to teach the same scientific topics in fundamentally the same ways as they are taught without technology?”

Using technology to perform tasks that are just as easily or even more effectively carried out without technology may actually be a hindrance to learning. Such uses of technology may convince teachers and administrators that using technology is not worth the extra effort and expense when, in fact, the opposite may be true.

Making Scientific Views More Accessible

Many scientifically accepted ideas are difficult for students to understand due to their complexity, abstract nature, and/or contrariness to common sense and experience. As L. Wolpert (1992, 11) aptly commented, “I would almost contend that if something fits in with common sense it almost certainly isn’t science. The reason again, is that the way in which the universe works is not the way in which common sense works: the two are not congruent.”

A large body of literature concerning misconceptions supports the notion that learning science is often neither straightforward nor consistent with the conceptions students develop from their everyday experiences. Whether described as misconceptions or simply nonintuitive ideas in science (Wolpert 1992), teachers are faced with teaching concepts that pose pedagogical conundrums.

Appropriate educational technologies have the potential to make scientific concepts more accessible through visualization, modeling, and multiple representations. For example, there is evidence that kinetic molecular theory, an abstract set of concepts central to the disciplines of physics and chemistry, may be easier for students to understand if they can see and manipulate representations of molecules operating under a variety of conditions (Williamson and Abraham 1995).

Once identified, the pedagogical task is to select appropriate teaching strategies and representations of content to address these topics. Digital technologies are an important category of options for approaching these conundrums. For example, a familiar but abstract science concept taught in secondary physical science classes is the Doppler effect. The Doppler effect is commonly defined as the change in frequency and pitch of a sound due to the motion of either the sound source or the observer. Although the phenomenon is part of students' everyday experiences, its explanation is not easily visualized or commonly understood.

Computer simulations are able to get past these limitations by simulating the sound waves emitted by moving objects. Being able to see representations of the sound waves emitted by moving objects presents new opportunities for understanding by offering learners multiple representations. Simulations also allow students to manipulate various components, such as the speed of the object, the speed of sound, and the frequency of the sound emitted by the object. Such interaction encourages students to pose questions, try out ideas, and draw conclusions.

An important consideration when using simulations as models for real phenomena is that, while simulations can be powerful tools for learning science, students must not mistake a simulation—meant to make a concept more accessible—for the actual phenomenon. Students should be taught that a sophisticated computer simulation for molecular motion, the Doppler effect, or any other phenomenon is still only a model with inherent assumptions and limitations.

Understanding the Relationship between Technology and Science

Using technologies in learning science provides opportunities for demonstrating to students the reciprocal relationship between science and technology. Extrapolating from technology applications for classrooms, students can develop an appreciation for how advances in science drive technology and, in turn, how scientific knowledge drives new technologies. Computer modeling of chemical structures leads to the development of new materials with numerous uses. In reciprocal fashion, high-quality computer displays and faster computers make possible types of scientific work that were impossible before such advances. This leads to new ideas in science.

It is important to realize, however, that such understandings are unlikely to be learned implicitly through using technology alone. Rather, students must be encouraged to reflect on science and technology as they use technology to learn science. When using microscopes, whether the traditional optical microscopes or the newer digital versions, students can be encouraged to think about how science influenced the development of the microscope and how the microscope in turn influenced the progress of science. For example, the modern compound microscope began as a technological development in the field of optics in the seventeenth century. The instrument created a sensation as early researchers, including Antoni van Leeuwenhock and Robert Hooke, used it to uncover previously unknown microstructure and microorganisms. This new scientific knowledge led to new questions: Where do these microorganisms come from? How do they reproduce? How do they gain sustenance? Such questions, in conjunction with advances in optics, led to the development of ever-more-powerful microscopes, which in turn became the vehicles for even more impressive discoveries. The cycle continues to modern times with the invention of the electron microscope and its impact on knowledge in the fields of medicine and microbiology.

Teachers recognize that when students are making new discoveries of their own with microscopes, they are well positioned to understand the reciprocal relationship between technology and science. For instance, fifth-grade students who are recording video footage of microorganisms with a digital microscope can easily appreciate the concept that new discoveries lead to new questions, as their curiosity is piqued by their observations of the miniature world that exists in a drop of pond water.

Furthermore, students can see how their questions fuel the desire for new technologies, as they experience the limitations of the microscopes available to them. A skilled teacher can exploit the resulting “teachable moment” to encourage students to consider how their experiences with the technology relate to those of real scientists.

Technologies are simultaneously tools for learning about science and examples of the application of knowledge to solve human problems. When students understand technologies as a means of solving human problems, they can be made aware that technologies come with risks as well as benefits. For example, efficiencies of storage and retrieval of information have the associated risks of losing large quantities of data in damaged disks, system malfunctions, or incorrect actions on the part of users. Uses of technology can emphasize how technologies produce trade-offs, for instance, between gaining more sources of knowledge through the Internet and CDs while expending more time and effort sorting appropriate, high-quality information.

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See also

Curriculum Integration; Probeware; Teachers: Preparation and Training; Technology in K-12 Schools; Web-Based Inquiry Science Environment

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Self-Regulated Learning

Self-regulation is the process whereby students activate, modify, and sustain thoughts, behaviors, and affects that are systematically directed toward achieving personal learning goals (Zimmerman 1989). Self-regulation is evident in learners who are both goal-oriented and self-directed; that is, during learning, self-regulated students plan, monitor, and evaluate learning strategies so that they progress toward, and attain, specific learning goals.

Although interest in self-regulation has increased over the last decade, B. Zimmerman (1994) noted that individuals have been encouraged to become educated on their own for more than two centuries, primarily by undertaking personal programs of reading. Historically, as part of these efforts, recommendations have been made for increasing learners' use of self-directed learning strategies. Like other skills, self-regulation skills must be learned; they do not develop automatically as people become older. However, instructional interventions can build and enhance these skills in learners who have not yet developed their full capacities for self-regulation. Therefore, it is important for instructional designers to understand how to embed self-regulated learning strategies within instructional programs and materials that can promote the development of self-regulated learners.

Conceptual Framework

Zimmerman (1994) developed a conceptual framework of self-regulation that delineated six relevant dimensions of learning. Learning dimensions include *motive* (Why should I learn?); *method* (How should I learn?); *time* (When should I learn?); *behavior* (What should I learn?); *physical environment* (Where shall I learn?); and *social context* (With whom should I learn?). A critical element of self-regulation is that learners have a choice in one or more of these dimensions of learning. That is, for any task, learners might be able to choose whether to participate, what methods to use, how much time to spend, what level of proficiency to seek, where learning will occur, and with whom they will learn. To be self-regulated does not require having choices in all six areas; many situations in school allow little choice. Depending on the available choices, however, various subprocesses come into play that have implications for teaching self-regulatory skills. For example, if students can choose at what time they will learn or how much time they will spend mastering a specific goal, it may be appropriate to teach time-management skills. Similarly, if students can choose whether or not to participate in an activity, building self-efficacy for accomplishing the activity or teaching goal-setting strategies may be useful.

Theoretical Perspectives

Although theoretical traditions differ in their definitions of self-regulation, most stress that self-regulated learning involves the personal activation and sustaining of goal-directed cognitions and behaviors. For example, cognitive researchers emphasize mental activities such as attention, rehearsal, use of learning strategies, and comprehension monitoring, along with beliefs such as self-efficacy, outcome expectations, and perceived value of learning. By contrast, reinforcement theorists focus on the overt responses involved in self-monitoring, self-instruction, and self-reinforcement. Although theorists of different traditions agree that students contribute actively to their learning goals, they differ in the mechanisms proposed to underlie students’ use of cognitive and behavioral processes to regulate their activities toward those goals.

Reinforcement theory. Reinforcement theorists study how individuals establish discriminative stimuli (i.e., events or conditions that precede specific behaviors) and reinforcement contingencies (i.e., positive or negative consequences that follow behaviors). Self-regulated behavior involves choosing among alternative courses of action. Key subprocesses are self-monitoring, self-instruction, and self-reinforcement. Research shows that people can be trained to arrange discriminative stimuli, to establish consequences, and to self-administer rewards and punishments. Additionally, techniques can be embedded within instruction to provide cues or consequences for performing each of these tasks. For example, programmed instruction provides learners with immediate feedback regarding their performances, and then, based on those performances, recommends whether learners should repeat a particular step or move ahead to more advanced instruction.

Developmental theory. Developmental perspectives trace the acquisition and change of self-regulatory competencies to include the effects of personal (self) influences and those in the social environment. Developmentally, self-regulation seems to proceed from influence by others to internalization and greater self-control. Many self-regulatory skills are learned through teaching and observation of social models. Research suggests that all of the tasks comprising self-regulatory learning (e.g., preparing for learning, monitoring progress, keeping motivation high) can be provided by teachers or instructional systems, thus fulfilling these self-regulatory functions for learners. The goal, then, becomes one of gradually transferring the initiation and regulation of the learning process from the external control of others to the internal control of the learners.

Developmental theory also establishes a strong link between self-regulation and private speech, or speech that has a self-regulatory function but that is not socially communicative. Lev Vygotsky believed that private speech develops thought by organizing behavior. Children employ private speech to understand situations and surmount difficulties. Private speech becomes covert with development, although overt verbalization can occur at any age. Inadequate use of private speech to regulate behavior might reflect a production, mediational, or continued-use deficiency. A *production* deficiency occurs when a child fails to generate task-relevant verbalizations (e.g., rules, strategies to be remembered). A *mediational* deficiency occurs when task-related verbalizations are produced but do not affect subsequent behavior. Finally, a *continued-use* deficiency arises when students have an inadequate understanding of the strategy, possibly due to insufficient instruction or practice. Instructional training can help individuals learn to verbally self-regulate performances. For example, task-relevant verbalizations can be provided by instructional materials to help learners develop fluency in the use of their own verbalizations. Types of statements might include those related to problem-definition (“What do I have to do?”), focusing of attention (“I need to pay attention to what I am doing”), planning (“I need to work carefully”), self-reinforcement (“I’m doing fine”), self-evaluation

(“Am I doing things in the right order?”), and coping (“I need to try again when I don’t understand”).

Social cognitive theory. Social cognitive theory emphasizes the interaction of personal, behavioral, and environmental factors. Because these factors frequently change during the learning process, self-regulated learners monitor them in an ongoing, cyclical fashion. Such monitoring leads to changes in learners’ strategies, cognitions, affects, and behaviors. The cyclical nature of this process is captured in Zimmerman’s (1998) three-phase model of self-regulation (forethought, performance control, self-reflection). The *forethought* phase precedes actual performance and includes processes that set the stage for action such as goal-setting and modeling. The *performance control* phase includes processes that occur during learning and affect attention and action such as social comparisons, attributional feedback, and self-verbalization. The final phase, *self-reflection,* occurs after performance during which individuals respond to their efforts using processes such as self-evaluation, self-monitoring, and the application of reward contingencies.

Social cognitive theory postulates that perceived self-efficacy, or personal beliefs about one’s capability to learn or perform at designated levels (Bandura 1997), is a key variable that affects all three phases of self-regulation. For example, students enter learning situations with varying degrees of self-efficacy for learning (forethought). As they engage in the task (performance control), they use self-regulatory strategies on the basis of their knowledge of them, their beliefs that the strategies are effective, and their efficacy for using them skillfully. During periods of self-reflection, students evaluate their learning progress. Perceived progress sustains self-efficacy and motivation, which in turn enhance learning.

According to social cognitive theory, self-regulation is situationally specific; that is, people are not generally self-regulated or non–self-regulated. Although some self-regulatory processes (e.g., goal-setting) may generalize across settings, learners must understand how to adapt these processes to specific domains and must feel confident about doing so. Instructional designers can embed self-regulated learning strategies and cues into instructional materials as one way to prompt learners to set learning goals, employ effective cognitive strategies, and evaluate learning progress.

Information-processing theory. From an information-processing perspective, self-regulation requires metacognitive awareness, which includes knowledge of the task requirements as well as personal resources available for the task (e.g., prior knowledge, competency with given learning strategies). Self-regulated learning necessitates that learners understand task demands and their own personal strengths and weaknesses, as well as effective strategies for completing the task. Self-regulation is a type of metacognitive control, whereby students manage their learning of material, monitor the level of learning, determine when to take a different task approach, and assess test readiness. As a function of metacognitive control, then, self-regulation allows students to select, manage, and monitor learning strategies needed to be successful on specific learning tasks. Prompts, similar to the questions included in Table 1 (Ertmer and Newby 1995), can be built into instruction to help learners consider task requirements and personal resources, as well as appropriate learning strategies.

As suggested by Table 1, strategies can be of a cognitive, motivational, or environmental nature and may include activities such as selecting and organizing information, rehearsing material to be learned, relating new material to information stored in memory, enhancing the meaningfulness of material, and creating and maintaining a positive learning climate. To formulate a learning strategy, learners analyze the situation and their personal characteristics, devise a plan to accomplish the learning goal, implement the plan, monitor progress, and modify the plan as necessary. Metacognitive knowledge guides the operation of these steps. Learners select methods that they believe will help them attain their goals. As an example, consider the following scenario that illustrates how the process of self-regulated learning might proceed (adapted from Ertmer and Newby 1995, 10–11):

Before beginning a specific learning task, self-regulated learners tend to consider a variety of ways to approach the task. They access their metacognitive knowledge to recall past experiences with similar tasks and to select an approach that matches task requirements and personal resources in such a way that the desired results are obtained. Effective learners have a plan (either in their minds or on paper) that details how they expect to accomplish their goal. While executing the task, they constantly reflect on this plan to assess the extent to which it is working, then revise or modify it as necessary. As a result of this continuing reflection, expert learners make constant online adjustments, eliminating extraneous steps, implementing alternative strategies, and/or performing unplanned actions when necessary. In the event that an unavoidable or insurmountable block is encountered, self-regulated learners may even temporarily discontinue the task in order to locate additional information, secure outside help, or invest effort in learning new strategies that would be more effective.

Self-Regulation and Motivation

Regardless of theoretical tradition, self-regulation fits well with the notion that students contribute actively to learning goals and actively participate in the construction of their knowledge. According to M. Driscoll (2000), self-regulation becomes possible when learners acquire the metacognitive skills needed to monitor their progress toward goal attainment and sustain their own motivation during learning.

Table 1: Questions a Self-Regulated Learner May Ask during
Three Stages of Learning (adapted from Ertmer and Newby 1995)

Plan

Cognitive

- What is the goal of this lesson/task?
- What strategies are most effective with this type of task?
- What do I know about this topic/task? What useful skills do I have?

Motivational

- Does this task require a great deal of concentration and effort?
- How do I feel about this kind of task? Do I like this kind of work?

Environmental

- What kind of study conditions are best for meeting the requirements of this task?
- When and where do I study best? Is that time and place available for this task?

Monitor

Cognitive

- Are the strategies I've chosen working with this task? Have the task demands changed in any way?
- Do I understand what I am doing? Am I making progress toward the goal?

Motivational

- Is this task holding my attention? Is this lesson/topic interesting to me?
- How am I feeling as I work on this task? What is my level of confidence?

Environmental

- How supportive is the learning environment? Do I need to find a new place to work?
- What outside materials or resources should be added?
- Am I giving myself the time I need?

Evaluate

Cognitive

- How well did my approach work with this task? What did I do when strategies didn't work?
- When else could I use this approach? How could I improve this approach?
- Did I achieve my goal? What did I learn about this topic/task?
- What new goals do I have now?

Motivational

- How much effort was required to complete this task? How did I stay motivated?
- How do I feel about the outcome? Did I enjoy this work?

Environmental

- Did I encounter any unexpected obstacles in completing the task? How did I remedy the problem(s)?
- How well did I arrange my study environment? Did I choose a good time and place to study?

Source: Adapted from P. A. Ertmer and T. J. Newby (1995). *The Expert Learner: Strategic, Self-Regulated, and Reflective. Instructional Science,* 24: (1), 1–24. Used with permission of Kluwar Academic.

Although self-regulation and motivation are not synonymous, they are related. Processes such as goal-setting, self-efficacy, and outcome expectations are important motivational variables that affect self-regulation. Other motivational factors that are important for self-regulation include values, goal orientations, self-schemas, and help-seeking. Collectively, these factors may help determine how achievement behavior is instigated and sustained as learners engage in choices regarding the content, location, timing, and outcomes of their learning.

As noted above, simply knowing how to use strategies does not guarantee that students will use them when required to do so. Learners need to be taught to use self-regulated learning strategies. A common approach is a constructivist one in which teachers and students assist in formulating effective strategies for learning. Strategy instruction often is incorporated into programs designed to enhance academic studying. Strategies also are taught in conjunction with time management. Regardless of the domain, an important aspect of training is providing students with strategy value information that links improved performance with effective strategy use.

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See also

Active Learning; Cognitive Psychology; Gagné, Robert Mills; Instructional Design; Vygotsky, Lev

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Simulation and Gaming

Simulations and games are interactive exercises that transport learners to other worlds where the participants control the action. For example, student teams may compete to answer vocabulary questions to reach a pot of gold (game), sift through a miniature archeological site and analyze the artifacts (simulation), or manage a financial institution for several business cycles (simulation).

Overview

Although games and simulations foster maximum student involvement in learning, they differ in purpose, participant responsibilities, and the nature of the interaction. Academic games are competitive exercises that consist of an objective, rules of play (including penalties for illegal actions), and paraphernalia to execute the play, such as tokens, cards, or computer keys. The sequence of game events typically is linear. That is, the player or team responds to a content-related question and either advances or not depending on the correctness of the answer.

Unlike recreational examples, academic games base winning on knowledge in a defined subject area, such as literature or mathematics. Furthermore, to be fair, academic games should be designed so that luck (such as guessing or the draw of a particular card) or strategies with questionable ethics (such as bankrupting other players) are not factors in winning. Example of academic games range from simple exercises, such as matching fractions to their decimal equivalents, to more complex contests, such as classroom tournaments involving several teams.

Simulations differ from games in three major ways. First, they are evolving problem-solving situations that model a particular social or physical reality. Examples include a town facing the tourism threat of a proposed nuclear reactor and a computer model of an ecosystem.

Second, the goal is not that of winning. Instead, participants assume bona-fide roles with well-defined responsibilities and constraints and, in a series of decisions, address the issues raised in the simulation. In a face-to-face exercise, for example, the mayor, business owners, environmentalists, and other citizens address the issues raised by a proposed nuclear reactor (experiential simulation). In another example, a research team, working with a computer, addresses the health of an ecosystem presented in the software (symbolic simulation).

Third, in games the rules establish rewards and penalties for different actions of the players. By contrast, the feedback to simulation participants is in the form of reactions of other participants and/or the effects of each action or decision on the problem. A government official advocating the installation of a nuclear reactor, for example, precipitates objections from the tourism director in the nearby seaside town. In another situation, a medical student treating a comatose “patient” receives the elevated blood-pressure reading resulting from the stimulant he administered. Thus the event sequence in a simulation is branching; the problem takes different directions in response to the actions of the participants.

Simulations differ from role-playing activities in complexity, duration, and role specification. A role-play is a ten- to twenty-minute exercise that is a single incident; participants improvise their roles. An example is a school principal talking to an angry parent. By contrast, simulations address multidimensional evolving problems and run from fifty minutes to several days; role descriptions include goals, constraints, background information, and responsibilities.

Games and simulations may utilize computer technology either to assist with data analysis or as the medium to deliver the exercise. Medical schools, for example, implement patient-management simulations that are computer-based. However, some computer-based exercises that purport to be simulations or games fail to meet basic criteria. Some are guessing exercises in which the computer randomly generates conditions or consequences. Others are dominated by graphics and/or sound to the exclusion of meaningful interaction by the participants. For example, simply observing a simulated event, such as a chemical reaction on a computer screen, does not constitute a simulation experience for the learner.

Academic Games

From the early use of spelling bees, classroom games have evolved to fulfill any of four academic purposes: (1) to practice and/or refine already-acquired knowledge and skills; (2) to identify gaps or weaknesses in knowledge or skills; (3) to serve as a summation or review; and (4) to develop new relationships among concepts and principles. For example, the object may be to match chemical formulas to names, to classify paintings into styles or periods, or to roll a pair of dice and form algebraic equations from the numbers and symbols that are showing.

Games also may be used to reward students for working hard or doing well on a particular lesson. A version of Twenty Questions in which the task is to identify a particular author or historical event is one example.

Academic games are appropriate with any group of learners in any setting that addresses the learning of knowledge, procedures, or problem-solving skills. An example, designed for a workshop for cafeteria workers, awards points for identifying errors in food arrangement, nutritional balance, and color and format in printed menus. Another is a game that helps to teach slow learners number recognition by matching number squares to different-sized groups of objects.

Five issues are important in the design or selection of games for the classroom. Already mentioned is that winning is based only on the demonstration of knowledge, not on other factors. Second, the game should address important concepts or content, not trivial details. That is, the knowledge required in the game should apply to situations beyond the exercise.

Third, rules and constraints should be easy to understand, and the exercise should be challenging and interesting to the learners. Some games add interest by assigning weights to different difficulty levels of questions (e.g., 1 = easy, 3 = difficult) accompanied by teams' choice in the level of question they wish to attempt.

Fourth, students should not lose points for wrong answers. Punishing learners for errors also punishes their effort and generates frustration. Instead, errors should simply not permit players to advance in the game.

Finally, games should not be zero-sum exercises. In zero-sum games, such as Monopoly, players periodically receive rewards for game-sanctioned actions. However, only one player achieves an ultimate win while others exhaust their resources. The problem with such games in the classroom is that many students (players) may demonstrate substantial learning but are not recognized as winners. Solutions include providing for several winners (e.g., team with the fewest errors, team with the best strategy) and defining success in terms of earning a certain number of points. In this way, teams are playing against an external standard rather than competing against each other to be the only winner.

Manual games are limited in the amount and extent of feedback they can provide for learner actions. The data-processing capability of the computer, by contrast, makes possible the use of sound and graphics. Teachers report that computer games are useful in addressing weaknesses in students' basic mathematical skills because they are interesting and provide a nonthreatening environment for correcting student errors.

However, the inappropriate use of sound and graphics can lead to two problems: They are drawing so much attention that they detract from the application of one's learning, and they are inadvertently rewarding guessing and wrong answers. The latter problem occurs when the sound and/or graphics following a wrong answer are more interesting than that for correct answers.

Computer technology also has the capability to present games with branching sequences for different levels of sophistication in student answers, as well as games that require reasoning skills. However, to date, commercially available computer games that purport to teach critical thinking and reasoning skills are simply puzzles. Winning requires only a good memory in order, for example, to match objects to cells.

Advantages of games in the classroom are that they can increase student interest and provide opportunities to apply learning in a new context. A disadvantage is the time required for implementation. A current problem in the field is the lack of well-designed computer games for classroom use.

Experiential Simulations

Experiential simulations are dynamic case studies, or social microcosms with the participants on the inside. Learners step into scenarios and execute well-defined roles with associated responsibilities and rewards. Originally, simulations were developed to provide learner interactions in situations that are too costly or hazardous to address in real-world settings. Early examples, developed in the 1600s, were war games, in which opposing “armies” attempted to defeat each other. More recent examples are pilot and astronaut simulators used during training.

The need to provide real-world experiences for other learners led to their introduction into the broader educational setting. Initially, efforts to replicate complex problem-solving situations in education were in the form of in-basket exercises. The student, in a decisionmaking role, responded to a series of written communications in her in-box. One exercise, centered on a typical school system, included roles for the superintendent and an elementary and secondary school principal.

The importance of providing realistic nontextbook problems for different professions led to the replacement of crude exercises with sophisticated interactive exercises. Examples include case diagnosis and management by medical students, social workers, and counselors, and the management of financial institutions and other enterprises by business students.

Experiential simulations should develop knowledge and/or insights that participants can apply to new situations or problems. Currently, the varied purposes include developing an understanding of the dynamics of complex social organizations, developing an ability to communicate in an unfamiliar situation, and executing professional expertise. Essential components of experiential simulations are: (1) a scenario of a complex task or problem that can take any of several directions; (2) specified roles for participants that include responsibilities, resources, and constraints; (3) learner control of the decisionmaking; and (4) changes in the problem or situation that result from learner actions.

Because experiential simulations are models of real-life situations, validity—the fit between the structure and the reality it reflects—is particularly important. For example, is chance used appropriately to represent unpredictable influences, or is it used inappropriately for purposes such as speeding up the exercise? Also important for validity is that the learner experience the feelings, questions, and concerns associated with the particular role.

Experiential simulations may be face-to-face, technology-supported, or technology-based exercises. The delivery mechanism depends, in part, on the purpose of the exercise. For example, understanding the complex social processes involved in addressing the placement of a nuclear reactor near a seaside town requires a face-to-face exercise with townspeople. The focus of such simulations is the ways one's beliefs, assumptions, goals, and actions may be questioned, supported, or hindered in interactions with others.

Simulations to enhance language learning also involve face-to-face communication. Exercises that put students in charge of resources with the requirement to use those resources to optimize outcomes are particularly useful. Simulations that require decisions about running a fast-food booth at a fair or allocating a workforce to operations in a manufacturing plant are examples.

By contrast, patient-management simulations in which a medical student selects and interprets data and selects corrective actions for a complicated illness typically are computer-based. After the student enters each particular decision, computer feedback indicates test results or describes the effects on the virtual patient. Here the focus is on identifying the level of the student's skills as she faces complications in the changing situation.

Other simulations that require data analysis at particular points are technology-supported. For example, business teams confer and make decisions about investments, loans, and corporate operations for their respective companies for the next quarter. The computer analyzes the inputted data and provides each team with an updated printout on the institution's financial condition, the basis for the next set of decisions. The focus is on the interrelationships among profitability, liquidity, and solvency and between profits and business volume.

Experiential simulations vary in the type of reality reflected in the exercise and the type of causal model that links actions and consequences or effects. In face-to-face simulations that reflect social processes, contingencies for different actions are imbedded in the scenario description and various role descriptions. For example, the role cards for space travelers stranded on a strange planet each contain two or three unrelated bits of information important for survival. Clear communication and careful listening by the participants are essential if they are to find food and water and stay alive.

By contrast, development of computer-based simulations requires: (1) the identification of an open-ended problem; (2) the development of the likely decisions and courses of action (both positive and negative) that a problem-solver may undertake; (3) the validation of the proposed options by experts in the discipline; and (4) the specification of the changes in the problem that follow each action by a participant.

Finally, the management of financial institutions, the economics of a country, and similar exercises involve quantitative relationships among variables. The simulation designer specifies the set of mathematical equations that reflects these relationships. During the simulation, the computer program adjusts the values of the variables, such as profits, for each virtual company after the management team enters its financial decisions each quarter.

To be maximally effective, the participant's experience should lead to reflection and new patterns of thinking. Essential to this purpose is the postsimulation activity referred to as debriefing. The three components of a debriefing following a team exercise are: (1) determining the events that occurred; (2) identifying participants' thoughts and feelings about the events; and (3) developing initial generalizations based on the experience. For a single-participant simulation, such as patient diagnosis and management, the first task is to determine the student's perception of her performance during the exercise and some general view of strengths and weaknesses. Then a discussion of the student's specific decisions concludes with the selection of follow-up activities for the student.

Advantages of experiential simulations are that they bridge the gap between the classroom and the real world, provide experience with complex nontextbook problems, and can reveal student misconceptions and misunderstandings. Furthermore, implementation of patient or client-management simulations can provide information about students' problem-solving strategies, whether thoughtful and discriminating, shotgun, or random. A disadvantage of experiential simulations is the time required for implementation and debriefing.

Symbolic Simulations

Increased computer capabilities in recent years have led to the development and implementation of symbolic simulations. They differ from experiential simulations in two major ways. First, a symbolic simulation is a dynamic representation of the functioning or behavior of a data universe or a physical or biological system by another system, a computer. A key characteristic is that symbolic simulations reflect the dynamic interactions of several variables. Examples include a population ecology simulation that portrays the effects of particular variables on population, capital investment, food production, and pollution; and a steam plant system and subsystems with operational valves, components, throttles, dials, thermometers, and digital printouts.

The second difference with experiential simulations is the role of the learner. The experiential simulation immerses the student in an evolving situation in which the learner is one of the functioning components. That is, through their actions, participants can change and redirect events within the social reality of which they are a part. By contrast, the student interacting with a symbolic simulation is not a functional element of the situation. Instead, the student functions as a researcher or investigator and tests hypotheses about relationships among the variables in order to correct a problem, predict future trends, or troubleshoot equipment.

Important student skills required for interacting with symbolic simulations are relevant subject-area knowledge and particular research skills. That is, students should be proficient in developing mental models of complex situations, testing variables systematically, and revising one's mental model if necessary. For example, interacting with a simulation to compare the characteristics of different generations of organisms requires an understanding of classical Mendelian genetics and strategies for plotting dominant and recessive genes.

Symbolic simulations differ from two other types of computer-based exercises that use dynamic graphics. One is a discrete problem accompanied by visuals. So-called dry labs in science, which are sets of specific experiments, are examples. The other type of exercise that is visually based is the microworld. Found in mathematics and science, microworlds are defined as elements and operations accompanied by operations for acting on or transforming the elements. Microworlds typically are used for open-ended explorations by learners. An example is LOGO, which allows learners to discover geometric principles as they construct designs with a cybernetic figure referred to as a turtle.

A disadvantage of symbolic simulations is the time and effort required for development. However, once developed and field-tested, they are a valuable resource for student development of model-building and hypothesis-testing skills involving complex interactions.

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See also

Active Learning; LEGO/Logo; MOOs and MUDs; Problem-Based Learning; Situated Cognition; Virtual Reality

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Situated Cognition

Situated cognition is a general theory of how knowledge is acquired. This theory emphasizes the importance of the activity, culture, and context in which knowledge is learned. In other words, the way knowledge is learned is situated in, or dependent on, the situation. Key principles of this theory include the need for an authentic learning context or a context in which the knowledge would normally be applied; social interaction or collaboration among the learners; and progressively more sophisticated development of understanding. Educational technology can provide opportunities for simulating authentic environments, facilitating collaboration among geographically disparate individuals, and developing instruction that meets a learner at his current level of understanding.

Traditional Teaching and Learning

The theory of situated cognition contrasts with several assumptions about learning that are prevalent in all levels of education today (Berryman 1991). It contradicts the idea that knowledge is easily transferred from one situation to the next and emphasizes a need to help students transfer knowledge among school disciplines, from school to everyday practices, and vice versa. It also contradicts the idea that learners are passive receivers of knowledge and that teachers are information providers; it thus emphasizes the need for students who are actively involved in their own learning processes. Finally, it contradicts the idea that learners are blank slates, and it emphasizes students' prior knowledge and experiences in the learning process.

The difference between traditional instructional methods and situated cognition is sometimes referred to as the difference between "know-what" and "know-how" (Brown, Collins, and Duguid 1989). Traditional didactic instructional methods assume a distinction between knowing and doing, whereas situated cognition challenges this assertion and claims the two cannot be separated. An excellent example of this distinction uses the issue of vocabulary development (Miller and Gildea 1987). Vocabulary is typically taught in schools by having students look up definitions in the dictionary and write sentences using those words. This knowledge is often tested through multiple-choice or fill-in-the-blank tests. This typically results in no more than 200 vocabulary words per school year and frequently is useless in practice because students cannot apply the words correctly in context. By contrast, vocabulary is naturally developed in the context of ordinary communication, and children learn an average of 5,000 words per year through the first sixteen years of their lives through ordinary communication with others (Miller and Gildea 1987).

To explain the idea that concepts must be both situated and gradually built upon from previous knowledge, a metaphor of conceptual knowledge as a set of tools is useful (Brown, Collins, and Duguid 1989). Just as it is entirely possible to acquire a tool and be unable to use it appropriately, children frequently acquire algorithms and definitions that they are unable to apply. And just as the same tool may be used differently by people in different fields, so may algorithms and definitions. To illustrate this point, consider how a carpenter and a cabinetmaker use a chisel differently, or how a physicist and an engineer use a mathematical formula in different ways (Brown, Collins, and Duguid 1989).

In order for students to develop more than a surface understanding of conceptual knowledge, they must essentially learn to use tools (or concepts) as practitioners do. This means developing reasoning skills via contextual understanding and causal models rather than through concrete laws, definitions, or algorithms; resolving ill-defined complex problems rather than well-defined problems with one correct strategy and solution; and producing multiple meanings of conceptual knowledge that is based on social interactions and deep understanding rather than on fixed meanings and absolute conceptions (Brown, Collins, and Duguid 1989).

Instructional Stategies

Situated cognition has principles very similar to the concept of active learning. Numerous instructional strategies may be considered when implementing the theory of situated cognition and the principles of active learning, including: anchored instruction, collaborative learning, problem-based learning, cognitive apprenticeships, and case-based instruction. A brief definition of each follows (see also the relevant entries in this encyclopedia). Although the strategies are presented separately, they are rarely used independently, as there is considerable overlap among them.

Anchored instruction is grounded in a realistic event or problem that is meaningful and motivating to students, is complex, requires consideration of multiple perspectives and solutions and use of multiple processes, and facilitates collaboration, cooperation, and negotiation.

Collaborative learning is built on the need for students to collaborate with each other to share perspectives, solutions, and plans related to a complex task or scenario. Collaborative learning requires individual accountability within a group situation and parallels expectations in today’s workforce.

Problem-based learning is grounded in the process students go through to solve a realistic problem and requires self-directed learners, acquisition of content knowledge, and use of metacognitive strategies (Savery and Duffy 1995).

Cognitive apprenticeships are modeled after traditional apprenticeships. Whereas traditional apprenticeships involved learning a visible activity or skills, cognitive apprenticeships involve using mentors to model processes that are typically invisible, such as problem-solving, comprehension, and computation.

Case-based instruction involves the use of stories or teaching "cases" to facilitate contextual knowledge and understanding.

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See also

Active Learning; Anchored Instruction; CaseNEX; Cognitive Apprenticeship; Computer-Supported Collaborative Learning; Jasper Woodbury; Problem-Based Learning

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Social Studies and Technology (K-12 Education)

Due to its close relationship with information literacy, the social studies classroom has been greatly influenced by the impact of technology integration. Information literacy refers to equipping students with "both knowledge about the subject-specific content and research practices of particular disciplines, as well as the broader, process-based principles of research and information retrieval" (Grafstein 2002, 197). Technology lends itself to the active exploration of history and, in theory, the development of lifelong learning (Bass and Rosenzweig 2000). The Internet allows for the expansion of perspectives, content, and issues (Newmark 2000) by broadening the scope of the social studies classroom. Especially for schools in the United States, the Internet offers the opportunity to steer away from resources that are predominantly written from a Western perspective (Newmark 2000).

Although some researchers argue that the content of social studies is already too full (Stoll 1999), others identify the need for students to become technically literate in order to serve as productive, democratic, informed citizens (Martorella 1997). Students of social studies in the information age need to understand historical and social concepts and events in addition to developing critical thinking and the analysis of resources available through a variety of media (McKenzie 1998).

Based upon the analysis of data collected on a statewide Massachusetts technology integration program (Learning Network), researchers linked the systematic integration of technology within the social studies classroom to the promotion of student achievement and standards-based lesson development (Danker 2000). A longitudinal study, which followed the formal integration of technology within an Alabama secondary social studies classroom over a period of five years, associated technology integration with increases within the skill level of students' critical thinking, collaboration, presentation, and self-learning (Rice et al. 2001). Additionally, the use of technology within the social studies classroom has been linked with an increased application of constructivist learning (Dils 1999). Technology in the social studies classroom has been identified as a successful motivator to "serve" learning to students (Bass and Rosenzweig 2000).

Effective Uses of Technology

Educators have overwhelmingly responded to the need to integrate technology within social studies. As a result, many examples of dynamic and creative utilization are available. A brief description of some of the more commonly used pedagogical strategies is provided below.

With the use of productivity suites that include presentation software and spreadsheet applications, a social studies educator can develop tools for enhancing the traditional classroom lecture (Dils 1999). With even a limited amount of technical proficiency, presentations can incorporate historically accurate visuals, audio clips, and video clips. Additionally, when working with geographic elements, maps (which are current) can be layered so that students can simultaneously identify physical and political elements of an area. Using a spreadsheet, students can manipulate data in order to identify and analyze the resulting consequence. Additionally, students can visually represent data from a variety of perspectives through the development of charts and graphs (White and Glenn 1984). For example, a government class could analyze the results of the 2000 presidential election from the perspectives of the Electoral College and the popular vote. Visual representation of the figures in such a case can assist in the discussion of this key governmental concept.

Likewise, the traditional written report completed by students can be transformed into the development of high-level multimedia productions (Howard 2001). Authentic assessment through the use of multimedia provides educators with a more detailed indication of the educational growth of each individual student by analyzing his growth in both process and product development (Prestidge and Glaser 2000).

In 1995 Bernie Dodge introduced the concept of WebQuests to the educational environment. This Internet-based strategy provided a context for educators to incorporate inquiry-based learning with the utilization of a variety of resources (Dodge 1995). The impact of this strategy has been great and is also linked with an increased use of collaborative strategies within classrooms (Milson and Downey 2001). Online databases provide educators and students with an abundance of resources to supplement the content of a typical social studies curriculum (James 2001). A recent study indicated that students using online resources tend to revisit the resources more often than print-based resources (Kelly 2000). In addition, the same study also identified that exploring on the web did encourage a higher level of original thought and reflection within history students (Kelly 2000). WebQuests provide educators with a teaching strategy that emphasizes the richness of online resources, the benefits of collaboration, and the excitement that is inherent within inquiry-based activities (Dodge 1995).

As a result of using resources found on the Internet, many social studies educators require students to critically examine the content, currency, and credibility of the web-based resources (Rayner 1999). The process of online research and analysis is indicative of challenging students to participate in higher-order thinking (Dils 1999) and has been identified as a critical learning skill for social studies students (Warren 1999).

In an effort to increase the utilization of primary resources within the social studies curriculum, educators have used e-mail as a means for students to directly communicate with experts, historical witnesses, political analysts, and international peers. Through this interaction, students are provided with an opportunity to discuss and analyze a variety of perspectives that may not be readily available within the geographic constraints of their environment (Newmark 2001). An additional method for increasing primary resources has been found with the incorporation of message boards, chat rooms, and other asynchronous communication devices (Newmark 2001). Asynchronous environments can also encourage students to actively reflect upon their personal learning when they are required to conduct self-assessment and/or journaling techniques as part of the learning process (Bowman 2001).

Educational computer software in the form of tutorials, simulations, reference sets, and video collections has also served to enhance the curricular needs of the social studies classroom (Wassermann 2001). Titles such as Oregon Trail, SimCity, and Hot Dog Stand are all examples of dynamic applications that can be used to underscore and supplement basic historical and social concepts. These types of simulations provide students with an opportunity to manipulate data and identify resulting consequences within the context of an authentic assessment system (Staley 2000).

Challenges

The infusion of technology into the social studies curriculum also faces potential pitfalls. Funding, technical support, and adequate training are all prominent issues and barriers that face the educational technology community (Danker 2000; Wassermann 2001; Mulqueen 2001; VanFossen 2001).

These barriers block the smooth integration of technology and complicate the development of pedagogical strategies that incorporate technology.

At times the inclusion of technology adds yet another dimension to an already packed social studies curriculum (Stoll 1999). Due to the inherent differences in the pedagogical styles of traditional classrooms and technology-infused classrooms, traditional forms of assessment must be modified to reflect the paradigm of technology (Bass and Rosenzweig 2000). This move toward authentic assessment can be overwhelming for educators as they work to balance professional accountability with new forms of assessment (Prestidge and Glaser 2000).

The evaluation of resources is a critical component to identifying materials that enhance curricular development. Certain educational software titles focus upon passive learning as opposed to active engagement (Bass and Rosenzweig 2000). Additionally, this same passivity is reflected within educational environments that do not directly couple higher levels of critical thinking with the integration of technology (Bass and Rosenzweig 2000). It seems as though educators must look to strategically select engaging resources as well as instructional methods that stimulate the learning environment (Milam 2002).

Future Issues

The future of the social studies classroom is embedded within the skills of the information age (Martorella 1997). It is critical that social studies curricula utilize technology in such a manner that students can acquire skills to assist in their future political participation, geographical exploration, and information analysis within the digital world (Gooler 1995).

An *Education Week* survey indicated that teachers are “more likely to feel better prepared to use technology in their classrooms if they receive curriculum-integration training than if they receive basic-skills training” (Jeraid and Orlofsky 1999). In response to this finding, professional development for in-service teachers and methods instruction for preservice teachers must blend the acquisition of technical skills with content-based strategies (Diem 2002).

Preservice teacher education programs seem to have initiated a response to the call for additional technology integration within content-based methods instruction (Mason et al. 2000). The emphasis of such programs is upon the ability of technology, particularly the Internet, to increase future teachers’ recognition of available resources and specific recommendations for integration. The future of technology integration within the social studies curriculum is dependent upon the expansion of such programs for both preservice and in-service educators.

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See also

Curriculum Integration; Information Literacy; Teachers: Preparation and Training; Technology in K-12 Schools; WebQuests; *Who Built America?*

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Society for Information Technology and Teacher Education (SITE)

The Society for Information Technology and Teacher Education is a nonprofit international association of individual teacher educators, affiliated organizations of teacher education in all disciplines, and others who are interested in the creation and dissemination of knowledge regarding the use of information technology in teacher education and related professional and organizational contexts. This society encourages appropriate uses of information technology (IT) in teacher education worldwide. Its scholarship and annual meetings benefit a membership of more than 1,000 technology-using teacher educators from more than 40 countries. Membership is open to anyone with an interest in information technology in teaching education. SITE seeks to promote research, scholarship, collaborative exchange, and support among its membership and to foster the development of new national organizations as the need emerges. SITE is the only international organization that has as its sole focus the integration of instructional technologies into teacher education programs and organizations. Since its inception, SITE plays a significant role in promoting reflective, participative leadership in the use and deployment of new technologies in teacher education nationally and internationally.

Founded as the Society for Technology and Teacher Education in 1990 in the United States, the first national conference was in Greenville, North Carolina. The founding president of SITE was Jerry Willis. Jerry Willis and DeeAnna Willis led the organization of the first two conferences and edited the conference proceedings. The first proceedings were published as a special volume of the *Journal of Computers in Schools.* Proceedings were published as an edited annual (which later changed to conference proceedings), published at the time of the conference. Refereeing and editing support were obtained from section editors, which was an innovation at that time. SITE was also one of the first societies to simultaneously publish proceedings in paper and CD-ROM formats.

The foundation of SITE was supported by the older but smaller UK-based Association for Information Technology in Teacher Education. In recognition of this collaboration, the two organizations formed an accord in 1995 whereby membership of one organization provided members benefits to both. Other notable events included the first volume of the societies' scholarly *Journal of Technology and Teacher Education* (*JTATE*) in 1993; collaboration on the federal Office of Technology Assessment (1994) study of technology in teacher education; and the online journal *Current Issues in Technology and Teacher Education* (*CITE*) in 2000.

Leadership and Governance

The society is led by its president and governed through an executive committee chaired by the elected president. SITE's working committees have been reorganized following the acceptance of governance to be led by a vice president and an associate vice president, and they remain open to all participants, supported by meetings at the annual conference and in an online forum (www.aace.org/site/forum). As the number of working committees grows they will be organized into three councils to promote intercommittee communication. The three councils will be the SITE Specialist Council for content areas, including science, math, English, and information technology as a discipline; the SITE Generalist Council for cross-curricular themes, including distance education, social justice and equity, and research and evaluation; and the SITE Leadership Council for the societies' leadership interests, including the conference committee and publications.

As described in the governance document at www.aace.org/site/Site_governance.htm, the main ongoing activities of the society are the annual conference and its proceedings, scholarly journals (the traditional *JTATE* and the online *CITE*), websites, and ongoing working committees.

SITE's main activities are the annual conference and publication of the two journals, managed on a day-to-day basis by an executive director, with services provided through the Association for the Advancement of Computing in Education (AACE). AACE is also a nonprofit organization (www.aace.org). The president and the executive council currently lead the planning of the annual conference. SITE is increasing its shared leadership approach with its committees to increase their influence on their sections within the conference. This began with the 2001 nomination of proposals for awards. The reorganization of SITE's committees following adoption of the governance has also improved links with related professional associations, such that membership of SITE's committees overlaps with a committee of related professional associations of teacher educators. The online journal *CITE* also shares editorial control across its sections with the related discipline association (see Bull et al. 2000).

SITE aims to take a proactive role to reform education. In 1999 the past and current presidents of SITE cowrote the Ames White Paper that set out the principles for technology in teacher education and provided a set of recommendations to national policymakers (Willis, Thompson, and Bull 1999). Currently, leaders within SITE are participating in a number of commissions and task forces within and beyond the United States to provide guidance to teacher educators and their organizations. Finally, SITE's commitment to educational renewal for societies worldwide has resulted in the creation of a special award for digital equity in teacher education. This award was instituted in 2002 to spread good practice, raise the profile of the ways in which technology can increase access to education through good practice in teacher education, and heighten awareness of these issues.

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See also

Association for the Advancement of Computing in Education; Instructional Technology; School Reform; Teachers: Preparation and Training

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Teachers: Preparation and Training

The potential of technology to revolutionize teaching and learning in K-12 schools has been recognized, and billions of dollars have been invested to realize this dream. As business has discovered, however, realizing the potential of technology demands adequate and ongoing training of those who are expected to use the technology. In schools, the most crucial need is to train teachers to become technology-proficient educators who can use these tools to improve the learning of their students.

The need to prepare new technology-using teachers was chronicled by the congressional Office of Technology Assessment (OTA) in its landmark 1995 report, *Teachers and Technology: Making the Connection.* The report concluded that teachers were not confident of their ability to use technology in the classroom and that teacher education programs did not prepare them well to use technology across the curriculum. Since the publication of that report, schools and colleges of education have expended much effort to address these needs within their programs. Aided by initiatives such as the U.S. Department of Education's Preparing Tomorrow's Teachers to Use Technology (PT3) program, new teacher education graduates are reporting greater readiness to integrate information technologies in their teaching. By all accounts, though, much work remains to be done.

What does it mean to prepare teachers to use technology? It is difficult to give a precise answer to this question, given the pace of change in the development and diffusion of new technologies. Generally speaking, the goal of teacher education is to prepare teachers of K-12 students for a world in which technology has expanded problem-solving capabilities, transformed economies, and provided instant access to information. To accomplish this goal teachers must be prepared to: (1) select and use technologies appropriate for their own professional productivity; and (2) plan and execute lessons in which both they and their students use technology as instructional and learning tools within the curriculum. For example, communications technologies such as the Internet, online discussions, and chat rooms can be used by teachers for professional productivity. In addition, they can be part of a lesson in which students ask questions of experts and communicate with other students around the world. Similarly, teachers may use productivity programs such as reference, word-processing, and presentation programs to prepare and present lessons. In addition, students can be taught to use such programs as tools to locate and analyze information for a report and present the highlights to the class.

Other technologies that can be used both for personal productivity and student learning include multimedia production tools (such as video editing, digital cameras, CD-ROM drives, and scanners) and productivity tools (such as spreadsheets and databases). Also, teachers may use tools that support student assessment, such as grade-book and portfolio software. Finally, teachers may use a wide range of specialized educational software designed to provide learning experiences for students in specific content areas. Overall, preparing teachers to use technology involves exposing them to a wide range of potential applications, teaching them how to select appropriate materials to meet their teaching and learning goals, and preparing them to manage logistical considerations.

Some of this is not new, as many of these technologies have historical roots in earlier equipment and instructional design. Before computer and information technologies were readily available, teacher-training programs often had audiovisual courses that included topics such as instructional design, production of overhead transparencies, lamination, and use of 16-millimeter and filmstrip projectors. Underlying principles of use may be similar to today's technology (e.g., attention to minimal text size, font clarity, number of items on a slide, and amount of white space needed to communicate the message effectively). Modern preservice teachers are learning to use computer-based multimedia, but the design principles remain similar. What has changed is the ubiquity and complexity of the technology.

With the introduction of the personal computer into schools in the late 1970s and early 1980s came recognition that teachers needed training to make optimal use of those tools. Because teachers were often unfamiliar with computers, early efforts at training necessarily focused on items such as powering up the computer and accessing programs, teaching keyboarding skills to students, writing computer programs in BASIC and Logo, using rudimentary word-processing and drill-and-practice programs, managing student access, and evaluating educational software. As technologies matured, computers became easier to use, more powerful software was developed, and the potential for student and teacher use of technology became recognized. Accordingly, teacher training, while still attending to the basics of computer use, expanded to emphasize the planning of lessons with technology as an integral part of student work.

Translating the general goals of teaching and learning with technology into specific outcomes for K-12 students and specific competencies for their teachers is a challenging task. Through its recent National Educational Technology Standards (NETS) project, the International Society for Technology in Education (ISTE) has developed a comprehensive set of performance-based standards for both students and teachers. With broad input from educators across the country, the primary goal of NETS has been to enable stakeholders in preschool and K-12 education to develop national standards for educational uses of technology that facilitate school improvement in the United States. The National Technology Standards for Teachers (NETS-T; www.iste.org), which are closely tied to the student standards, are organized into the following categories: (1) technology operations and concepts; (2) planning and designing learning environments and experiences; (3) teaching, learning, and curriculum; (4) assessment and evaluation; (5) productivity and professional practice; and (6) social, ethical, legal, and human issues.

The NETS-T standards provide a helpful framework for program planning in teacher education and for in-service training in local school districts. The National Council for Accreditation of Teacher Education (NCATE) has adopted NETS-T as well as the educational technology standards of the Association for Educational Communications and Technology. Guided by these standards, NCATE (ncate.org) now expects its accredited schools of education to provide adequate access to computers and other technologies and expects faculty and students to be able to use it successfully.

A study of exemplary technology integration in colleges of education (Strudler and Wetzel 1999) suggests that there is a complex web of enabling factors that support student learning opportunities and desired technology-related outcomes for preservice teachers (see Figure 1). At the lower portion of the figure are *enabling factors* that support technology integration. Next, a range of *student learning opportunities* is included, followed by *student outcomes,* the ultimate goal of technology integration efforts.

Colleges and universities have attempted to provide preservice learning opportunities through a variety of methods, including a stand-alone educational technology course, cooperatively planned methods courses, integration across teacher education courses, and integration into practicing

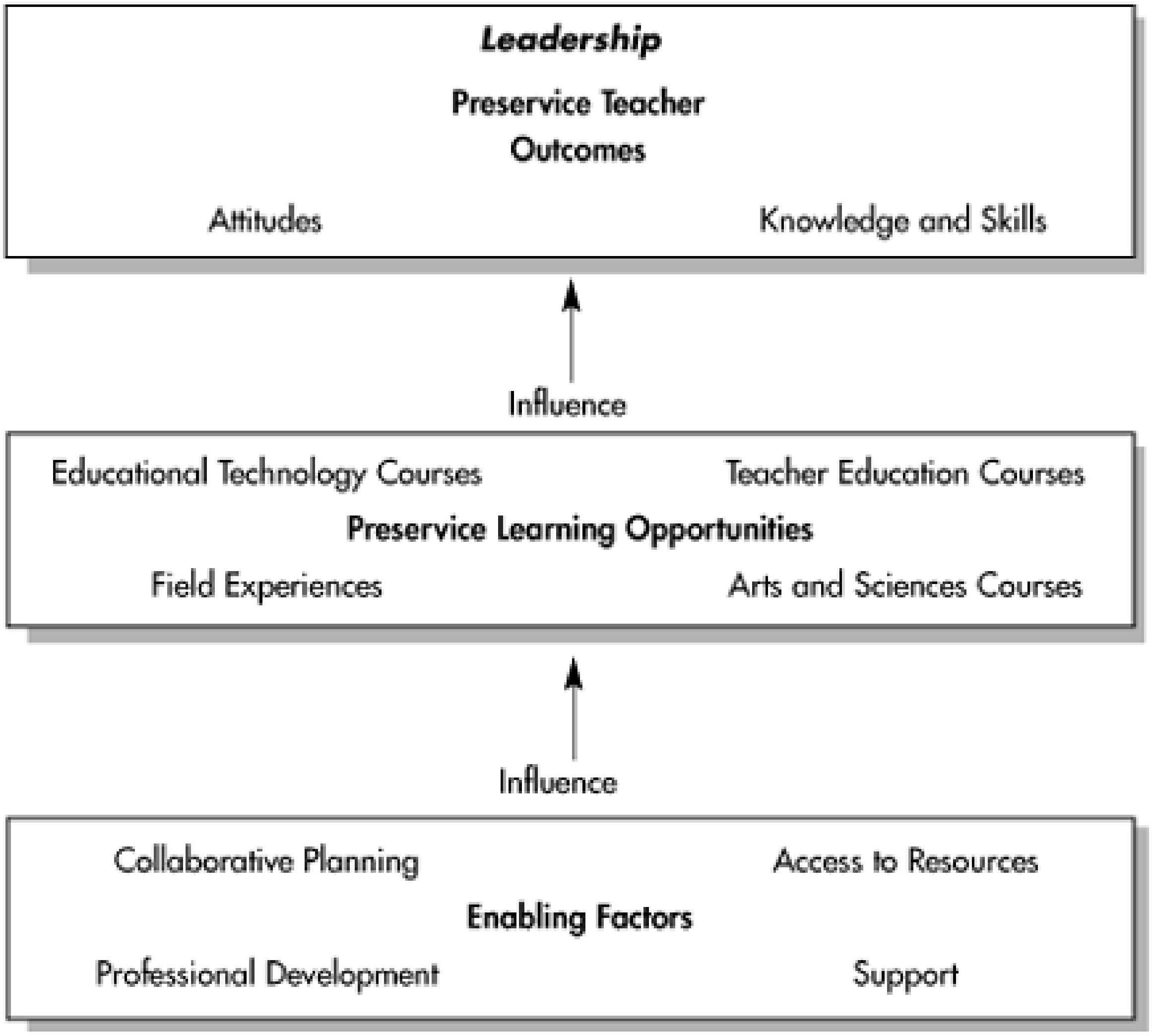

Figure 1:

Factors That Support Preservice Teachers' Preparation to Use Technology

Source: Created by the authors.

teachers' clinical experiences in schools. Although the stand-alone course has been widely implemented, there has been a controversy about the effectiveness of the typical required technology course. A large-scale survey of teacher education institutions (Moursund and Bielefeldt 1999) concluded that a single required technology course does not adequately prepare preservice students to teach integrating technology. However, in a study (Strudler and Wetzel 1999) of teacher education programs thought to be exemplary in their uses of technology, it was discovered that the exemplary programs retained the required technology course in addition to emphasizing the integration of technology across teacher education courses. Although a required educational technology course may provide a useful foundation, it is clear that such a class, by itself, is inadequate to prepare teachers to use technology effectively.

Exemplary institutions also sought to overcome the field placement barrier (i.e., they made concerted efforts to place student teachers in technology-integrating K-12 classrooms). Such efforts underscore the benefit of close collaboration between teacher preparation institutions and school districts in order to promote effective modeling for prospective teachers and the transfer of their learning from courses to K-12 students.

Impediments to technology integration in colleges of education are quite similar to those cited in K-12 schools. Common obstacles include the lack of adequate technology resources, time, professional development, and support. Whereas access to technology resources was previously cited as the most challenging obstacle for teacher educators, the lack of time to learn new programs and to infuse them in their teaching is currently seen as a major challenge. Large-scale integration into the professional preparation of teachers requires that university faculties explore and model appropriate applications of technology in their disciplines. A 1999 national survey (Moursund and Bielefeldt 1999), however, revealed that most education faculty do not feel that information technology is adequately or effectively modeled for the future teachers they serve. This presents a major challenge for teacher education programs to better prepare prospectively. Faculty need opportunities for professional development as well as follow-up support to help them learn new programs and apply them in their teaching. Research indicates that follow-up support is critical to implement any major changes in one's teaching repertoire, whether at the K-12 or university level.

Another common problem is the lack of student teaching placements in technology-rich classrooms with teachers who actively model effective use of technology tools. Research (Willis, Thompson, and Sadera 1999) has indicated that technology use is not commonly considered in student teaching placements, and only a minority of student teachers are required to teach with computers. Researchers in the 1995 OTA report concluded that this would likely remain a problem for some time.

As the literature attests, this component of technology integration in teacher preparation is clearly the most lacking—and arguably the most important. Because technology has generally been implemented unevenly across K-12 schools and classrooms, it is difficult to place education students with teachers who are both accomplished in technology integration and have adequate access to appropriate computer resources. But as the OTA report concluded, if information technologies are to become an integral part of teacher education programs, K-12 and university educators must work together to integrate technology into curriculum and classroom practice.

Many teacher education programs, however, are successfully addressing these obstacles and are making clear advances in their technology integration efforts. In 1995 the OTA reported on four case studies in which such advances were documented. Since that report, many other colleges of education have followed suit.

The U.S. Department of Education initiated its PT3 program in 1999 to support schools and colleges of education in their efforts to prepare teachers for twenty-first-century classrooms. This large-scale program is an indication of the federal government's recognition that teacher preparation has emerged as a critical factor in the effective use of new technologies in education. In recognition of the urgent need for technology-proficient educators, the Department of Education, with the support of Congress, has offered this important initiative.

To address the need for technology-proficient educators, the PT3 grant awards were designed to support the transformation of teacher preparation programs into twenty-first-century learning environments. Implementation grants support consortia that are initiating significant organizational changes to transform teacher preparation programs. Catalyst grants support consortia that provide technical assistance and statewide, regional, or national leadership for the transformation of teacher education with modern learning technologies. The program emphasizes that participating colleges of education and school districts need to undertake and sustain significant organizational changes in how teachers are prepared. During the first two years of PT3 a total of 352 grants were awarded, including 138 capacity-building grants (one-year grants), 179 implementation grants, and 35 catalyst grants. Implementation and catalyst grants involve three-year projects.

PT3's emphasis on supporting long-term projects reflects a commitment to bringing about systemic change in teacher education. The Department of Education has stated that the transformation of teacher preparation programs into twenty-first-century learning environments will require fundamental organizational changes that need to be sustained over time by leadership at all levels of education. Such changes may include improvements in pedagogy, curriculum and faculty development, long-term faculty incentives and rewards, professional assessment and credentialing of teachers, budgeting and support for new information technology infrastructure, and the formation of new organizational partnerships that transcend the boundaries of traditional classrooms and schools. (Additional PT3 program information is available at www.ed.gov/teachtech.)

In addition to government support, professional organizations have formed to study and advance technology in teacher education. During the early use of computers in schools, the International Council for Computers in Education (ICCE) formed under the leadership of David Moursund to provide leadership in promoting and defining the use of technology in K-12 education through conferences, publications, and research. In 1983 the ICCE formed the Special Interest Group for Teacher Educators (SIGTE) to provide a forum for those interested in discussing the issues around the preparation for preservice teachers in the area of technology. SIGTE began to publish the first nationally refereed journal of research and practice devoted solely to teacher education and instructional technology, the *Journal of Computing in Teacher Education.* In 1990 ICCE merged with the Association for Educational Data Systems and changed its name to the International Society for Technology in Education (www.iste.org).

In 1990 the Society for Technology and Teacher Education (STATE), founded by Jerry Willis, held the first international conference dedicated to information technology and teacher education. This organization is now known as the Society for Information Technology and Teacher Education (SITE). Throughout the ensuing decade, SITE has provided leadership and support for faculty and graduate students around the world through its conferences and publications, including the SITE *Annual* (conference proceedings) and the *Journal of Technology and Teacher Education.* (More information about SITE is available at www.aace.org.)

Keith Wetzel
Neal Strudler

See also

Curriculum Integration; LEGO/Logo; Society for Information Technology and Teacher Education; Technology in K-12 Schools

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Technology across the Curriculum (TAC)

As technology increasingly pervades all aspects of modern society, institutions of higher education are called on to ensure that their students graduate with the skills to survive and thrive in such an environment. The

Technology Across the Curriculum program, originated at George Mason University in 1998, responds to this challenge by introducing technology skills into the undergraduate curriculum in a programmatic way. Students use technology across a range of courses to create products and solve problems appropriate to their area of study. A collaborative project of the College of Arts and Sciences and the Information Technology Unit (ITU), TAC supports individual faculty and entire departments in the redesign of courses to incorporate one or more of ten technology goals that form the core of the program. In the first five years of TAC, more than 125 courses in sixteen departments in within the College of Arts and Sciences have incorporated these goals, and more than 12,000 students have taken these courses. At full TAC implementation, all students will graduate with fluency in a wide range of technologies.

Framework

Unlike some other technology initiatives, TAC goes beyond a general encouragement of the use of technology by building on a framework of ten specific technology goals collaboratively developed by faculty throughout the university, with input from instructional support staff and the regional business community. Faculty indicated, through surveys, how information technology (IT) was being used within their discipline and identified the skills that students would need to be successful practitioners of the discipline. A preliminary list of technology skills was developed, emphasizing areas of substantial agreement across disciplines. Business executives and human resources professionals were then asked to review the skills and comment on how they fit with skills they sought in hiring new staff for their organizations. From these discussions, the program derived a basic set of technology goals that include the following:

- The ability to engage in electronic collaboration
- The ability to use and create structured electronic documents
- The ability to create technology-enhanced presentations
- The ability to use electronic tools for research and evaluation
- The ability to use databases and to manage information
- The ability to use spreadsheets to manage information
- The ability to use electronic tools for analyzing quantitative and qualitative data
- The ability to use graphical and multimedia representation technologies
- Familiarity with legal, ethical, privacy, and security issues in using technology
- A working knowledge of major hardware and software platforms

For each skill, faculty have identified essential-level and advanced-level performance standards. The complete description of the technology goals is available on the TAC website (cas.gmu.edu/tac).

As the skills indicate, the focus of TAC is on student learning, not on delivery of instruction or materials. The measure of the success of the program is the degree to which students are able to use technology productively within their disciplines. This means that the technology goals do not replace the disciplinary goals but rather enhance them. In TAC courses, technology is not seen as an add-on but integral, allowing students to learn the discipline in a richer, deeper way that would be unavailable without it. In a Renaissance history course, for example, students find online resources and analyze information, using databases in order to explore hypotheses about life in fifteenth-century Florence. Similarly, students in a course on Spanish in the United States listen to speech samples, classify specific sounds, and record their classifications in a database. They query the database in order to describe the general phonetic features of different linguistic varieties represented in the database. The goal of these courses is not to produce skilled technicians but to produce skilled historians and linguists who can use technology effectively to advance their discipline.

The list of technology skills may make it appear that they are discrete and unconnected, but in fact TAC aims to help students integrate them so that when confronted by a complex problem, they will be able to choose the most appropriate technology tools to solve it. Because TAC students are familiar with spreadsheets, statistical applications, databases, and so on, when faced with a need to test hypotheses or analyze data, they are able to assess the relative strengths and weaknesses of each tool and apply the most effective one. Through the program, students develop a conceptual understanding to prepare them for a future in which the only certain thing is rapid technology change.

Underlying Principles

In addition to a focus on student learning, TAC is based on two other underlying principles. Unlike some technology initiatives, which take an individualistic and episodic approach to developing student skills with technology, TAC is both collaborative and programmatic. Instead of focusing on one course in the curriculum or relying on individual faculty preferences about what technology skills students learn, TAC looks across an entire program of study and creates a sequence of learning to ensure a broad range of skills for every student and to facilitate consistent planning for academic departments. TAC projects emphasize entire courses or sequences of courses rather than an individual section of a course. Groups of faculty or entire departments collaborate in developing assignments and teaching materials that are used across a department rather than by just a single faculty member in a single section of a course. The English department, for example, agreed on a set of technology goals to be included in all sections of the first-year writing courses and developed a library of assignments incorporating these goals for all faculty to draw from. In other cases, multiple departments have agreed on goals. The science departments, for example, jointly agreed on a set of goals for using spreadsheets in all introductory science courses.

TAC uses a matrix to track the program's progress in integrating various skills throughout the curriculum. In this way, all faculty are aware of what skills have been introduced in which courses and can plan assignments in subsequent courses that use those skills and introduce new ones. The chemistry faculty, for instance, can introduce more sophisticated use of spreadsheets into second- and third-year courses because they know that all students in the introductory courses have significant practice in the agreed-upon set of basic skills. Likewise, curriculum developers can see which skills have been introduced in a particular program of study and which have not and then plan for the orderly sequencing of additional skills within the program.

Goals of the Program

To fulfill its overall mission, the TAC program developed two types of goals in addition to the technology goals discussed above: curricular goals and program goals. To ensure that students develop technology skills throughout their education and in ways appropriate to their majors, the TAC curricular goals chart the spread of the ten targeted IT skills across the curriculum. The first curricular goal is to incorporate the essential-level IT skills in general education courses. For example, the essential-level electronic collaboration skills are taught in the required general education English composition classes; technology-enhanced presentations in required general education communication classes; spreadsheets in general education natural science classes; and so on. When fully implemented, all undergraduates will have a good foundation of shared IT skills at the essential level. The second curricular goal is to foster the incorporation of advanced-level IT skills in courses required for the majors. The goal is for departments to determine which IT skills are important for students to be successful in their disciplines and to develop a plan for teaching those skills in the courses required for the major. To help achieve this goal, the TAC program supports departmental planning as well as the development of specific assignments, courses, or shared technology tools that will enable the department to implement its plan.

A third curricular goal is to offer a subset of students even more specialized technology skills through technology-focused minors. Technology-focused minors are available in information technology, telecommunications, electronic journalism, multimedia, geographic information systems, computer science, and data analysis. The TAC program supports some of these minors by funding courses, recruiting students, and developing internship opportunities.

Working with the TAC advisory committee, the program sets annual program-level goals. These grow out of assessment activity, which determines gaps in coverage and identifies needed improvements. TAC program goals have included:

- Develop better tracking of TAC projects and their impact.
- Develop a more systematic assessment plan for the TAC program.
- Revise the TAC website.
- Identify gaps in the IT goals covered in the curriculum and develop a plan for targeted faculty development in those areas.
- Develop a code of ethics that can be used by TAC-supported courses.

Program Operation

The TAC program has a full-time coordinator who oversees the day-to-day operations, working with faculty to develop and implement their course redesign projects and with the graduate students who support faculty projects. In addition, two staff members in the ITU are devoted full-time to TAC for training and faculty support. TAC hires between ten and fifteen graduate students a year and apportions their time among the various faculty projects active in a given year. A few of the graduate students also work centrally for TAC, carrying out projects that benefit the program as a whole, such as assessment, database development, and website maintenance. Two executive directors, from the College of Arts and Sciences and the ITU, provide overall direction for the program. A seven-member advisory board, drawn from both units, helps to set annual goals and assess annual progress of the initiative.

The program operates on an annual budget of approximately $400,000, including the salary of the coordinator, stipends and tuition support paid to graduate assistants, and incentive funds for faculty to support fifteen to twenty course redesign projects each year. In the annual proposal process, individual faculty may request funds to support an individual project. For example, a faculty member may propose to develop a new technology assignment for an upper-division course in the major. However, TAC strongly encourages projects that engage an entire department in rethinking a series of courses. Departments may receive $25,000–$50,000 (for multiyear projects) to support a major course redesign of a large-enrollment course or sequence of course redesigns across the department’s offerings.

The English department, for example, received a departmental grant to incorporate specific technology goals in all sections of the first-year writing course and to develop technology goals for majors. TAC may also offer extra incentives to faculty or departments to develop assignments that incorporate skills that are not being introduced elsewhere in the department's curriculum. For example, one year TAC focused on developing course redesigns that incorporated the use of databases.

Course redesign projects generally follow a yearlong cycle with proposals accepted and reviewed in the spring, developed and sometimes piloted in the summer and fall, and implemented or piloted the following spring. The proposal requires faculty or departments to outline the project, define the connection between the project and the TAC technology goals, state the student learning goals, and indicate how the project will be assessed. Each proposal is reviewed and rated by readers from Arts and Sciences and the ITU. The complete proposal and background information is available online (cas.gmu.edu/tac/rfp).

Support

The collaboration of the ITU and Arts and Sciences ensures that TAC provides multiple levels of support. Technology and infrastructure needs are jointly planned so that faculty and students will have the technology tools needed to carry out the curricular projects designed in the program. Because TAC included electronic presentations as an essential skill, for example, the ITU concentrated its classroom resources to equip more spaces with electronic presentation capabilities. If a particular proposal requires technology that is not available at the appropriate level, then TAC works with faculty or departments to develop alternatives that can be supported. For example, when TAC faculty began to develop projects that incorporated student use of graphical and representational technologies, the ITU collaborated in the development of a new tool for managing images and pilot-tested technologies that would allow for rapid access of images with minimal demands on the campus network.

The ITU also provides support to undergraduate students enrolled in TAC courses through its Student Technology Assistance and Resources (STAR) Center. STAR offers training in a wide variety of technologies through periodic open-enrollment sessions as well as through sessions designed for a specific class of students. STAR also provides four technology facilities where students may work on TAC projects, each supported by student mentors with expertise in TAC's technology skills.

Support for faculty is also jointly planned and implemented. Professional staff from the ITU's Instructional Resource Center provide group training as well as one-on-one assistance to faculty in designing new assignments to incorporate technology skills. TAC targets training in technology areas most needed in the curriculum. For example, when an assessment of TAC progress noted a lack of courses that focused on databases, a special series of workshops helped faculty design and implement assignments that required students to develop and use databases. A similar series was created to assist in developing course assignments that used representational technologies. TAC also employs graduate assistants each year who are assigned to assist faculty with their TAC projects. The ITU provides training and facilities for these grad students. The ITU’s Technology Assistants Program coordinates undergraduate students who are assigned to assist faculty with classroom mentoring and some technology project development.

Faculty Incentives

Faculty have many demands on their time, and the presence of good support in the TAC program is one of the things that encourage them to participate. The program offers other kinds of incentives to maximize faculty involvement. Faculty members receive stipends for participation, varying in size according to the scope of the project and occasionally (depending on the project’s scope) released time from instruction. Many faculty are assigned a graduate student to help support course development. Participation in the TAC program has come to be a valued activity at George Mason, serving as a demonstration of serious engagement with curriculum development; this is a less tangible, but still meaningful, incentive for the faculty.

Assessment

The TAC program is committed to continuous improvement and engages in regular assessment as part of that process. Because the core of TAC activity is the annually funded projects for curricular change, faculty members are asked to describe how they will assess their projects in the proposals for funding. The program also conducts an annual review of previously funded projects. Information about what is and is not working well provides feedback for future program direction and project selection.

The focus of TAC is on student learning of technology skills, and it is important to know if students have acquired targeted skills. TAC has explored various available tests of technology skills without finding any one entirely suitable for its needs. Therefore, the program is developing tests within the university to assess student skills. In addition, starting in 2002 TAC began to develop electronic portfolios as a technique to demonstrate the kind of student learning coming out of the program.

The TAC program has three kinds of program-level assessment. First, to assess the progress of incorporating the ten IT goals into the curriculum, TAC has developed a series of IT matrices. A quick look at the matrices helps identify IT areas that are and are not covered well. Information about the gaps is used to foster further development. Second, to assess the impact of the program in terms of coverage, the program tracks the numbers of students, courses, faculty members, and departments involved in TAC projects. These numbers are used to chart the growth of the program, to identify gaps in participation, and to help plan future activities. Third, the program assesses itself through its annual program goals as described above.

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See also

Active Learning; Campus Computing Project; Curriculum Integration; Educational Systems Design; Information Literacy; Instructional Design; Problem-Based Learning; School Reform

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Technology in K-12 Schools

Although technology has played an important role in schools since the beginning of formal schooling, the availability of computers for K-12 classrooms has increased and expanded this role. Computer-related technology has become an increasingly important part of the educational environment in K-12 schools. Beginning in the 1980s, school districts have purchased large amounts of hardware and software and placed it in classrooms and computer labs for use by students and teachers. And schools in the United States continue to increase the amount spent for instructional technology. Today virtually every K-12 school in the United States has computer capabilities available for teachers and students. Even though technology acquisition has increased rapidly in recent years and accessibility to the technology has improved for most, significant challenges still exist that affect how these technologies are being used in K-12 schools to positively impact student learning.

Schools have opted to spend a significant amount of their total technology budget on computers and connectivity. As of 1995, it was estimated that there were 5.8 million computers in schools, a ratio of about one computer for every nine students. It has also been a priority for most schools to connect the computers to the Internet. Although it is estimated that 90 percent of schools have access to the Internet, only 40 percent of classrooms have Internet access. In the past, as computers were being purchased, many were placed in laboratory environments so teachers could take their entire class to the computer lab to complete an assignment or a project. Recently, there has been a trend to distribute clusters of five to ten computers into classrooms. This allows students to have easy access to computers while they are working on projects in their classrooms, an important consideration if students and teachers are to view computers as cognitive tools for learning. Clearly, these data indicate a continuing commitment to significantly increase the accessibility of computers and related technologies in schools, but this increase in numbers does not necessarily guarantee effective use in classrooms.

Henry J. Becker has regularly conducted large-scale surveys on K-12 computer use in U.S. schools, and his work has provided useful insights into computer use in K-12 schools. In general, his work reveals a slowly increasing use of computers in K-12 classrooms. This expanding use is characterized by more frequent use of computers in classrooms as well as more effort to integrate computer use into the curriculum. In his most recent study, completed in 1999, Becker reported that the most frequent use of computers was reported in secondary computer and business classes, with 80 percent and 70 percent of these teachers reporting frequent use. Forty-three percent of elementary teachers reported frequent use, whereas only 11 percent of secondary mathematics teachers reported frequent use. Word processing was the most frequently used software application reported in the 1999 study.

In the 1999 study, Becker noted that location and number of computers in a classroom are significantly related to frequent use of computers in K-12 classrooms. Sixty-two percent of teachers who had five or more computers in their classrooms reported frequent use, whereas only 18 percent of teachers with access to a school computer lab with fifteen or more computers reported frequent use.

Becker also noted in 1999 that schoolwide emphasis on technology had a positive effect on the amount and type of computer use in a school. He also reported that broad uses of different types of software, emphasis on student writing, and emphasis on using web-based sources of information were all uses that helped teachers create more active, student-centered classrooms.

In general, Becker’s work presents a relatively positive view of steadily increasing computer use in U.S. schools. Although such progress is slow, Becker’s data reveal significant increases in classroom use of computers and movement toward using computers as tools to improve student acquisition of problem-solving and information-processing skills.

Although use of computers in the K-12 setting has expanded, the educational goals for use are not always clearly articulated. We know that merely using the technology does not automatically improve student learning, yet many schools and districts still tend to use technology in relatively unfocused ways. For example, we know that just using a word processor does not improve student writing. For the word processor to be effective, the capabilities must be applied to the careful teaching of writing. If we want to use the word processor to help encourage students to revise and edit their written work, we need to structure activities and experiences to achieve that goal. Increasingly, teachers and schools around the country are working to define learning goals associated with the use of technology and then provide technology-enriched curricula that lead to these goals.

Various partnerships between K-12 schools and colleges of education have been established to assist with school improvement and technology integration initiatives. Since fall 1997, personnel from the North Polk Community School District, Heartland Area Education Agency, and Iowa State University (ISU) have worked collaboratively to design and implement a technology integration model that focuses on improving student learning through technology use in K-6 classrooms. The Educational Communities of Mentors, Educators, and Technology (eCOMET) project is a school-university collaboration designed for educators at all levels to work together as they learn about technology and its potential to create active, learner-centered classrooms that provide technology-rich learning experiences for students. As a result of the project’s efforts, extended and enhanced professional development opportunities for classroom teachers have been provided, and extensive school-based learning experiences for ISU students who are preparing to become teachers are scheduled with teachers. The eCOMET model provides a framework for current and future teachers to learn together how to use and integrate technology in classrooms.

During the school-based experiences, expertise is shared between classroom teachers and ISU students, something that is otherwise difficult to replicate in a university classroom; the ISU students are able to share their technology expertise while the classroom teachers share their years of classroom teaching expertise. For example, two third-grade classrooms were studying a unit on living in a community. Together, the ISU student and the two classroom teachers planned the unit of study and discussed ways technology could be used to make this instructional unit more meaningful for students. The focus was not on the technology but on *using* technology to expand and enhance the unit. During the unit, the students in both third-grade classrooms became actively involved in researching their own community and the people who live and work there. With the help of the ISU student and classroom teachers, the third-graders documented their research by taking digital pictures and videotape of people and places in their community and interviewed several people living in the community. Using all of the materials and resources that they had collected, the third-grade students produced a digital video about their own community. The finished video was then shared with parents and members of the entire community.

It is becoming increasingly clear that the real promise of technology in K-12 schools lies in its potential to facilitate fundamental, qualitative changes in the nature of teaching and learning. Technology can be used to create active, student-centered environments where students can create complex products and test ideas. Used meaningfully, technology can facilitate change in the ways teachers teach and students learn. Some other examples of the successful application of technology grounded in active, student-centered environments are evident in projects in the Carter Lawrence School (Tennessee), Clearview Elementary School (California), Ralph Bunche School (New York), and the Apple Classroom of Tomorrow studies.

Whereas initial uses of computer-related technology in schools tended to replicate what was already happening in classrooms, newer uses tend to focus more upon enhancing and expanding the K-12 curriculum. Specifically, promising uses include the following:

- Emphasize creating and solving authentic problems similar to those of the adult world.
- Use technology as a tool to create communities of learners and thus expand the influence of the classroom.
- Emphasize more active learning approaches where important learning goals such as critical thinking skills, evaluation skills, and communication skills are fostered.
- Allow students to synthesize and apply knowledge and produce complex products.
- Meet the needs of students with special learning needs.

Challenges

The somewhat disappointing record of K-12 schools in the area of technology integration suggests that barriers to technology use must exist. Probably the most significant barrier to effective use of technology is the fact that most teachers are not prepared to use technology in classrooms. Although technology access has improved, teachers have been given little support in their efforts to use and integrate technology into classrooms. Integrating technology into teaching and learning is a difficult task for most teachers because it requires them to first learn how to use the technology and then reconceptualize their approach to teaching. Because meaningful uses of technology in the classroom tend to support active, student-centered learning and teaching, many teachers must change how they teach if they are to use technology effectively.

Some educators have chosen not to utilize various technologies as instructional tools in classrooms because they simply do not know how to use them. Most technology that is accessible to teachers today did not even exist twenty years ago. In a relatively short period of time, K-12 teachers have been overwhelmed with a number of major technological changes. Clearly, it is difficult for teachers to become comfortable with one piece of technology before another piece of technology is announced and placed in their classroom. The slow acceptance of technology in education may be due in part to the fact that teachers have not been given opportunities to develop personal computer skills and to design specific classroom applications using the technology. For technology to be successfully and effectively utilized in schools, teachers must be provided with adequate professional development opportunities to develop these skills.

There is general agreement that the most immediate technology-related need for K-12 schools today is effective professional development approaches to educate teachers both in the use of technology and in new methodologies for teaching with the technology. Although the opportunities for using technology to improve K-12 schooling are immense, the challenge of providing effective staff development for teachers is equally large because we ask teachers to learn to use technology and to change the way they teach. Clearly, this is no small task for a K-12 teacher whose professional life is consumed by the need to effectively teach students for eight hours each day.

Part of the teacher professional development problem can be traced to the early days of computer use in schools. In the early days, emphasis was placed on acquiring hardware and providing student access to the computers. Typically, very few resources were allocated toward preparing teachers to use the technology in classrooms. This situation contributed to the relatively unfocused use of computers in K-12 schools. In many schools, students used computers in ways that were totally unrelated to their classroom curriculum and, in many cases, did not involve the classroom teachers. The emphasis was placed on giving students experience with computers, not on what they were *learning* with the computers. In more recent years, however, educators have recognized that effective computer use must involve direct connections to the curriculum and that teachers must be educated on how to provide such integrated experiences for students.

The training of the nation's teachers to use technology is an enormous challenge. A partial solution to this problem involves teacher education programs. It is clear that new teachers must be educated on how to use technology in their teacher preparation programs and how to create learning experiences for their students that effectively infuse technology into the learning process. Teacher preparation programs must model the effective use of technology throughout the program in order to begin to produce a generation of teachers who can lead future efforts in this area. In recent years, there has been a more focused effort nationally to ensure that teacher education institutions are incorporating technology meaningfully throughout their teacher preparation programs. Although these efforts will take time, the need to make changes at all levels of education is apparent. Each level must confront the challenges faced with viable and feasible solutions.

Technology has created enormous opportunities as well as challenges for K-12 schools. Specifically, technology challenges for K-12 schools can be summarized as follows:

- Emphasis on using technology in focused ways to expand and enhance the K-12 curriculum;
- Professional development for teachers in learner-centered models of computer applications and methods of teaching with technology;
- Adequate time for teachers to develop new technological and pedagogical skills;
- Preparation and recruitment of new teachers with technological skills;
- Professional development for administrators; and
- Financial resources for technology acquisitions and upgrades.

Concerns

Critics have suggested that educators need to take a critical perspective on the use of computers in K-12 schools. In the early years of school computer use, there was a tendency to assume that any learner's or teacher's use of computers in school was positive and productive. In more recent times, educators have taken a more analytical view of computer use in schools and suggested that computers are among many tools available to classroom teachers. Teachers must use the computer as a tool to expand and enhance classroom activities and to extend student learning. Computer use should be carefully integrated into content-area learning. Having students use computers just for the experience of using the technology is no longer considered an appropriate use.

Use of computers with young children has also generated controversy. Most agree that computer use should not replace real-world experiences in the education of young children and that parents and teachers should work to ensure that children are using computers in active, student-centered ways.

A second major area of concern with respect to technology use in K-12 schools is related to issues of access and equity. It is clear that students in poorly financed districts and/or students from lower socioeconomic backgrounds have less access to technology, both in and out of school, than other children. In addition to having fewer computers available, children in disadvantaged schools tend to have fewer opportunities to use computers in active, student-centered ways. Similarly, children from racial minority groups have less access to computer-related technology and also have less opportunity to use technology in higher-level ways. This phenomenon has been named the digital divide and is a cause of deep concern. Unless educators begin to directly address this troubling issue, differing access to computer-related technology in K-12 schools could increase the educational difference between rich and poor in the United States.

In addition to socioeconomic and racial concerns, there are also equity and access concerns for girls in K-12 schools. Statistics suggest that K-12 boys use school computer facilities more than girls and that boys have more access to computers at home and in extracurricular activities. Parents as well as teachers must work to recognize and equalize these differences and to ensure equal access for female students.

The Future

Given the increased attention to teacher education in technology, both at the K-12 level and postsecondary level, technology use in K-12 schools is showing signs of achieving its potential to improve student learning. In order for this to happen, careful attention must be paid to the following areas:

- Development and implementation of learner-centered technology applications that will improve student achievement in standards-based and higher-level cognitive skills;
- Research on the most effective uses of technology that improve student learning in the K-12 setting;
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- Professional development for teachers in learner-centered models of computer applications and methods of teaching with technology;
- Adequate time for teachers to develop new technological and pedagogical skills;
- Education of new teachers with technological and pedagogical skills;
- Professional development for administrators;
- Programs to equalize both the amount and type of access to computer-related technology across socioeconomic and racial bounds; and
- Financial resources for technology acquisitions and upgrades.

Computer and computer-related technology access for learners in K-12 schools has increased dramatically. Educators have learned valuable lessons about the most appropriate use of this technology to improve student learning. It appears that K-12 teachers and teacher education programs are on their way to discovering and implementing truly powerful ways that technology will enhance education.

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See also

Apple Classrooms of Tomorrow Project; Curriculum Integration; School Reform; Teachers: Preparation and Training

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Technology Planning

Usually, when people begin talking about their technology plan, they refer to a written, physical document. Their plan may be a single-volume or multivolume treatise in which either a person or a group of persons attempted to capture the essence of their dreams for what could become reality when they applied technologies in a particular manner. The plan may have a lengthy description of their philosophies, history, personnel, physical facilities, policies, budgeting practices, and even some examples of successful attempts at using technology in their workplace. Or the document may be a very brief synopsis of general planned ideas, the time frame for

accomplishment, and personnel responsible for overseeing the accomplishment of the activity. Another way to look at a technology plan is to consider that it is not a thing at all; rather, it is a concept. It is the actual *doing* of what an organization has in mind. Some have called this the verb form of a technology plan. It is a healthy enterprise to consider both the physical (the noun form) and the conceptual (the verb form) notions of a technology plan.

The National Center for Technology Planning (NCTP) likes to promote the analogy of comparing a road map to a vacation when attempting to explain differences between the noun form and the verb form of a technology plan. A person can pull out a U.S. road map and plan a trip from Atlanta to Seattle. One could look at the map and see, at any point along the journey, how far she had come; how far she still must go; what landmarks lie around her; what road she is on; what alternate routes she could explore; and what general preparations she needs to make as she continues the journey. All of this is important to the trip. This would be a plan in the noun form.

There is absolutely no comparison, however, between seeing the name of the Mississippi River as printed on a map and actually standing there alongside that powerful body of water and becoming engulfed in its majesty. Examining a map and seeing the notation “Grand Canyon” is no comparison at all to standing at the precipice of that great wonder of the world. So the *map* would be the noun form of a plan, whereas the *trip* would represent the verb form of a plan. Some self-proclaimed authorities might tell you that a true technology plan is one or the other. In truth, however, it is an appropriate blend of the two.

What Is a Technology Plan Not?

As hard as we might try, we cannot craft a technology planning document that provides all the answers, gives every possible scenario for solution, or captures the perfect essence of what schools and communities must do in order to achieve maximum success. It is a guiding set of beliefs, strategies, and systems that will improve our chances for enhancing the comprehensive nature of our instructional programs.

A technology plan is not an absolute mandate. Neither is it something to be used as a punitive measure when somebody or some component of the institution doesn’t measure up. A well-prepared and well-implemented technology plan is merely a snapshot—a momentary picture—of what several people, functioning in a collective arrangement, agree to challenge themselves to accomplish. It is not cast in stone; rather, it is, by design, a malleable framework of dreams and visions that may be adjusted multiple times as the users of the plan progress through implementation.

History of Technology Planning in the United States

In 1991 the concept of technology planning transitioned from a simple entry in some people's notebooks into a full-fledged national strategy for improvement. This was accomplished by the Council of Chief State School Officers, headquartered in Washington, DC, which released a written statement that encouraged each state to develop and publish its own technology plan. States started holding conversations in which similar questions were the center of focus: What should our plan include? For whom should we publish our plan? In what ways should we involve school districts in our state? Who should help us write the plan? Little by little, answers to these questions began to surface as state leaders compiled their thoughts and dreams into planning documents.

Texas was the first state to release a statewide technology plan that was approved by the legislature. Leaders in the Texas Education Agency worked closely with members of the Texas legislature on a bill that would provide funding for technology-related ventures in schools. One of the key elements of the resulting legislation was that, in order for a district to receive the $30 appropriation (per pupil, per year), the district had to submit a written technology plan to the Texas Education Agency. Texas's success in this measure gave impetus to many other states to follow suit.

Federal Legislation

Apparent success of multiple states' programs that tied technology funding to technology planning through legislation gave rise to a duplicated effort at the federal level. Beginning in 1993 (with the Technology in Education Act, which was never actually passed into law) Congress made its first foray into including technology planning as an essential component of its education programs. Appropriations of federal funds to specific educational initiatives were tied to the submission by a local school of a written long-range technology plan that had been adopted and approved by local school boards. Most frequently, these plans were submitted from local districts to the state department of education.

The importance of a technology plan in the comprehensive picture of educational effectiveness has been displayed continuously by the U.S. Congress, as nearly all technology-related funding and policies now have the requirement that schools develop and submit a technology plan to some supervisory agency. The federal government has provided a key role in helping thousands of schools realize the significance of having a well-crafted, well-written plan for use of technologies. As a result of federal encouragement in this area, the U.S. Department of Education Office of Educational Technology wrote and published the first National Technology Plan in the late 1990s.

Basic Principles of Planning

“Steps! Just give me *steps!*” This is the cry of many people who think that developing a technology plan is a matter of merely capturing simple concepts in textual form. Not so, however. There are some basic principles that must be understood clearly by all serious planners. To make this easy to conceptualize, perhaps an analogy is the best tool.

Think of a map, as mentioned previously. One can hold the map, so it is a physical thing. It is, though, merely the representation of something in which we are able to participate—a vacation. Consider the map as a *noun* form and the vacation as a *verb* form. Although the map (noun) allows us to see the point from which we start our trip, the distance we have yet to go, and the landmark names along the way, it is not a reliable substitute for the vacation (verb). Thus, the written plan (noun) is merely the documentation for what exciting venture (verb) is to occur. Neither is better than the other; both are necessary for a full and complete experience. The process of developing a technology plan can be divided into two parts: process and product.

Process

Technology planning, as a process, can be expressed in three basic steps: plan, implement, and evaluate. Process refers to all the activities that must occur in order to bring the written plan into fruition. This includes all the organizational activities, such as: forming the committee, selecting the chairperson, conducting surveys and inventories, seeking constituent input, formulating the rough draft, establishing the public relations campaign, crafting a funding mechanism, conducting training (also known as professional development), polishing the final draft, acquiring administrative approval, implementing it throughout the school system, organizing the evaluation scheme, collecting and analyzing data, reporting results, and revising the existing plan. The committee chairperson, along with appropriate administrative and instructional personnel, must monitor the progress and effectiveness of the *process* by which the technology plan functions.

Product

The *product* is the plan itself—both the written plan and the plan that is implemented. When the evaluation phase dictates that all components of the plan are scrutinized, this means that planning committee members must examine the effectiveness of the document itself. This might include such notions as: appearance of the document, the physical organization of the written plan, the elements that were included in the written plan, and availability of the plan when crucial decisions were made.

Now What?

Far too often, school leaders have expressed their feelings that once the technology plan is written and made available to the public in hard-copy format, their work is finished. Quite the contrary; true leaders realize that no technology plan is ever complete. Just as a photograph is merely a snapshot of the subject, frozen in a moment of time, a written plan is just a concrete example of what visions were expressed at one moment in time. When the final draft of the plan has been approved by the highest administrative body in the school (most often, this is the school board), it triggers the beginning of the revision process. What, then, is the technology leader to do after the plan has been approved?

Appropriate examples of action are: providing suggestion boxes throughout the school that allow teachers and others to provide feedback related to the plan; conducting periodic surveys of students, teachers, staff, administrators, parents, and other community members to gauge effectiveness of the plan's events; setting timetables and deadlines for preparing to submit a revision to the plan; monitoring funding patterns, resources, and needs in order to maximize the financial leveraging of what is being accomplished; and establishing/conducting ongoing technology leadership workshops so that teachers, students, and others can learn how to make the best use of their individual and combined talents in improving the overall condition of the education enterprise. The work of a technology planner is never finished. It merely moves from phase to phase, always striving for continuous, perpetuating improvement.

New Millennium Model

The NCTP has been a part of a movement to develop extensive and detailed models for planning that can be used by any organization or group of people. Although this has been of value to many, the complexity of these models has, at times, served as an impediment to practitioners' understanding of how technology planning can serve to aid the schools.

The area of confusion, at all levels, seems to be the concept of *accountability* through technology. Many have asked the legitimate questions "How can we be sure that the money we have spent on technology in schools really pays off?" or "Can you show me how student achievement is increasing as a result of technology use?"

At the early point of the twenty-first century, it seems prudent to suggest a new model for technology planning—a model that can be used by educators in all sectors at all levels and to accomplish the goals of demonstrating accountability to those who ask the stirring questions. The beauty of this model is that it is simple, understandable, quick, and meaningful. The NCTP's New Planning Model, as shown in Figure 1, involves the following

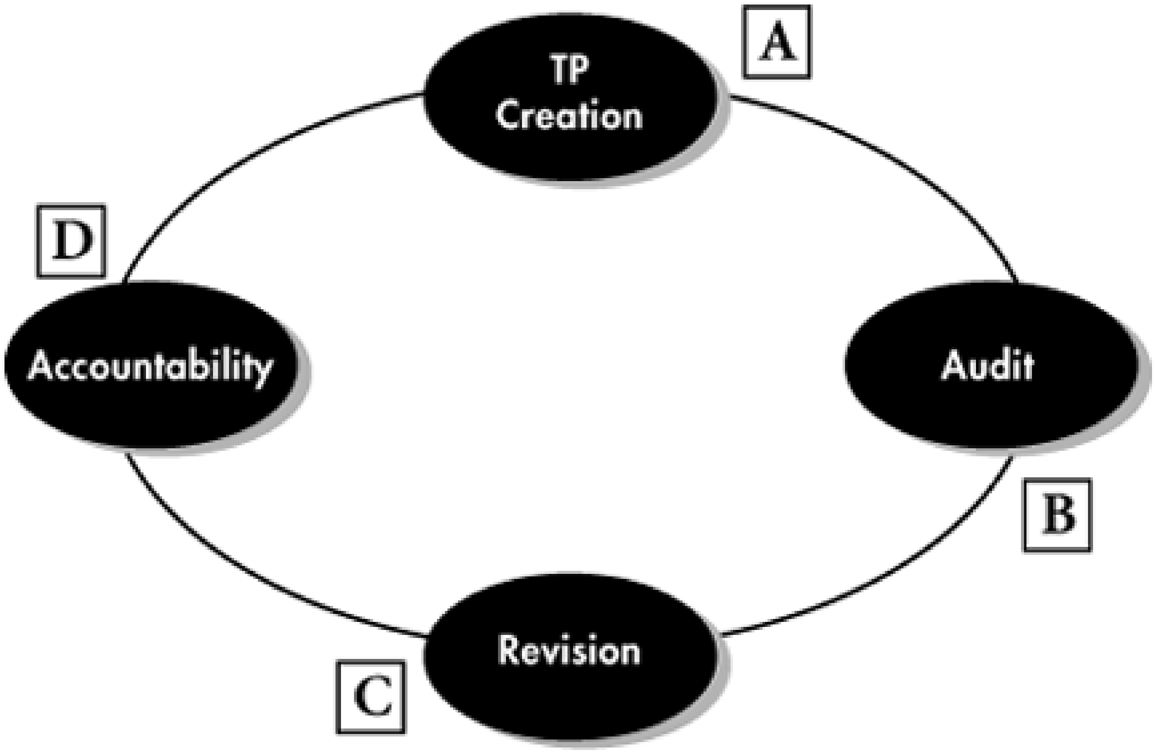

Figure 1:

NCTP New Planning Model

Source: Created by the author.

rudimentary components: technology plan creation; audit; revision; and accountability.

The first phase is to create the technology plan. This seems straightforward; however, it is a simple step that must not be taken for granted. Completion of this phase is necessary prior to moving forward to the second phase, in which a *technology audit* must be conducted. NCTP has prepared a strategy for auditing that is simple and based on the essential goals formed by the school or institution during the vision statement development process. The audit matrix, in its simplest form, may be constructed to appear like that shown in Table 1. The third phase involves the development of a formalized, revised technology plan. The revision is based upon findings in the audit, with an eye toward ensuring a robust accountability position. In the fourth phase, accountability, planners and leaders can provide clear, defensible accountability to their communities by capturing essential information from lessons learned during the first three phases. This compiled information can be prepared and submitted in a variety of formats—tabular, matrix, chart, or narrative—depending on the audience. The predominant theme in the NCTP New Planning Model is one of simplicity, clarity, and benefit. No longer is it absolutely essential that technology plans are exotic, complex, endlessly detailed documents that *confuse* more than *communicate.*

Table 1: An Example Audit Matrix

Action	Time	DRI (Directly Responsible Individual)	Evidence	Lesson
Broadband network access in each physical plant facility (related to instruction)	March 15, 2002	Evelyn Briscoe, ITS		
Broadband wireless access available 24/7 throughout	December 8, 2002	J. Moreau, LRC		
All personnel have portable computing capability	April 15, 2003	Henry Burnett, Support		
Technology-based instruction becomes financially profitable	January 31, 2004	Andy Carvin, Comptroller		
All teachers are proficient in building technology-based lesson plans	August 12, 2004	Phyllis Marr, Curriculum Coordinator		

Note: This is an example, only illustrative of the kind of matrix that could be used to help make the accountability process, coupled with the technology audit, more manageable. Remember, the goal is to make this process simple, easy, doable, and meaningful.

Source: Created by the author.

Essential Elements

For any technology planning effort to be successful over the long term, leaders should remember to employ a few basic elements. First, involve people. A danger exists that those charged with the responsibility of writing the plan will seclude themselves and attempt to prepare the entire planning document alone. This is a recipe for disaster, because there is no buy-in from organizational constituents. Second, identify resources. It is an amazing realization to learn about the fantastic array of talent available in a community. The alert technology planner will attempt to capture those talents and put them to good use in the implementation efforts that are such necessary parts of sustainable progress. Third, examine the total cost of ownership. This element provides an exciting component to planning, because the technology committee has the opportunity to examine thoroughly all the costs (and their associated benefits) related to this entire activity. Fourth, ensure meaningful evaluation. Evaluation can reveal not only the needed areas of improvement but also the places where strong successes are occurring. Fifth, strive for excellence in all realms of technology planning, implementation, evaluation, and revision. This element requires no explanation; true leaders accept the challenge to reach excellence in all their activities.

Admonition to Leaders

Technology planning is an activity in which there is potential for success and improvement. If local technology planners invest the time at the beginning phase of the process in order to understand fully the various components of what they can include in their planning process, they will ensure positive results and a sustainable improvement pattern. The key is to initiate and sustain the focus on student learning, not merely student achievement.

The process of planning is never-ending and inclusive. It involves every member of the school community, every instructional component of the educational program, and acceptance of new ways of thinking, new ways of organizing, and new ways of building success. If the principal people involved will commit to adopting a positive mindset and undaunted leadership, technology planning will be perceived, increasingly, as an *opportunity*.

Larry S. Anderson

See also

School Reform; Technology in K-12 Schools

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National Center for Technology Planning (www.nctp.com).

Telecollaboration and Teleresearch

Telecollaborative learning activities are those in which learners communicate with others at a distance as an integral part of curriculum-based study. To do so, e-mail, online discussion forums, real-time chat, and/or videoconferencing tools are used. Telecollaborative learning activities often incorporate teleresearch, or purposeful information-seeking online.

Telecollaboration and Teleresearch

Internet-supported, curriculum-based learning can take many forms but is essentially either *online collaboration,* also called “telecollaboration,” or *online research,* also called “teleresearch.” Telecollaborative learning activities are those in which students communicate electronically with others. Teleresearch learning activities are those in which students locate and use online information. Online collaboration and research are frequently combined in larger-scale educational projects. Both can be done using text, still images, animated images, and sound. Both are available in either synchronous (immediate) or asynchronous (delayed) modes. Both can reproduce what students already do when they collaborate and do research using earlier-vintage learning materials. Yet to make these new opportunities worth the time, effort, and other resources necessary to bring them into the classroom, it is important to use the new tools in new and powerful ways.

Collaborative online learning activities can offer many educational benefits to participants. The nature of these benefits depends, in large part, upon the specifics of each activity’s design and how well the activity matches the needs and preferences of participating students. In general, curriculum-based telecollaboration is most appropriate when students can be well served by:

- Being exposed to multiple points of view, perspectives, beliefs, interpretations, and/or experiences;
- Comparing, contrasting, and/or combining similar information collected in dissimilar locations;
- Communicating with a real audience using written language; and
- Expanding their global awareness.

Teleresearch can offer an ever-expanding wealth and variety of current information to learners. Whether this abundance helps or hinders students’ learning depends, like online collaboration, upon the activity’s design and also upon students’ information-seeking and information-appraising skills. In general, teleresearch is most appropriate when students can be well served by:

- Accessing information not available locally;
- Viewing information in multiple formats (e.g., text, graphics, video);
- Comparing and contrasting differing information on the same topic;
- Considering emerging and very recent information (e.g., interim reports of research studies in progress); and
- Delving deeply into a particular area of inquiry.

How can educators design online activities and projects that help students to experience and benefit in these ways? The answer is by considering telecollaborative activity structures and teleresearch activity purposes.

Telecollaborative Activity Structures

Activity structures characterize a telecollaborative learning activity's framework, or skeleton. Each structure can support learning in most curriculum areas and at most grade levels. For this reason, the activity structure serves as an instructional design tool. It is a way for teachers to think about learning processes specific to particular types of educational activities.

Of course, other activity structures exist; teachers use them, often without realizing it, every time an educational activity is designed. However, telecollaborative activities are supported by structures that are unfamiliar to many educators. This is why it's important to learn about and use them consciously and deliberately.

There are eighteen telecollaborative activity structures that have been identified to date (Harris 1998). The structures are grouped into three genres of online activity:

Interpersonal exchanges are those activities "in which individuals talk electronically with other individuals, individuals talk with groups or groups talk with other groups" (Harris 1998, 18). Interpersonal exchanges include: keypals, global classrooms, electronic appearances, telementoring, question-and-answer activities, and impersonations.

Information collection and analysis activities are those that "involve students collecting, compiling, and comparing different types of interesting information" (Harris 1998, 33). Information collection and analysis activity structures include: information exchanges, database creation, electronic publishing, telefieldtrips, and pooled data analysis.

Problem-solving activities promote critical thinking, collaboration, and problem-based learning. Problem-solving structures include: information searches, peer feedback activities, parallel problem-solving, sequential problem-solving, telepresent problem-solving, simulations, and social action projects.

The activity structures are summarized in Table 1. Please remember that these structures are *tools* to help teachers think about how the Internet may be used to enhance curriculum-based teaching and learning in classrooms via telecollaboration. They are not prescriptions for successful Internet use.

Teleresearch Activity Purposes

Teleresearch is not an educational activity unto itself and is often used in conjunction with telecollaborative learning activities. It supports learning processes differently compared to telecollaboration. Its nature is determined

Table 1: Telecollaborative Activity Structures

Genre	Activity Structure	Description
Interpersonal Exchange	*Keypals*	Students communicate with others outside their classrooms via e-mail about curriculum-related topics chosen by teachers and/or students. Communications are usually one-to-one.
	Global Classrooms	Groups of students and teachers in different locations study a curriculum-related topic together during the same time period. Projects are frequently interdisciplinary and thematically organized.
	Electronic Appearances	Students have opportunities to communicate with subject matter experts and/or famous people via e-mail, videoconferencing, or chatrooms. These activities are typically short-term (often one-time) and correspond to curricular objectives.
	Telementoring	Students communicate with subject matter experts over extended periods of time to explore specific topics in depth and in an inquiry-based format.
	Question and Answer	Students communicate with subject matter experts on a short-term basis as questions arise during their study of a specific topic. This is used only when all other information resources have been exhausted.
	Impersonations	Impersonation projects are those in which some or all participants communicate in character, rather than as themselves. Impersonations of historical figures and literary protagonists are most common.
Information Collection and Analysis	*Information Exchanges*	Students and teachers in different locations collect, share, compare, and discuss information related to specific topics or themes that are experienced or expressed differently at each participating site.
	Database Creation	Students and teachers organize information they have collected or created into databases that others can use and to which others can add or respond.
	Electronic Publishing	Students create electronic documents, such as webpages or word-processed newsletters, collaboratively with others. Remotely located students learn from and respond to these publishing projects.
	Telefieldtrips	Telefieldtrips allow students to virtually experience places or participate in activities that would otherwise be impossible for them due to monetary or geographic constraints.
	Pooled Data Analysis	Students in different places collect data of a particular type on a specific topic and then combine the data across locations for analysis.

Table 1: *Continued*

Genre	Activity Structure	Description
Problem-Solving	*Information Searches*	Students are asked to answer specific, fact-based questions related to curricular topics. Answers (and often searching strategies) are posted in electronic format for other students to see, but reference sources used to generate the answers are both online and offline.
	Peer Feedback Activities	Students are encouraged to provide constructive responses to the ideas and forms of work done by students in other locations, often reviewing multiple drafts of documents over time. These activities can also take the form of electronic debates or forums.
	Parallel Problem-Solving	Students in different locations work to solve similar problems separately and then compare, contrast, and discuss its multiple problem-solving strategies online.
	Sequential Creations	Students in different locations sequentially create a common story, poem, song, picture, or other product online. Each participating group adds its segment to the common product.
	Telepresent Problem-Solving	Students simultaneously engage in communications-based real-time activities from different locations. Developing brainstormed solutions to real-world problems via teleconferencing is a popular application of this structure.
	Simulations	Students participate in authentic, but simulated, problem-based situations online, often while collaborating with other students in different locations.
	Social Action Action	Students are encouraged to consider real and timely problems, then take action toward resolution with other students elsewhere. Although the problems explored are often global in scope, the action taken to address the problem is usually local.

Source: K. Dawson and J. Harris (1999). "Using Internet-based Telecollaboration to Enhance Elementary-Level Social Studies Learning," *Social Studies and the Young Learner* 11: 1–4.

by the purposes for and ways in which information is located and used in a learning activity. Stated according to what learners do when engaged in teleresearch, these purposes include:

- Practicing information-seeking and information-evaluating skills;
- Exploring a topic of inquiry or finding answers to a particular question;
- Reviewing multiple perspectives upon a topic;
-

- Collecting data remotely;
- Assisting authentic problem-solving; and
- Publishing information syntheses or critiques for others to use.

Designing Telecollaboration and Teleresearch

Given these many options, how do teachers select which combination of telecollaborative structures and teleresearch purposes to use so that curriculum-based activities are customized to their students' learning needs and preferences? The answer is by focusing upon what students should *do* to build understanding while engaged in the learning activities planned. Not only must the activity be structured; teachers need to predict, to some extent, the *sequence of actions* necessary to complete the activity in ways that promote and support students' learning. Some of the *student action sequences* commonly seen in such activities include:

Correspond—prepare a communication locally, then send it to others. They respond, and the process continues.

Complete—register to participate, then do an activity locally. Submit completed work by a deadline, then receive feedback.

Comprehend—locate online resources, then make primarily local use of them.

Collect, share, and compare—create something locally, then add it to a group of similarly created works, combined to form a centrally located collection.

Chain—do an activity locally, create records of that activity, then send something on so that the next group can do something similar.

Come along—shadow others as they travel either physically or cognitively, perhaps communicating briefly in the process.

Collaborate—work with remotely located others to realize a common goal.

Multiple action sequences are usually evident within a particular curriculum-based telecomputing project. Activity structures often work together to form the project's overall structure. In any telecollaborative and/or teleresearch project, therefore, there are one or more activity structures, teleresearch purposes, and action sequences working together that describe the plan and its implementation in the classroom.

First published in 1993, these structures, purposes, and sequences combine in numerous permutations to describe the wide range and variety of online, primarily telecollaborative, project designs. They also serve as planning tools that can help teachers to think concretely about facilitating students' learning processes within the context of curriculum requirements, with an eye toward customized, motivating educational experiences. It is hoped that they will continue to be used to develop and frame the ways in which students engage with curriculum-related content—and with each other—in learning space designs that educators may sketch but that learners and teachers *together* bring to life.

Judi Harris

See also

Collaborative Technologies; Computer-Mediated Communication; Computer-Supported Collaborative Learning; Electronic Emissary; Learning Circles; Telementoring

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Telementoring

Telementoring is mentoring at a distance. More specifically, it is a type of long-term, online learning relationship between an older, experienced person and one or more younger, less experienced people. In its most common usage, the term "telementoring" refers to a practice in which teachers purposely orchestrate long-term, online relationships between their own students and a number of knowledgeable volunteers. Telementors may be drawn from the community surrounding a school or from around the world; they can provide many different forms of assistance to students, from the provision of career advice to guidance on a specific school project or investigation.

Telementoring relationships draw their central inspiration from the mentoring relationships that have traditionally taken place one-on-one and face-to-face in work settings, schools, and neighborhoods. Mentoring relationships have a long history and should not be confused with tutoring or ask-an-expert services. Both of the latter normally aim to deliver information and assistance to learners through relatively short-term transactions and are targeted at teaching clearly delineated bodies of knowledge or skills, such as reading, mathematical problem-solving, or computer programming. By contrast, mentoring and telementoring involve the development of relationships that support learners in solving ill-defined problems—such as those related to designing and carrying out an original research project, planning and developing a career, or apprenticing into a new intellectual community. Also, while the agenda in tutoring is largely set by the tutor, in mentoring the junior party brings most of the problems to the table.

The idea of mentoring dates back at least to the ancient Greek poet Homer and his epic work *The Odyssey*. In the poem, the young prince Telemachus is counseled and guided by a wise sea captain named Mentor about coping with the consequences of his father's disappearance in the Trojan War. Today, the word "mentor" is used to describe advisory relationships that take place in a host of settings. The term denotes a supportive relationship in which an experienced person has the opportunity to initiate less experienced people into a new profession, organization, or stage in life. And while the focus of attention is largely on the junior party (called the protégé, or mentee), mentoring relationships are ideally *reciprocal*. This means that they have developmental benefits for the mentor as well.

Unfortunately, naturally occurring mentoring relationships are rare (Kram 1985). Many people who might excel as mentors do not have the opportunity to serve in this capacity, and many people who need mentors never find them. Among the factors that can hamper face-to-face mentoring relationships are the structure of organizations, physical distance, and varying daily schedules. Developing mentoring relationships depends on regular contact over an extended period of time; thus while programs do exist that link school, university, and work settings, these programs have not become widespread enough to support deep changes in how children learn at school. Distance and schedules make it difficult to maintain face-to-face relationships across organizations.

In response to this problem, and in an effort to expand the resources available to K-12 educators for supporting constructivist teaching, researchers and corporate volunteers began actively orchestrating mentoring relationships over the Internet. Beginning at least as early as 1996, teachers and researchers have involved thousands of volunteers from around the world in telementoring relationships, primarily using e-mail. Although not yet as ubiquitous or as simple to use, text-based conferencing systems have also proven useful as media for telementoring. Videoconferencing, valued for its immediacy and the richness of the cues it supports, has thus far had limited usefulness as a medium for telementoring because it requires the mentor and mentee to be available at the same time.

Three important theoretical sources of inspiration for telementoring are the sociocultural theory of learning, the concept of communities of practice (Lave and Wenger 1991), and the concept of cognitive apprenticeship. Together, these three ideas point toward an ideal of education in which students undergo a gradual initiation into the practices, values, and use of tools that are shared by a learned community.

In a well-designed telementoring program or initiative, volunteer mentors help educators to realize the ideal of cognitive apprenticeship by serving as a bridge to communities of practice outside the school (e.g., anthropologists, creative writers, historians, mathematicians, physicists). Rather than offering a brief glimpse of the way they work, as in a field trip, telementors work closely with students online for an extended period, actually involving them in doing authentic work. For example, in the CoVis project, volunteer scientists helped guide students through the design, implementation, and reporting of original, empirical research projects. One in-depth study showed that the more effort students put into maintaining their relationships with their telementors, the more sophisticated the argument strategies they used in their research reports (O'Neill 1997).

Project-based learning is often a good context for telementoring. Ambitious school projects can be extremely energy-intensive for teachers to support, particularly if students develop their own individual project ideas. This freedom can be highly motivating but pulls the teacher's attention in many directions at once and may demand a great deal of subject matter expertise. Rather than coping with these problems by confining students' work to a narrow range of topics that they may find uninteresting, telementors can help teachers scaffold their students' work on the problems that interest them most. Telementors can also serve as a responsive audience that both challenges and supports students in meeting the standards of thinking and reasoning authentic to a scholarly or work community.

Telementoring Programs

Because the practice of telementoring is relatively new, most telementoring relationships discussed in the literature have been orchestrated by university researchers or corporations, working in partnership with individual teachers. These programs have varied widely in their objectives, design, and size. A few examples will illustrate this variety.

One of the largest telementoring programs implemented to date is the Hewlett Packard e-mail mentor program. In this program, engineers at Hewlett Packard use e-mail to support the studies and career development of students around the world. The program is aimed primarily at promoting study in engineering and the sciences and serves thousands of students at a time. Entry to this program is competitive, based in part on descriptions that teachers and students submit of their personal objectives for their participation in the program. An elaborate system is also in place to ensure that students and mentors are in regular communication.

Another ambitious program, the Electronic Emissary, orchestrates e-mail mentoring relationships between K-12 students and subject matter experts in a wide array of fields, from anthropology to zoology. Subject matter experts volunteer from a host of institutions worldwide, rather than a single company, and are matched with students and teachers by project staff based on their expertise. One of the unique facets of this program is its paid staff of facilitators, who work with teachers to develop and plan the telementor's involvement in the class. They also monitor the correspondence between students and volunteers continuously, intervening as necessary to keep the dialogue productive (Harris and Jones 1999).

Telementoring initiatives can also be tailored to serve the needs of specific communities and pedagogies. In the CoVis project, for example, telementoring relationships were organized between hundreds of volunteer scientists and small teams of middle school and high school students as a way to support their work on long-term, original research projects in earth science. Participation in the larger project (which included summer in-services and other elements) was required to participate in the telementoring program. The tight focus of this program (as compared with those above) permitted the researchers, teachers, and staff to construct more supportive materials and instructions for participants, reducing the need for paid facilitators.

Like face-to-face mentoring programs, telementoring relationships can also be organized to redress social ills by providing needed support to historically disadvantaged groups. In the MentorNet program, for example, college-age women are matched with experienced female volunteers who advise them on their academic and career development. With sponsorship from several high-technology companies, this program is attempting to increase the representation of women in stereotypically male job roles.

Telementoring Functions

Telementors may provide students and teachers with many different forms of advice, guidance, and support depending on who is recruited, the purpose of the program, and its organization. In the research literature, the different kinds of assistance that mentors provide are referred to as *mentoring functions.*

As one might expect, online mentors are not able to perform all of the same mentoring functions as face-to-face mentors. For instance, while telementors can do some amount of role-modeling online, it is not likely to be as rich or informative as the kind that takes place when mentors and mentees can work side by side. Mentees who do not work in the same organizations as their telementors are also unable to experience classic mentoring functions such as recommendations for plum job assignments.

Within such limitations, however, telementors can do a great deal to support students' learning. At the simplest level, they can help mentees craft ideas about questions to investigate or ideas to explore, and they can offer pointers to appropriate learning resources (books, websites, etc.). In these ways, a well-matched mentor's knowledge can help students and teachers commit their time to thinking rather than combing the library or the web.

Good telementoring goes well beyond this. Although advice on information searching can be useful, volunteers are unlikely to find much reward in it. Older students may question whether a few pointers are worth the effort of sustaining an online collaboration. For telementoring relationships to be worthwhile for students, teachers, and volunteers alike, they must progress to examining the work that students are doing and how they are doing it. If students keep their mentors sufficiently informed about the progress of their thinking, much more advanced functions are possible. These include asking questions to help students think about their work, reviewing its direction, and making suggestions about how they can improve it. These more advanced functions have been referred to as the “prodding partner” functions (O’Neill and Scardamalia 2000) and are more reflective of the classic mentoring relationship.

Program Elements

The design and operation of a telementoring program or initiative will depend greatly on the community it is intended to serve and its objectives. However, all telementoring initiatives face the same central challenges and require the same essential components to meet them. These include:

Curricular occasion. Although telementoring relationships do not have to be tied to a specific curriculum unit or project, a well-thought-out connection makes it easier to justify the time commitment required by teachers and students and to clarify the contributions that telementors should make to students’ learning. Choosing the time and place for telementoring takes careful thought. It is tempting to think that knowledgeable volunteers might add value to any curriculum related to their expertise, but most published curricula are designed to make classrooms self-sufficient—leaving telementors with very little to do.

Mentor recruitment and screening. Every program or initiative must have ways to reach out to would-be volunteers and to choose from among the respondents those who are best suited to help students and teachers in the work they are pursuing. Larger programs usually do all of the recruiting over the Internet, since Internet access is a prerequisite for participation. Local initiatives are more likely to rely on friends, neighbors, or partnerships with nearby employers as avenues for recruiting.

Mentor and student orientation. After appropriate volunteers have been selected, the next step is to prepare them for their new roles as well as possible given the available time and resources. How extensive mentors’ preparation needs to be depends entirely on the experience they bring to their work and the responsibilities that will be entrusted to them. Some volunteers may have many years of experience as classroom teachers, scout leaders, or parents; others may have little experience working with children.

Matching is a process in which the available mentors are assigned to work with particular students. This process can vary between being quite simple and informal, and it can be formalized to the point of being technocratic. In any case, the criteria used in the matching process will vary depending on the goals of the program. There is no single correct way to make matches, and while research continues to probe such questions as whether mixed-gender or same-gender matchings produce the best results, there are no decisive empirical findings on this question.

The number of mentees matched with each mentor is a crucial issue. Although telementoring relationships do not have to be one-on-one, volunteers vary in their capacity to juggle mentees; and as the number of mentees per telementor grows, the more the role of the telementor begins to parallel that of a teacher. Matching each mentor with six or more students may entirely defeat the purpose of providing students with individualized support.

Monitoring. In many circumstances, particularly in the K-12 arena, a teacher, parent, or school staff member should regularly monitor the conversations that take place between mentors and students. This is important for several reasons. Instructionally, it is helpful to ensure that mentors and students are keeping in touch regularly and working toward the kind of dialogue that supports advanced telementoring functions. Although friction between students and mentors is rare, monitoring also provides important opportunities for teachers to offer feedback on how students and volunteers are conducting themselves online. Finally, it is important to be able to reassure parents that their children are being properly supervised when working with any nonschool personnel.

The experiences of teachers in some projects suggest that even monitoring telementoring relationships can be helpful to teachers, since it gives them a unique window on their own teaching (called unintended professional development).

Closure. Retaining experienced mentors from year to year is of great benefit to any telementoring program, since it reduces the need for recruiting and orientation. To retain volunteers, it is critically important to provide them with a clear indication of how the effort they invest has paid off. Minimally, teachers should have each student send a thanks and goodbye note containing the work that he or she produced with the mentor’s guidance.

Challenges for the Future

In every telementoring program or initiative, no matter how well designed and managed, relationships will sometimes fail to meet the expectations of one or more of the parties involved: the teacher, the mentor, or the students.

This is unavoidable. It is important to remember that the performance of the most knowledgeable and well-prepared volunteers will vary at least as much as the performance of knowledgeable and well-prepared teachers. And like the performance of teachers, the performance of telementors is dependent on many factors besides their own knowledge and skill.

One of these factors is the participation of students. Mentoring is commonly called a "developmental" relationship, meaning that through it the participants grow. This fact presents a critical design problem for telementoring, since it means that as students begin a relationship they may have only a limited notion of the benefits they might derive from it. This can sometimes make them unwilling to invest the up-front effort necessary for a relationship to succeed. This problem has been called the "developmental Catch-22" of telementoring (O'Neill and Gomez 1998).

The problem can be addressed in several ways. One way, used primarily in the Electronic Emissary project, is to have adult facilitators monitor the telementoring dialogues, periodically remind the participants to keep talking, and make suggestions about what they might discuss. Another solution is called mentoring in the open. In this approach, mentees in the same class are given convenient access to one another's telementoring dialogues online. This enables everyone to observe what is happening in the most productive relationships and model their own behavior on them.

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See also

Cognitive Apprenticeship; Computer-Mediated Communication; Constructivism; Electronic Emissary; Vygotsky, Lev

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Television and Learning

Television, as an entertainment source, news provider, and instructional medium, has retained an ambiguous status as an educational technology since its widespread adoption by the general public in the 1950s and 1960s. Critics argue that television is a mind-numbing medium that precludes critical thought, whereas television’s proponents tout the positive aspects of broadcast programming designed to reduce barriers among social classes and ethnic groups. As TV was originally conceived as an informational and educational medium, debate continues to this day regarding the problems and the potentials of the medium—its influence on learning, its power in the social environment, and its use for direct instruction.

Television as a broadcast medium—one that could bring information to a massive group of individuals simultaneously—drew the attention of educational reformers early on. Projects to utilize this new technology for distributing instruction in developing nations and territories sprang up in the mid-1960s and early 1970s, typically with the goal of increasing literacy levels, expanding primary school enrollments, and/or addressing teacher shortages. American Samoa, with funding from the U.S. Department of the Interior, developed a program aimed at elementary and secondary schoolchildren, as well as preschoolers and adults. A “master teacher” delivered live instruction to thousands of students, and local classroom teachers were expected to follow up these lessons with activities that were designed by a centralized production team. Similar projects were initiated in Niger, El Salvador, and the Ivory Coast.

The long-term results of such programs have been mixed. Samoan children demonstrated gains in spoken English (one of the project’s goals), but the value of this remains debatable, mainly because the improvement did not carry over into reading comprehension or writing in that language. The other major goal, to improve the school system in general, appears to have been moderately successful. The use of television as a delivery medium was reduced gradually after seven years of intensive integration, mainly due to the successful upgrading of the local instructors' teaching skills and improvements in the instructional facilities.

In the United States, an initiative to utilize broadcast television as a learning medium got under way in 1969 with the debut of *Sesame Street*, produced by the Children's Television Workshop. Funded with a combination of public and private monies, *Sesame Street* was aimed at preschool children (in particular, those considered disadvantaged in some way) and was produced using techniques specifically intended to compete with potential distractions. Unfortunately, these fast-action and quick-cut techniques have led some critics to condemn this program's influence, charging that it has contributed to the shortening of children's attention spans. The Children's Television Workshop went on to produce several other programs, all aimed at young audiences, but none has attained the international success of *Sesame Street.*

The Influence of Television on Achievement

How television (especially broadcast programming) influences children has been a source of controversy since it became a ubiquitous presence in the home. Although research suggests that watching television can and does influence how we think, the specific results are mixed, probably due in part to the difficulties in isolating television viewing as a variable. W. Schramm and colleagues (1961) bewildered some and angered others with intentionally vague remarks, for example, "For most children, under most conditions, most television is probably neither harmful nor beneficial." His underlying message—that there were few clear answers to the question of television's effects—was not what educators wanted to hear, however, and forty years later little has changed. More specifically, G. Salomon (1994) studied children's cognitive processing abilities and noted that viewing television programs appears to facilitate a kind of symbolic mental representation of concepts that resembles video production techniques (e.g., zooming in, panning, slow motion, etc.). Arming learners with a diverse repertoire of cognitive strategies is a desirable goal; however, it is not clear if these influences could also cultivate the development of erratic patterns of handling information, much like the quick-cut techniques seen in many prime-time programs. Additionally, while television is typically thought of as a primarily visual medium, content analyses of programs indicate that most of the salient content is carried in the audio portion of the signal. (For evidence of this, alternate watching television with the sound off with listening to it minus the picture and see which is easier to understand.)

There have been some studies of incidental learning that occurs as a result of television viewing, although this has not been a popular subject among researchers, possibly because the results depend so heavily on the individual personality characteristics of each viewer. Some viewers will be interested enough in a new topic they learned about on television to pursue additional information, whereas others will quickly forget they ever heard of it. There is no doubt that television can expand the vocabularies of viewers, and this benefit has been especially noticeable in learners attempting to learn or improve their command of a new language. When viewers are directed to pay attention to specific content, there is little difference in recalling televised information than that from other media, but this is not how most individuals watch television. Ultimately, although information learned incidentally by watching television may be retained for years, even decades, much of it is of a trivial nature, with limited usefulness beyond games or cocktail-party chat.

Incidental learning from television may also include imitation, whether done intentionally or as an unconscious response. Some imitation is harmless—mimicking a particular way of speaking, copying a popular hairstyle, or adopting a new golf swing, for example. This phenomenon is of great concern, however, when viewers choose to imitate violent acts, abusive language, or destructive pranks. Unfortunately, it is as yet unclear why some individuals appear susceptible to this indoctrination while others can clearly separate the fantasy of television from the reality of daily life.

Investigating the belief that television mesmerizes children into a passive state of receptivity, several researchers have studied children's screen-viewing patterns, their recall of televised information, and level of engagement with the content being presented (see, e.g., Huston and Wright 1998; Neuman 1995). In none of these areas does research support the hypothesis that watching television reduces mental activity. Children attend rather selectively to most programming, "tuning in" for those topics in which they're interested and that are presented in a developmentally appropriate manner, refuting the "television zombies" argument posed by critics. (For example, highly abstract presentations typically do not appeal to very young children who pay little attention to such displays.) There is also little evidence that level of engagement with televised presentations varies from that seen with other media such as audiotapes, print materials, and still images. Finally, recall of content presented in a televised format is comparable to that of other media, as well. Obviously, continued daily exposure to television will influence thinking; the challenge is identifying whether the effects are damaging, beneficial, or some mix of the two.

One frequently cited criticism suggests that watching television takes time away from more productive activities, such as reading, playing sports, or engaging in creative play with others. This *displacement effect* is particularly appealing, considering that it posits a simple solution to the worst effects of television viewing (i.e., turn off the set). Unfortunately, while this hypothesis seems commonsensical, there is as yet little conclusive research to support the idea that if children weren't watching television they would use their time more beneficially. Instead, studies of children's academic achievement have shown a clear link between achievement and *some* television viewing (typically two hours or less per day), with those learners who watch no television at all scoring less well, and those who watch significantly more than the optimal amount doing the worst. In addition, studies conducted with novice television viewers (i.e., individuals in geographic regions in which television had been unavailable) found that viewing displaced activities that fulfilled similar goals and required similar levels of cognitive effort, such as listening to the radio or reading comic books to fend off boredom. If there is one area of agreement among educators, however, it is that children (and adults, for that matter) watch more television than is ideal.

Perhaps the strongest arguments against television's effects can be leveled against its psychological or attitudinal influences on viewers. There is little doubt that television programming reinforces societal messages related to gender roles, physical appearance, and problem-solving. Unfortunately, these messages are often of a destructive, or even violent, nature. How viewers may be influenced by such programming is a source of intense debate, and its effect on learning remains unclear.

In response to uncertainties regarding television's effect—and rather than fighting a losing battle trying to eliminate the presence or influence of television—many educators are instead integrating critical viewing skills into their curricula. Critical viewing skills can be considered a subset of what is often referred to as *media literacy*, the ability to produce and interpret messages utilizing a wide variety of delivery systems. In the early 1970s, after the novelty of television had worn off and its presence had become a readily accepted (some might say unchallenged) part of daily life, teaching children about this medium became increasingly important. The goal of critical viewing instruction is not to protect the learners from television's effects but to help them become empowered consumers of televised programming by demystifying it and helping them to understand its underlying symbolic structures.

Critical viewing instruction is based on inquiry, challenging television viewers to develop skills that enable them to consider the messages presented, how those messages have been constructed, and for what purposes. Such instruction falls into a constructivist paradigm, rejecting the idea that children (or any group of learners) are simply passive vessels that helplessly absorb whatever stimuli they perceive. Most critical viewing instruction includes content related to advertising and persuasion, fact versus fiction (and what falls in-between), video production techniques, and what could be labeled "media language" (e.g., how visual design elements can be used to embed value-laden messages). Ideally, those individuals who become critical viewers will select television programming based on their own goals as opposed to those of advertisers, station managers, or special-interest groups.

Promoting Positive Options for Television Viewing

The airwaves are considered part of the public domain, but the Federal Communications Commission is charged with regulating their use to serve the "interest, convenience, and necessity" of the public while still protecting First Amendment rights. This balancing act became a bit more structured, however, when the Children's Television Act of 1990 became law. Television programming on commercial stations is, first and foremost, a profit-driven enterprise. Fearing that educational content aimed at children wouldn't pay the bills, most stations chose to market their programs to larger audiences and those with discretionary income to support advertisers. Public advocacy groups—realizing the potential of commercial, prime-time television as an influence on children's social, cognitive, and moral development—pressured Congress to pass regulatory legislation after it became clear that quality children's programming would not be produced voluntarily by broadcasters.

The Children's Television Act of 1990 requires that all stations provide "educational and informational programming" that would "further the positive development of the child in any respect, including the child's cognitive/intellectual or social/emotional needs" (FCC 1990). In 1997 new guidelines went into effect that required three hours of educational or informational programming per week; unfortunately, these programs are sometimes of questionable value as learning activities, but most educators and critics of children's television feel that the law has achieved its primary goal.

Another initiative that has facilitated the positive use of television for learning is Cable in the Classroom (CIC). Begun in 1989, this project by 2001 had grown to include nearly forty national cable networks with participation from more than 8,500 local cable companies. Schools that sign up for this free service get a cable hookup and access to television programming that can be recorded and used for instruction, with copyright clearance on those tapes for at least one year. Some of the networks produce programming especially for CIC use (e.g., *SportsFigures,* ESPN's math-oriented show), and others release rights on general-purpose programming (e.g., A & E's *Biography*). All of the programs are nonviolent, educational, and free of commercials. (For more information on this initiative, see www.ciconline.com.)

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See also

Clark, Richard E.; Entertainment-Education; Instructional Communications; Interactive Television; Research on Media and Learning; Schramm, Wilbur

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U

Usability

Usability, according to the international standard, is “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.” (The International Organization for Standardization issues standards with a numeric designation—e.g., ISO 9241: Usability—which constitute documented agreements among participating international organizations that they will ensure that materials, products, processes, and services are fit for their purpose.) In recent years, usability has often been regarded as a quality measurement of user performance and satisfaction for software applications and websites. Usability criteria, however, can be applied to a wide variety of products, including electronic systems (ranging from personal computer applications to aircraft piloting systems), technical documentation (such as user manuals and help systems), and other user-operated devices (such as digital thermometers). Put simply, the usability of a product is a measure of how well it can be used to perform a given task, in a given situation, with a minimum of frustration for the user. Methodical development approaches such as usability engineering help build usability into a product. Figure 1 shows the interrelated aspects of usability.

Forerunners of Usability

Usability has its roots in fields dating back at least to the early twentieth century. In those years of growing industrialization, the field of ergonomics sought ways to improve worker productivity through time-motion analysis and standardizing tools, materials, and the job process. During World War

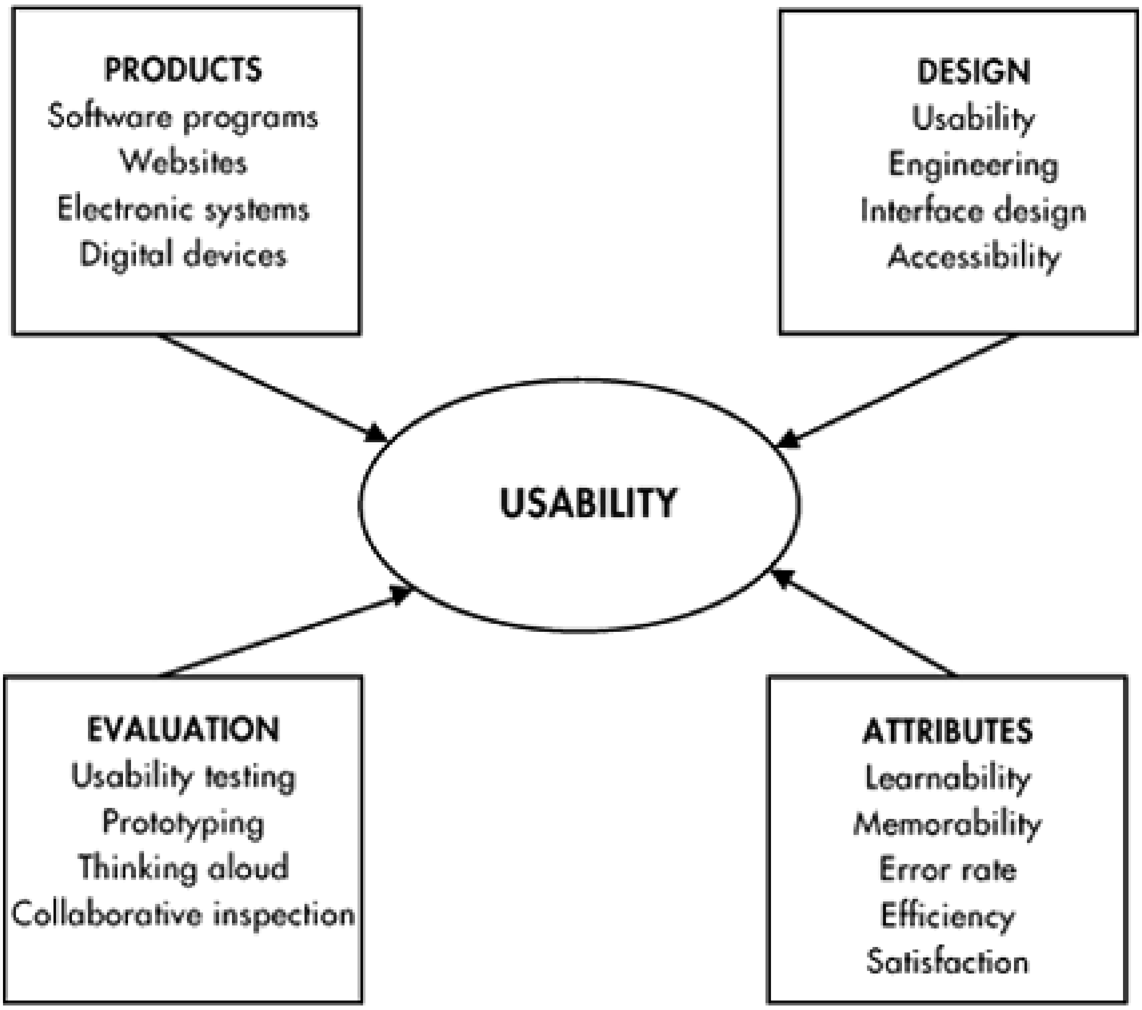

Figure 1:

Usability Results from an Iterative Process Whereby Product Design Incorporates Attributes of Importance to Real Users

Source: Created by the author.

II the field of human factors explored ways to optimize the design of sophisticated military equipment to minimize operator error. In both ergonomics and human factors, studies focus on how human characteristics, abilities, behavior, and environment influence how effectively an object can be used and, in turn, how it should be designed. With the advent of computers, a related field called human-computer interaction (HCI) evolved that considered the unique aspects of human interaction with computers, including information exchange through input devices (mouse, keyboard) and output devices (computer monitors, printers) and the design of graphical and text interfaces. Most recently, with widespread use of personal computers and the Internet by noncomputer professionals, the term “usability” (a focus of HCI) has become prominent in literature targeted to developers of electronic products and services who hope to support a mass market.

Usability Concepts

The usability aspects of a system or device differ depending on its intended use (Ferré et al. 2001). For example, the design of an automated teller machine needs to ensure accuracy both on the part of the system, through fail-safe error checking, and on the part of users, through an unambiguous interface. When dealing with money, users have a zero tolerance for error. For a graphics software program, however, efficiency through automation of complex tasks (such as creating special effects) may be the most important usability aspect, even though ease of learning suffers. For users comparing graphics software programs or transitioning from manual preparation of artwork, satisfaction may depend on the number of labor-saving features the program offers.

Because the concept of usability is broad, technical literature usually explains it as a combination of factors. According to expert Jakob Nielsen (1993), usability consists of five attributes:

1. *Learnability:* How fast can a novice user become proficient in using the system?
2. *Efficiency:* How fast can an experienced user complete tasks?
3. *Memorability:* How well can a user remember how the system works when use is sporadic?
4. *Error Rate:* How often do users make errors when using the system, and how do these errors affect accomplishment of tasks?
5. *Satisfaction:* How much does the user like using the system?

Ideally, from the beginning of the development process, manufacturers incorporate these attributes into product design through an approach called *usability engineering.*

Usability Engineering

Usability engineering is a systematic approach to designing and testing technological products to make them easy to use. It involves a variety of methods, including analysis of tasks for which the product will be used, development of prototypes (initial versions of the product), evaluation and revision of the design, and testing of the product with representative users (Usability.gov 2002).

A common approach taken by usability engineers is user-centered design. In user-centered design, engineers work to understand users and involve them in the design process. User involvement is accomplished through progressive phases, as described below (Ferré et al. 2001).

User Studies

In user studies, engineers gather information about users through methods such as site visits (observing users in the environment in which they will use the product), focus groups (interviewing groups of representative users), and task analysis (identifying the techniques people use to accomplish a task). By understanding the context in which users perform tasks and the steps they go through to accomplish work, usability engineers can tailor the design of the user interface (parts of the product with which the user interacts) to user needs. Also during this phase, engineers establish usability benchmarks or goals that reflect the user information gathered in relationship to the five usability attributes described above.

Design

During the design phase, usability engineers document how the product will function and appear to users. Usability and visual design principles are applied, as are standards for developing product specifications. The design documentation is then translated into mockups (nonfunctioning representations) and prototypes (functioning initial versions) for evaluation.

Usability Evaluation

During the evaluation phase, feedback is sought through a variety of methods, both from users and usability experts.

Mockups. Testing may begin with users being shown a paper mockup or nonfunctioning prototype of the product and asked to provide feedback. This feedback process is iterative, with engineers showing improved designs to users multiple times. Once the paper mockup has been refined, a working prototype of the product is produced for more rigorous evaluation.

Usability testing. The next step in usability testing involves observing a group of users interacting with a working prototype in multiple scenarios or hypothetical situations. Testing often takes place in a formal laboratory with audio and video recording devices to document user responses for later analysis; however, testing may also take place in less formal settings such as user offices.

Thinking aloud. As part of the testing process, users may be asked to state aloud their thought processes as they try to determine how to use a product. This thinking aloud feedback is useful in revealing ambiguities in the user interface.

Expert evaluation. Obtaining critiques of the design by usability experts can shorten the evaluation process or identify usability weaknesses not revealed by user feedback. One type of expert evaluation process is called *heuristic evaluation.* Heuristic evaluation involves having a small group of evaluators critique a user interface in terms of its compliance with generally accepted usability principles (the “heuristics”), such as the ones described by Jakob Nielsen (1993). Another evaluation approach is to conduct a collaborative usability inspection (Ferré et al. 2001), whereby a team of developers, usability experts, and users collaboratively review the prototype product. Because of the combination of different perspectives, voids in feedback may be filled, significantly improving the product design.

Alternative Design Approaches

Software engineering has seen a rise in popularity of an alternative design approach called usage-centered design. This approach makes extensive use of task cases or use cases to model the actions and responses a system and user will make as they interact in a variety of scenarios. A use case reads almost like a script in which the actors (both system and users) have designated lines and stage directions. For example, a use case may include lines such as “system prompts for login and password,” “user enters login and password,” and “system validates login and password.” By making extensive use of modeling and selective user involvement, proponents of usage-centered design maintain that it produces a more systematic design than the trial-and-error, iterative approach of user-centered design.

Accessibility

Since 1990 increasing political and manufacturing attention has been given to a dimension of usability called *accessibility,* or the capacity of a product to be used by a person with a disability. Disabilities take many forms, such as vision, hearing, and movement, and may be permanent or temporary. Impairments such as blindness and deafness may come to mind when disabilities are discussed; however, even color-perception difficulties can affect product usability if a design does not provide contextual clues for color-coded information.

In some cases, a combination of products provides accessibility to disabled users. These ancillary, or add-on, products, referred to as *assistive technologies,* are particularly useful in making computer systems and websites accessible to the blind and deaf. An example of assistive technology is screen-reader software, which reads the contents of webpages aloud using a synthesized voice. The successful use of assistive technology depends in large part on the design features of the main product for which accessibility is being provided. For example, an unlabeled graphic on a webpage cannot be articulated by screen-reader software for access by the blind, and an audio track without closed-captioning cannot be accessed by the deaf. To provide accessibility, usability engineers incorporate design guidelines that have evolved from requirements specified in legislation. One such legislation is section 508 of the Rehabilitation Act of 1973, which mandates that accommodations be made to make information accessible to federal employees with disabilities and disabled users of federal websites. With its foundation in the Americans with Disabilities Act of 1990, which mandates public accommodation to commercial facilities and public services, section 508 has since been more broadly interpreted in court cases to require accessibility to a variety of technology products and services, such as Internet-based services (Guenther 2002). Aside from legislative requirements, many businesses are recognizing that providing accessibility to their technology products allows them to capture what may have been previously untapped markets.

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See also

Assistive Technology; Human-Computer Interaction; Rapid Prototyping; Web Accessibility

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V

Virtual High School Inc.®

Virtual High School Inc.® (VHS; www.govhs.org) is a cooperative project in which high schools from around the world pool their resources to offer a wide range of secondary-level classes via the Internet. Each member school can enroll up to twenty students per semester in VHS classes in exchange for contributing one online course to the VHS catalog. As new schools join VHS, the total number of available courses grows, thus providing each school with a cost-effective means to increase the range of courses it can offer without increasing its own enrollment (Melucci 1997; Droste 2000). In addition to expanding academic options for thousands of students, VHS levels the playing field for many students from smaller schools and schools with limited resources (the majority of participating schools serve student populations under 1,500; half of those have student populations less than 800) (Droste 2000). The VHS catalog contains advanced academic classes, as well as technical and specialized courses and many elective courses, that attract a wide range of students. The project also attracts a range of teaching professionals—from new teachers just starting out to those near retirement. Many teachers see VHS as an opportunity to teach a subject they're interested in but cannot offer locally. For others, participation in VHS is a way to stay current with new educational technologies, a means for reaching a larger audience of students, and (especially for those living in rural areas) a chance to interact professionally with a community of teaching colleagues from around the world.

VHS Inc. began in 1996 as a Technology Innovation Challenge Grant awarded by the U.S. Department of Education to the Hudson, Massachusetts, public schools. The principal investigators of the grant were Sheldon Berman, superintendent of public schools, and Robert Tinker, president of Concord Consortium, the major subgrantee. In the fall of 1997, the first group of VHS teachers offered nearly thirty secondary classes to approximately 500 students in twenty-eight schools located in ten states. By the 2000–2001 academic year, there were more than 150 courses being offered by 200 schools to nearly 5,000 students in the United States in thirty-three states and eleven foreign countries. In September 2001, at the end of its five-year grant period, VHS was incorporated as an independent nonprofit company with Liz Pape as CEO. VHS continues to offer an array of secondary courses to member schools in exchange for membership fees. A small sampling of the 2002–2003 catalog includes:

- American History: All History Is Local History
- AP Economics: Micro and Macro
- AP German
- Bioethics Symposium
- Eastern and Western Thought
- Environmental Chemistry
- Kindergarten Apprentice Teacher
- Music Composition and Arranging
- Nuclear Physics: Science, Technology and Society
- Number Theory
- Screenwriting Fundamentals

All VHS NetCourses are instructor-led, scheduled asynchronous courses, which means that students are able to get online anytime. Course assignments have weekly due dates, and students must post to the discussion area at least three times per week, but within those guidelines there is freedom to work when it is most convenient. This format allows for greater scheduling flexibility and the opportunity for participants from different time zones to learn together. Students are able to get online at their peak learning times, whether that is during the first school period with nineteen other VHS students in a common computer room, over a private lunch with a laptop, or at midnight on a home computer. Access to the World Wide Web is the only technical requirement needed to open the virtual door to the VHS classroom.

Students post written comments and work in a threaded discussion area, which organizes participant comments according to topic, with subtopics appearing below (and indented from) the main thread. The dialogue is permanently recorded, so students can take it all in without worrying that they're missing something as they might in the fast flow of a face-to-face dialogue or an online synchronous chat. All students must participate, but they can do so when and where it’s most comfortable. Students don’t have to raise their hands to speak in this environment, which affords them the opportunity to mull things over, post to multiple subthreads, and take conversations to new depths. Some jump right into the topic, whereas others may wait for a peer to post first; all students must post a minimum required number of times each week.

Teachers act as facilitators to guide student discussions by weaving thoughts together, summarizing comments, acknowledging participants, answering specific technical or assignment-related questions, highlighting important issues, and asking open-ended questions. In other words, VHS teachers step down from the traditional face-to-face model of teacher as sage on stage; they act instead as guides on the side of student learning (Collison et al. 2000). Through group discussions, students engage in course content: They reply to questions on readings, share feelings about the process and nature of their own learning in an online course, and respond to peers’ inquiries. In this way, they co-construct their knowledge, a hallmark of the constructivist approach to learning on which VHS NetCourses are based.

Although the core learning area is the discussion forum, a virtual course is not all text-based. In fact, because a virtual course focuses on online reading and writing in the discussion area, it is also critically important to include offline activities, as well as activities that tap into different learning styles (McIntyre and Elbaum 2000; Elbaum et al. 2002). Like their face-to-face counterparts, VHS courses feature a variety of activities that are completed both on and away from the computer. For example, VHS offers science and programming courses that include labs and hands-on work. Other courses use interviews in the local community, offline library research, classroom apprenticeship, or artwork done offline (and later scanned). Online assignments take many forms as well, including written essays, Internet research, journal entries, debates and simulations, webpages, music compositions, computer-aided design, and more.

Another feature critical to the success of an online course is the virtual community. To help establish community, VHS provides ongoing Water Cooler threads (one for students, one for faculty), where participants are encouraged to hang out and share personal stories or professional news. VHS courses typically have a casual discussion thread equivalent to the face-to-face student lounge, as well as creative getting-acquainted activities at the beginning of the course, where students are able to break the ice and get to know one another. Within their courses, participants complete a profile with a photo of themselves (or other graphic) and as much information on hobbies and personal background as they wish to share.

The average VHS class has eighteen students from twelve schools and seven states, and each student brings his own set of experiences to class.

Students and teachers learn a great deal from each other; they have different skills and expertise, different perspectives and cultural backgrounds, and different ways of working. Accordingly, students in VHS professional development and secondary courses collaborate in both independent and team activities, modeling the working world in this global, technological environment, where communicating and collaborating online are keys to success.

VHS courses foster student-to-student interaction and feedback. This feedback comes in the form of responses to comments on readings or in more specific activities that are designed to elicit constructive feedback on a particular assignment. Students do not simply hand in their homework to an offsite teacher with whom they have little or no contact; they actively interact with student peers and the teacher. Correspondence courses, where students work in isolation and receive little or no direct feedback on their work, lack this critical feature. In VHS, by contrast, students receive weekly or biweekly grades, often with extensive written feedback. Assessment is based on both participation in the online discussions and completion of assignments. Because participants can feel estranged in an online course, providing timely evaluations of student work is critical for participants' sense of where they are in relation to the course goals. Private discussion threads provide further opportunity for discussing evaluations.

As one of the earliest, largest, and widest-reaching virtual high schools (members range from a rural school of 200 to an urban school with nearly 4,000 students), VHS has faced a variety of pedagogical and logistical challenges, and many lessons have been learned as the Virtual High School grew to its current size. For example, VHS learned early that it was difficult to single-handedly take care of the technology required for such a massive project. VHS initially housed its servers in Concord, Massachusetts, where it stored all of its professional development and secondary courses. Without sufficient technical staff to oversee the servers, however, VHS participants encountered frequent down time. VHS now relies on enormous servers at a technical service company whose job it is to provide reliable storage service for online courses.

One of the earliest and most important discoveries was the key role played by the local site coordinator present at each member school site—a person responsible for providing administrative support to the school's VHS teacher and students. As it became clear that a competent site coordinator was critical to the success of a school's involvement in the program, VHS developed Site Coordinator Orientation (SCO), a graduate-level online course that trains site coordinators to provide the local connection between students and the virtual world. Site coordinators receive four weeks of training in the courseware technology VHS uses and

VHS policies and procedures in order to help local students and teachers participate successfully in VHS. The SCO is mandatory for all site coordinators, and schools may not register students in classes until the site coordinator has completed the training.

In addition to providing local support, VHS site coordinators provide feedback on VHS courses and their teachers, thus helping VHS administrators understand the needs of the many different schools involved and identify what is and is not working. With the rapid growth of VHS came the problems of coordinating classes across time zones and wildly varying school calendars. It proved impossible logistically to create a school calendar that would conform to the schedules of all member schools. After a series of interviews and regional conferences with site coordinators, a plan was implemented whereby VHS teachers created Independent Learning Opportunities (ILOs), or short independent study modules (on topics ranging from using the World Wide Web to getting money for college, from photojournalism to sea turtles), that VHS students could take before and after their VHS course if their school's semester began before or ended after the scheduled fifteen-week VHS semester. Many of the ILOs created by VHS teachers complement a specific VHS NetCourse, enhancing the curriculum of the course without requiring prior course knowledge.

As VHS increased in size, the possibility of creating regional spin-offs was explored. Smaller VHS hubs organized by geographical location or school calendar were considered, but ultimately the participants indicated that the international aspect of the school—the ability for students and teachers alike to interact with peers from around the world—was more valuable than the benefits that might be gained from creating smaller VHS hubs, and the idea was abandoned. As VHS grew larger, other challenges emerged. With its growing catalog of unique course titles, VHS recognized the need to create sections of its most popular courses, and a new professional development course was created. NetCourse Instructional Methodologies is a fifteen-week course in which participants learn the pedagogy, methodology, and technology needed to teach an existing VHS NetCourse section effectively. Teachers who wish to create new VHS courses continue to do so in the original Teachers Learning Conference (TLC), a twenty-two-week NetCourse in which teachers learn both the methodology and pedagogy necessary to teach online, as well as the technology necessary in order to create a unique course. Both courses are offered for graduate credit and professional development points and are taught by trained facilitators.

VHS realized at the outset that evaluation and quality control of courses would be at the core of a successful virtual school. In 1998 VHS convened a group, the NetCourse Evaluation Board, comprised of university-level distance learning and instruction experts, state department of education curriculum experts, and VHS teachers, trainers, and administrators who developed the National Content and Curriculum Standards, which list criteria for high-quality online courses. An additional set of courseware-specific and technical standards was developed, based on the TLC training course. Courses in development must follow these standards closely in order to become approved for inclusion in the VHS catalog. Courses are also evaluated while in delivery to ensure high teaching standards; focus is paid to teacher attendance, delivery of instruction, responsiveness to student inquiries, assessments, work delivered, student activity, and integrity of course content.

VHS courses—both the professional development courses that are required for participating secondary teachers as well as the secondary course offerings themselves—emphasize pedagogy that bridges online and face-to-face classrooms. VHS classes are student-centered and feature inquiry-oriented activities that are interdisciplinary in nature. Unlike other web-based offerings, where instructor lectures are uploaded to the web via text or videotapes for students to read or watch at their own pace and where the communication is one-way, VHS courses are interactive and based on extensive student-to-student and student-to-teacher communication (Pape 2000).

VHS has served approximately equal numbers of male and female students, as well as a number of students from economically disadvantaged backgrounds each year (Pape 2000). Schools for the deaf have participated in VHS for several years. Early on, VHS rejected the notion that the successful virtual student is technically savvy and performs in the top academic rank in face-to-face courses. Site coordinators and teachers have found that the asynchronous online environment attracts a range of students with different learning styles and abilities; it isn't necessarily the straight-A student who excels in VHS. Many different students find the flexible environment of a VHS course well suited to their needs.

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See also

Distance Education; Florida Virtual School; Virtual Universities

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Virtual Library

The virtual library is a concept whereby a collection of digital electronic information resources may be accessed via the Internet. The virtual library is often regarded as synonymous with digital library, electronic library, online library, and library without walls. One of the cornerstones of the virtual library is the electronic dissemination of information, or electronic publishing. Electronic publishing is dynamic; thus it allows access to the most current information. This information is not just the printed word; it can be images, sounds, movies, or other digital resources.

The virtual library enables students and teachers to access information anywhere at any time. “The Internet as the primary infrastructure for the virtual library enables searchers to investigate resources such as electronic papers, newsgroups and e-mail discussions that were not accessible in the past” (Saunders 1999, 773). Many states have created consortiums to facilitate the growth associated with electronic library materials. An example of the virtual library concept is the TexShare program in Texas. This is a statewide consortium of academic and public libraries that shares electronic information resources. One aspect of this program is to emphasize access rather than ownership. Other virtual library initiatives over the years include CARL (Colorado Alliance of Research Libraries), VIVA (Virtual Library of Virginia), and FIRN (Florida’s Information Resources Network).

The virtual library is a system that allows access to information in remote databases housed by institutions or vendors other than the local library facility or through a personal computer via a network. A user can enter a query and have the computer search for the data. Some electronic or digital data come from the World Wide Web via commercial information vendors, which are generally companies that provide access to information for a fee. Through this system the researcher can learn of the existence of needed information via bibliographic or journal citations or actually find the desired information in electronic format. In addition, the ability to find specific topics is enhanced because every word and phrase can be searched when information is in the electronic format.

In the library, encyclopedias were the first reference sources to be available in the electronic format. In the last several years, there has been an increase in electronic journals, which are an integral part of the virtual library. Another part of the virtual library is the electronic book. An electronic book is a computerized version of a traditional print book that can be read by using a personal computer or by using an electronic reader. This technology offers advantages such as keyword searches and other enhanced searching capabilities as well as the ability to bookmark, make notes, highlight passages, and save selected text or download the entire text of the book. Project Gutenberg is an example of an initiative aimed at posting electronic books.

Although the virtual library is relatively convenient and easy to use, users may still require the assistance of a reference librarian. Within the electronic library, access to such assistance is no longer limited to the physical reference desk of the local library but rather is available through chat or e-mail. The virtual library also allows librarians to respond more effectively to questions. As the transformation from print to electronic access has taken place, there has been a change in the reference librarians’ responsibilities to include assisting patrons with navigating the Internet, creating content-rich websites, and constructing effective search strategies.

Some resources are not available to users because vendors or publishers require a license agreement or because a subscription is needed to gain access to some of the materials. This is known as copyright; it is a concern in the virtual library environment, as libraries must operate within the copyright laws. The ease with which digital information can be copied raises concerns for the ownership of intellectual property. In the area of education, the use of materials protected by copyright in instruction has been a sensitive issue. In some cases, costs are associated with the ability to obtain the needed information. For example, universities had local ownership of print journal subscriptions. Now the move is toward access to the full text of electronic journals via subscriptions that mandate that only certain users may access them.

In the virtual library, librarians continue to be responsible for collection development, which is the process of planning and building a useful and coherent collection of library materials, whether in print or electronic format. The proliferation of electronic resources has grown tremendously since the advent of the web. The quality of information being posted on the web varies considerably; “the Web is described as a collection of databases that are called Web sites or Web pages. The emphasis here is on collection, without reference to its organization, intellectual accessibility, or service attributes” (Watstein et al. 1999, 349). Librarians help decide what resources are made available or created for patrons.

The web has seen a growth in the amount of information available to people. Librarians have valuable expertise in being able to evaluate the quality of information. The expertise is even more necessary in the virtual library environment because the information available on the web is produced by a different means. Books and journals go through editorial processes, whereas many websites do not go through any selection or editorial processes; therefore librarians now train patrons to search the Internet using critical thinking skills.

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See also

Copyright; Electronic Books; E-texts and Readers; Information Literacy; JSTOR

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Virtual Reality (VR)

Virtual reality is the computer-generated simulation of a real or imagined environment or world. It can be graphics-based (e.g., a walkthrough of a building) or text-based (e.g., a description of a city where participants can interact with one another). Inherent in this broad-based definition is interaction between the users and the computer. VR has the potential to change the way we learn. The question is: How can this new medium be incorporated productively into the learning process?

Closely related, sometimes interchangeable, terms include “scientific visualization” and “3-D visualization.” VR, in which each change in the displayed image is the result of recalculating polygons, is distinguished from traditional computer animation, in which persistence of vision creates the perception of motion when a series of static images is viewed in rapid sequence. VR is also distinguished from computer-aided design, in which the designed object is programmatically a static object, although it can be rotated and turned and may be a three-dimensional object.

Choosing one particular event as the beginning of VR is problematic. Early attempts to represent three-dimensional objects on a two-dimensional surface go back at least 30,000 years when the cave paintings at Lascaux were created. Perspective drawing, developed during the Renaissance, enhances the 3-D effect while continuing to rely on a flat surface. Photographs can create the illusion of 3-D with special glasses and/or a curved screen. Computer displays, viewed either directly on a flat screen or through special viewing devices, can also create the illusion of 3-D.

In VR, the success of the 3-D illusion depends on the extent of self-perceived immersion, which is dependent on both hardware assistance and the psychological acceptance of the viewer. In other words, the extent or degree of immersion exists in the viewer’s mind whether she is looking unaided at a flat screen display or using mechanical aids (e.g., head-mounted display units, shutter glasses, and anaglyphic glasses). The degree of feeling of presence in a virtual environment is more dependent on the environment itself than on the particular hardware used.

Educational Uses

There is an extensive body of literature on using virtual reality for educational purposes (Youngblut 1998). The use of VR in education is well grounded in learning theory. Among the various theories, constructivism is particularly well matched with VR. Building and exploring virtual environments require active participation and critical thinking, the hallmarks of constructivist learning. Experiential learning, too, is well matched with VR, drawing on the student’s experience as a part of the learning process. In a related area, Howard Gardner and others are working on identifying types of intelligence. The spatial, bodily-kinesthetic, and logical-mathematical types are the most likely to benefit from using VR as a part of the learning process.

Initially, VR began as one-on-one, person-to-computer applications, in which an individual worked alone with a virtual environment. So-called collaborative virtual environments are being developed in which a number of users can meet and work with one another in a virtual environment. These can be either leisure- or work-oriented. One variation is tele-immersion, in which each participant is represented by a photorealistic avatar, based on real-time photographs of himself (Lanier 2001).

Flight simulators, beginning with the Link Trainer in 1929, represent a particularly successful application of VR and are often considered the first VR application, albeit without computer assistance at first. Today, a fully developed flight simulator is computer-driven and employs the visual, tactile, and aural senses to achieve the feeling of presence and complete immersion. Educational applications of VR are now found in K-12 education, higher education, industry training, programs for assisting persons with disabilities, the military and medical fields, corporate training, emergency training, and aeronautics. The principal limits are imagination and resources. Virtual reality can be an appropriate instructional tool in all subject areas, including but not limited to mathematics, the sciences, technology, the humanities, the social sciences, and occupational training.

In elementary mathematics, VR models can provide visual aids for counting the numbers of objects, observing the effect of adding and removing objects on total counts, seeing how subsets of a group form fractions, and learning about shapes and solids. In science, virtual physics labs, models of weather phenomena, models of physical features on the earth and the planets, and chemical models can provide entirely new insights to students and trainees.

In social studies, VR models can provide visualization of the key elements that differentiate environments from different parts of the world. VR models can be used to reconstruct archaeological and important historic sites for study.

In theater arts, VR models can be used to create stage sets, block action, and establish sight lines. In literature, VR can be used to visualize scenes as they are described, including floor plans, decorating styles, structures, and landscapes.

MUDs (multiple user domains) and MOOs (MUD, object-oriented), which usually use only text rather than graphics to create virtual environments, may be more attractive to linguistically oriented persons than to visually oriented persons. Because text-based VR places a premium on writing skills, it is well suited for use in teaching language arts in both the student’s native language and in other languages.

We have yet to find an area of study in which VR could not be applied to good advantage, provided that VR is an integral part of the learning process and that the virtual models are congruent with learning objectives. Finally, in considering the use of VR in education, it is very important that VR be viewed as one of many instructional tools that the effective teacher has in her toolbox. The choice of tools, especially for K-12 instruction, depends on the objectives of the lesson being taught, the instructor's preferred teaching methods, and the students' interests and skills.

VR Software

Several types of software support VR. The first is 3-D object/world creators, used to create virtual environments. These are complemented with walkthrough programs that enable one to interact with a virtual environment once it has been created. These two functions can be combined into a single program.

The preferred computer language for writing VR programs is C or C++. However, many developers of virtual environments use programs in which the elements can be either designed (e.g., by specifying vectors) or dragged into place. These can be augmented with motion-capture programs, surface generators, and terrain modelers/landscape generators.

Collaborative virtual environments enable groups of persons to work together in either developing or using a virtual environment. Specialized VR software enables tracking of body movement and force feedback (haptic) applications. Other software creates avatars and virtual humans who exist in virtual environments.

VR software ranges from free to expensive. In general, the complexity and learning curve is steeper and longer with the more expensive programs, but the level of realism, feeling of presence, and immersion are also greater.

Virtual reality modeling language (VRML) allows viewing of virtual environments on the World Wide Web. Although the concept is powerful, a lack of implemented standardization has inhibited widespread use and acceptance.

Although often technically considered a form of VR, interactive panoramas are still photos or computer-rendered images that the viewer can pan from side to side and up and down as well as zoom in and out. There is no interaction with the computer as in true VR. The best-known interactive panorama software is QuickTime VR, developed and distributed by Apple.

VR Hardware

The first computer-based head-mounted display (HMD), developed by Ivan Sutherland at the MIT Lincoln Laboratory in 1966, was a bulky affair, using a pair of small cathode ray tubes and a tracking device. Later, the two images were slightly offset, generating a stereoscopic view. Today's HMDs use flat display screens and are much more compact.

The wide range of VR hardware available today includes large simulator systems, immersive projection systems, as well as cabs, gloves, head-mounted displays, goggles, glasses, and other peripherals. Prices range

from a few cents for anaglyphic red-blue glasses to many thousands of dollars for high-end HMDs or hundreds of thousands of dollars for simulator systems that deliver a 3-D interactive environment.

There are many VR hardware categorizing schemes. The taxonomy found in *Virtual Reality Technology* (Burdea and Coiffet 1994) is particularly good, using as categories 3-D position sensors, trackballs, 3-D probes, sensing gloves, stereo viewing devices, and 3-D sound generators. Online sources vary the list, using HMDs, related displays, 3-D sound convolvers, haptic feedback devices, data gloves, 6-DOF (3-D) mice and wands, and trackers.

The choice of VR hardware for a particular application depends on the minimum level of immersion required and on the resources (chiefly monetary) available.

The Future of VR

Only a portion of the research on the educational and training uses of VR is available in the open literature, because many military applications are classified, and many industrial applications are proprietary. The most current and informative sources tend to be on the World Wide Web rather than in books and magazines (see the references listed below).

VR, particularly as an instructional tool, is not without its critics. Some feel that the possible expense involved does not justify its use in the schools. However, this has not hindered medical, military, and corporate training applications. Others feel that research has not yet proven the value of using VR over other methods in teaching or training. Again, years of use in some areas, such as military training, support its effectiveness when used appropriately.

The safety of using head-mounted display units is an unresolved concern. Damage to the eyes, possible brain effects, and simulator sickness have been studied. Long-term experience, research, and hardware evolution will gradually resolve such safety issues.

A primary ethical question concerns how people behave in shared virtual environments compared to how they behave in the real world. Do people behave the same, following the same moral values? Or do they behave differently because it isn’t real and they can’t be held accountable for their actions?

We can anticipate a number of developments in VR. With increasingly powerful computers, the seeming realism in virtual environments will improve, in some cases to the point that reality and virtual reality may not be distinguishable. Three-dimensional computer interfaces will probably supplant the 2-D interfaces that we now use. Some form of Holodeck™ will become available, although it will be somewhat primitive by Star Trek standards.

As VR becomes more lifelike and new applications are developed, its usefulness as an instructional tool will increase proportionately. When a virtual environment is used as a part of an instructional package, the final step is evaluation, providing an opportunity to assess the effectiveness of the lesson plan and the virtual environment. If the lesson is going to be offered again, modification based on the evaluation is the first step in the next round. With evaluative feedback, the lesson and the environment can be improved, making them more effective.

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See also

Constructivism; MOOs and MUDs; Simulation and Gaming

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Virtual Universities

Virtual universities are institutions that use Internet-based distance learning as a primary business model. Online courses offered through virtual universities rely on the Internet as a delivery mode. “Virtual” means an institution whose mission is to offer classroom education in web space, or the virtual environment, in contrast to the traditional, face-to-face space of the classroom. The term “university” may or may not be synonymous with what we have come to regard as a university. Universities, defined in the traditional sense, are not-for-profit, externally sanctioned institutions of higher education. Therefore, virtual universities are distance learning institutions that provide students with remote access to college courses and degree programs. Some virtual universities provide their own courses and programs for college credit, whereas others are distributors of online education, aggregating course offerings from many institutions and providing centralized access to those courses.

Origins

With the advent of the Internet as a new mode of course delivery in the mid-1990s, early adopters of Internet-based online education began to form virtual universities. Virtual universities were established to accelerate the adoption of online course delivery in the early stages of Internet-based education. In some cases, private entrepreneurs created institutions that offered online educational programs exclusively via the Internet; some state politicians and associations created organizations to encourage the growth of Internet-delivered college courses.

The first virtual university to receive widespread attention was the Western Governors University, a consortium of state governors who attempted to provide centralized access to college courses and programs online for the convenience of students searching for online college courses and programs. Access to a collection of online coursework was offered at a virtual location via the Internet. This was followed by several other states, regional collaborations, and university systems forming their own version of a virtual university. Many collaborations were formed to guide the business model direction that each virtual university took.

Structure

The structure of the virtual university varies. Some virtual universities, like Capella University in Minnesota, are for-profit, degree-granting institutions of higher education that offer programs exclusively through distance learning. Capella University and others like it provide degree programs and all related student services completely online.

By contrast virtual universities like Michigan Virtual University (MVU) are not degree-granting institutions and aggregate course offerings provided by traditional educational institutions in the state. MVU does not develop its own college-level programs or academic courses but instead collaborates with third-party, for-profit vendors, colleges, and universities in the state to provide students access to institutions and learning opportunities they might otherwise not have access to. Among its services, MVU provides scheduled course offerings in a centralized online course catalog at its website. The online catalog is a compilation of Michigan community college online course offerings organized in cooperation with the Michigan Community College Virtual Learning Collaborative (MCCVLC), a consortium of community colleges that accept other MCCVLC member courses for full academic credit.

This model of collaboration is fostered by the centralized access a virtual university like MVU provides. Access to online courses allows a learner to assemble courses from a collection of courses to form a single degree. In this case, MCCVLC members agree to accept courses and credit hours from all participating members. Using this model, MVU and similar virtual universities provide a service to both the state institutions offering online coursework and to learners seeking convenience and access while obtaining their degrees.

Growth of Virtual Universities

Although several institutions across the United States have been created to offer online coursework, many have not met with success. California Virtual University and the Western Governors University, two of the first virtual universities and acknowledged innovators in higher education, have experienced less than overwhelming success. These institutions formed to respond to the growing demand for online course delivery in higher education and were instrumental in the creation of the virtual university concept.

Since the initial launch of these organizations and the concept they brought to higher education, several additional virtual universities of various models have been created throughout the United States. The next generation of virtual universities will likely follow a much different business model. Successful virtual universities in the future may follow the Capella University model, with degree-granting capabilities, although it is also possible that state-sponsored organizations will find a niche. If virtual universities are to survive and thrive as an alternative to traditional brick-and-mortar institutions of higher education, they will need to be attentive to the changing needs of educational consumers.

The Future

Virtual universities filled a much-needed void early in the adoption cycle of learners seeking to gain college degrees using a nontraditional mode of delivery. Although many institutions of higher education have since adopted forms of online delivery, most still operate in a mixed-mode basis, defined as offering students a choice of either the traditional classroom or the virtual classroom.

Virtual universities that collaborated with state or regionally accredited colleges and universities early on may face a dilemma as the market matures. Increasingly, traditional institutions may not require the services or centralized distribution effort the virtual university partner provided. These colleges and universities continue to add online courses and degree programs in addition to their standard programs, offering students a greater choice and providing the convenience and service that the virtual universities originally provided. It is uncertain how the original mission of the virtual university will be affected by established brick-and-mortar colleges and universities in the future.

Also unknown is whether the self-sustaining virtual universities—those that provide an alternative to the traditional institution—will be fully accepted as a credible alternative to established educational institutions. Online course and program offerings and access will continue to grow at traditional colleges and universities. The growth and sustainability of this type of virtual university is yet to be seen. Although demonstrated growth in the demand for online course and program offerings is undisputed, the original need once met by virtual universities is now migrating to the traditional institutions as the Internet as matures and as demand dictates.

Virtual universities may become a fad of sorts, replaced by traditional institutions as they increasingly create their own virtual courses and programs as an alternative to traditional classes.

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See also

Distance Education; Virtual High School; Western Governors University

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Visual Literacy

Visual literacy involves the ability to interpret (read) and to produce or use (write) culturally significant images, objects, and visible actions. The term “visual literacy” dates from the 1960s, but the concept has much older roots. From prehistoric times, humans have used symbols and images to communicate. For the past several hundred years, however, Western cultures have privileged textual literacy. The proliferation of photography, film, television, and computer-based imagery has challenged text as the primary means of communication, fostering a movement to define, understand, and teach visual literacy. This movement at times has converged with efforts to study and develop multiple intelligences (Howard Gardner suggested seven of these, including visual-spatial) and multiple literacies (such as media or information literacy), marking visual literacy as one of the significant education reforms emerging in the late twentieth century.

Although people see images constantly, visual literacy is grounded in the assumption that people, specifically students, need to learn how to look at the visual world analytically. People are not visually literate simply because they live in an image-rich environment, just as people do not learn to play a range of musical instruments simply by listening to songs on the radio. The process of learning to read visual images is similar to the process of learning to read text. Infants cannot read words (or even recognize what is text and what is not), but they soon develop the ability to see and then to understand the textual world. Children at first begin to associate lines and curves on a page with certain letters, then to connect letters into words and words into sentences. Reading simple sentences, of course, is not the end of the story. Instead, textual literacy continues to develop through life as a reader learns to interpret new words, styles, and literary devices to make meaning out of complex lines and curves on a page. Similarly, with training and practice, people can develop the ability to recognize, interpret, and use the distinct vocabularies of different visual forms—such as the meanings commonly associated with specific shapes or colors in Renaissance art and the way camera angles and lighting shape the mood of a scene in a Hollywood film. The process of becoming visually literate continues through a lifetime of learning new and more sophisticated ways to analyze and use images.

The nature of the contemporary visual world, however, complicates the teaching and learning of visual literacy. Images on television, on a computer screen, or in print often are so familiar and so seemingly transparent that students fail to notice that those images have been constructed to convey certain meanings. Technology also may obscure the nature of images. Photographs, for example, appear to capture a slice of reality. “Seeing is believing,” according to the adage. However, a visually literate reading of a photograph involves more than simply looking at what is in the picture; such a reading also asks, among other questions, what is *not* in the picture, why the photographer chose to take this photo, and why this image was selected to appear in a particular context (such as next to an article in a newspaper). Because people easily can develop a superficial understanding of most modern images, the need to read images more closely is not necessarily apparent. Thus many advocates of visual literacy have found that people first must begin to understand the complexity of images before they will value the concept of visual literacy.

Despite this obstacle, the study of the physical processes involved in visual perception has both encouraged and reinforced advocates of visual literacy. Research demonstrates that seeing is not simply a process of passive reception of stimuli; it also involves the (often unconscious) active construction of what is being perceived. A typical person, for example, automatically perceives a line drawing of a cube to have three dimensions; our eyes project depth onto a flat surface by assembling a familiar shape from a simple drawing on a sheet of paper. If the *physical* act of seeing involves active construction, so the *intellectual* act of interpreting what is seen must require a critical viewer.

Research also demonstrates the power of visuals in shaping our understanding of the world. Not only do people process images more quickly than text; they tend to rely on their visual experience even when it contradicts their conceptual knowledge of a topic (once again, seeing is believing). Text and images, however, are not necessarily in conflict. Research suggests that students learn more, and that learning lasts longer, when text is combined effectively with visuals in academic exercises. But a teacher selecting images and text carefully is not sufficient to enhance learning; students also must have some fluency in reading both the text and the image for deep learning to occur. As students become more skilled at reading the visual world, they will become more adept at learning from images *and* text.

Strategies for teaching visual literacy generally begin by building on the knowledge that students already possess about images and then moving the students toward more sophisticated analysis, an approach sometimes called cognitive apprenticeship. A core aspect of cognitive apprenticeship involves teachers breaking a complex problem into component parts that can be addressed one at a time. Students progress from discreet and familiar tasks to more difficult work. The teacher, in other words, builds a scaffolding of small exercises or focused questions around a challenge, allowing students to climb step by step toward a higher level of understanding. In an elementary school's art classroom, a visual literacy lesson might begin with the teacher asking students to identify a favorite color, then prompting students to look at advertisements that use the color to explore how color directs the attention and shapes the mood of the viewer. In a university-level history class, a visual literacy exercise initially might have students describe what is pictured on a sixteenth-century Spanish map of the New World; students then would be asked to take a series of more complex steps culminating in an assessment of the ideology implicit in the design and production of that map. Like textual literacy teaching strategies, visual literacy pedagogy becomes more sophisticated as students develop skills using the vocabularies and styles of different visual forms.

Visual literacy teaching, therefore, is both process-oriented and content-oriented. Classroom lessons sometimes rely on students answering a uniform series of questions about any image, but students also must learn how to interpret the content and context of what they see. Although an old map and a contemporary fashion advertisement are both images, the reading of each requires more than just a process-oriented analysis of color, shape, and so on; a sophisticated reading involves close attention to both the content of each image and the context of the production and use of each. The teaching and learning of visual literacy, therefore, should not be divorced from the teaching and learning of different academic disciplines. In this sense, visual literacy parallels textual literacy in its mixture of process and content orientation; students use the same basic skills to read a poem and a mathematical word problem, but students are taught different strategies to help them understand a variety of textual forms. Like learning to read text, students need to develop their ability to interpret and use images in the full range of classroom subjects so that they can continue to apply and develop these skills throughout their life.

An emerging field of scholarship that studies how people interact with and learn from images is driving visual literacy pedagogy and research. This approach draws upon a range of disciplines from education and the arts to pure and applied sciences. Although many individuals and groups are doing visual literacy work, the International Visual Literacy Association (IVLA; www.ivla.org) is probably the largest entity supporting scholars and practitioners through conferences, publications, and other resources. The IVLA emerged in 1968 out of a collaboration between academics and people from business, most significantly from the camera and film company Eastman Kodak. Decades after the advent of visual literacy and the creation of the IVLA, the field continues to draw from industry and academia as it seeks to understand how people interpret and use images in their lives.

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See also

Association for Educational Communications and Technology; Cone of Experience; Instructional Communications; Learning Styles; Message Design

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Vygotsky, Lev (1896–1934)

Lev Vygotsky, a renowned Russian psychologist, is noted for his research and theories dealing with the development and structure of human consciousness. His theories and concepts, including social constructivism, the zone of proximal development, and language acquisition, have implications for teaching and learning in today's classrooms, as well as for the role that educational technology can play in designing and supporting learning environments in classrooms.

Born on November 5, 1896, in Orsha, a town in northern Belarus, Vygotsky was the second child born to a middle-class Jewish family. A year later his family moved to Gomel, a small town in southern Belarus where Vygotsky lived during his infancy and youth. His father was a banker, his mother a licensed teacher. Lev's life was filled with interesting conversations that took place in the family dining room, and these conversations played a decisive role in the Vygotsky children's cultural formation.

Lev received his primary education at home with Solomon Ashpiz, a private tutor who had been exiled to Siberia for his revolutionary activism. Ashpiz accepted only talented students and conducted lessons using a technique based on Socratic dialogues. Perhaps this experience influenced Vygotsky's conception of the zone of proximal development, a central tenet in his theoretical framework. After Ashpiz's tutelage, Vygotsky entered a public school and then a private Jewish school of higher academic caliber in order to finish this phase of his education. Theater, literature, and philosophy were his main interests at this time, and they remained so throughout the course of his life.

Jews were oppressed in czarist Russia and only 3 percent of qualified Jewish students were admitted into universities. Luck was with Vygotsky, as he was one of the Jewish students chosen by lottery to be admitted to Moscow University. He attended the university between 1913 and 1917, studied law, literature, art, philosophy, and history, and, like many young college men, was influenced by the revolutionary currents in Russia.

Vygotsky graduated in 1917 and returned to his hometown of Gomel, where he worked as a teacher, a profession he was able to practice due to the abolition of anti-Semitic legislation after the October Revolution. Vygotsky spent his next seven years in Gomel, pursuing his intellectual interests—teaching literature and Russian at a variety of schools, logic and psychology at the Pedagogical Institute, as well as aesthetics and art history at the Conservatory. He also edited and published articles in the theater section of a local newspaper.

In 1919 Vygotsky contracted the tuberculosis that would kill him fifteen years later. Despite his illness, he worked relentlessly, even during his most difficult periods. In 1924 he married Rosa Noevna Smekhova, a determined and intelligent woman, who provided encouragement to Vygotsky during his long, debilitating illness. They had two daughters. The elder, Gita Levovna, graduated as an educational psychologist, and the younger daughter, Asya, was a specialist in biophysics.

By the time he married, Vygotsky's interest in psychology had become his central focus. Some believe that his real interest was in solving problems of art and culture, and so he turned to psychology looking for solutions. Besides researching and teaching, Vygotsky continued to write, often after 2:00 a.m., when he had some time to himself. Because of his frenetic pace, he completed almost fifty works during the years 1929–1930.

In 1933 Vygotsky presented some of his most important theories. During a series of lectures in Leningrad, the zone of proximal development theory was introduced. It dealt with the question of what a child can learn at any given moment and has received much attention from current scholars. During this same period he wrote his book, *Thought and Language* (1934 [1986]), which analyzed the formation of human consciousness and emphasized the role of language in the development of thought. Vygotsky dictated the last chapter of this book from his deathbed.

In the spring of 1934 he suffered the last assault of tuberculosis. Doctors insisted on hospitalizing him, but Vygotsky refused because he wanted to complete as many works as possible. Those who knew him believe this decision precipitated his end. On June 2 he was hospitalized after suffering two throat hemorrhages. Late in the evening on June 10 or in the early morning hours of June 11 he died. His last words were, "I am ready." Vygotsky was buried at Novodevechy Cemetery in Moscow, near the final resting place of Anton Chekhov. He was thirty-seven years old.

Vygotsky's final manuscripts were published a year after his demise, but shortly thereafter Stalin's systematic persecution of intellectuals resulted in his writings being banned for twenty years. Starting in 1956, however, Vygotsky's work began to be reissued. The significance and usefulness of Vygotsky's work was not fully appreciated by U.S. psychologists until his writings were translated into English (1962, 1978, 1981). Today, many of his ideas are clearly evident in our conceptualizations of learning and instruction.

Cognitive psychology credits Vygotsky with social constructivism. According to this theory, learners actively construct knowledge, and emphasis is placed on the social context of knowledge construction. Several assumptions underlie the theoretical framework Vygotsky developed: (1) the role of culture; (2) language acquisition; and (3) the zone of proximal development. The first assumption is the importance of culture. Humans are the only species to have created culture, and every human child develops within the context of a culture. Culture provides the child with the cognitive tools needed for development, and the type and quality of those tools determine a child’s rate and pattern of development. A child’s learning development is affected by culture in a myriad of ways that include the culture of the family environment in which the child is situated as well as the larger social milieu. Vygotsky’s second assumption concerns the central role of language, which is the symbol system used by learners to construct meaning. Finally, Vygotsky defines what he referred to as the zone of proximal growth or development. Vygotsky argued that students can, with help from adults or other children who are more knowledgeable, master concepts and ideas that they cannot understand on their own. A short description of each of these assumptions follows.

According to Vygotsky, our use of tools and symbols, the artifacts of a culture, separate us from other animals and allowed humans to develop cultures. These cultures exert extremely powerful influences on all of us. They dictate what we have to learn and the kinds of skills we need to develop. Vygotsky further distinguished between two types of human learning: elementary mental functions and higher mental functions. As we develop, our elementary capacities are gradually transformed into the latter, and this transformation occurs largely through the influence of culture. No real thought is involved in elementary functions, as they are natural, unlearned capacities such as sensing and hunger. Higher mental functions (memory, thinking, attention, abstraction, and perception) involve the use of artificial stimuli, such as language, which serves as a means of influencing and regulating human behavior.

Language is an important cultural tool. Vygotsky believed that the learning of language (or signs) is influenced by social processes and ultimately makes thought possible. The meanings of words change as a child develops, and this in turn causes changes in the child’s mental structures. According to Vygotsky, thought and language are separate functions for infants and young toddlers. In these early years thinking occurs independently of language, and when language appears it is first used primarily as a means of communication rather than as a mechanism of thought. Sometime around two years of age, thought and language intertwine. Children begin to express their thoughts when they speak, and they begin to think in terms of words—and so language begins to direct the child's behavior and learning.

Vygotsky believed that the lifelong process of development was dependent on social interaction and that social learning leads to cognitive development. He named this phenomenon the zone of proximal development. Vygotsky described the zone as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with a more capable peer" (Vygotsky 1978). A child's actual developmental level indicates the functions that have already matured in the child at a particular time. A child's zone of proximal development defines those functions that have not yet matured but are in the process of developing. Children can typically do more difficult things in collaboration with adults than they can do on their own. For example, children just learning how to use a baseball bat can hit a baseball more successfully when adults are present to guide their swing. Students may be able to read more complex prose within a reading group at school than they are likely to read independently at home, thereby distinguishing between a student's instructional (zone of proximal development) and independent reading levels.

Tasks within the zone of proximal development promote maximum cognitive growth. A child's zone of proximal development includes learning and problem-solving abilities that are just beginning to develop within that child. Vygotsky proposed that children learn very little from performing tasks they can already do independently. Instead, they develop primarily by attempting tasks they can accomplish only in collaboration with a more competent individual—that is, when they attempt tasks within their zone of proximal development.

Scaffolding facilitates performance of tasks within a child's zone of proximal development. When adults and other more skilled individuals assist children in performing a difficult task, they often provide scaffolding—some form of structure that supports the child in her efforts. For example, adults might make the task simpler than it would otherwise be, give hints about how to proceed, or perhaps model the procedure themselves. As the children become more adept in performing tasks, adult guidance is gradually phased out, and the children are eventually performing tasks on their own.

After developing his theoretical framework, Vygotsky came to believe that intelligence tests were an inadequate measure of a child's ability because they only showed what the child was capable of on her own. In the real world children have access to older children and adults who will help them solve problems, and so Vygotsky advocated taking account of this phenomenon (the zone of proximal development) when assessing a child's potential. The more a child takes advantage of an adult's support, the wider her zone of proximal development. Two children may be at the same intellectual stage when measured by conventional IQ tests but may differ when measured using their respective zones. With help, one might manage to complete tasks usually completed independently by children four years older. Provided with the same help, the other child might only be able to extend her competence by two years. Thus the limits of a child's zone might provide a more realistic assessment of her cognitive potential and give us pause as we contemplate the utility of the current glut of standardized testing as a means of assessing and designing instructional environments. Educational technologists might also consider how students can work within their zones of proximal development without human help. Technological aids, rather than or in addition to more knowledgeable human others, might be able to provide students with more immediate and efficacious scaffolding when they are working in their zone.

Vygotsky believed that the development of human thought is determined by one's culture. Therefore, all education has a social character and is dependent on both the reality surrounding the learners as well as their own individual experiences. The teacher's role is to organize the social environment of the students so that students are provided with experiences that enable learning. Traditionally, schools have not promoted environments in which the students play an active role in their own education as well as that of their peers. However, Vygotsky's theory requires that a teacher should collaborate with his students in order to create meaning in ways that students can make their own (Hausfather 1996). Learning becomes a reciprocal experience for students and teacher and requires the active participation of each.

Based on Vygotsky's theory, the physical classroom would provide clustered desks or tables for peer instruction, collaboration, and small-group instruction. Like the environment, the instructional design of materials to be learned would be structured to promote and encourage student interaction and collaboration. Situated learning, simulations, case-based instruction, project-based learning, and problem-solving are some of the instructional strategies that would foster the kind of learning described by Vygotsky. Computer technology is only one of the latest cultural tools that students can use to mediate and internalize learning. Integrated multimedia software packages, the Internet, and as a variety of telecommunications tools can provide electronic communities in which students can collaborate and develop partnerships that will facilitate working and learning in their zones.

Although Vygotsky acknowledged that an individual's experience is part of what shapes understanding in any situation, he emphasized that it is only one influence. Vygotsky believed that biological and cognitive development did not occur in isolation; they were influenced by one's social setting. Currently the information age is responsible for great cultural changes in modern society, due in large part to the introduction of computer technology. Perhaps that is why Vygotsky's theories are receiving increasing attention. We can relate to the questions he wanted to answer. Today we wonder how these state-of-the-art technologies will affect our development, our learning, and our thoughts. Vygotsky might well advise educational technologists to consider how the role of culture and language will influence one's ability to use technology in ways that will enable rather than constrain learning and understanding.

He might also advise us to observe how the technologies themselves employ new, often unfamiliar, symbol systems that users will have to "speak" or understand in order to be able to make use of the technology. As the users learn and employ this new "language," educational technologists should attend to how this technological context might influence the users' thoughts and behaviors, impacting, and possibly even changing, their familiar human culture and language. Educational technologists will need to consider the benefits and constraints of this reciprocal relationship, or social interaction, between humans and machines as they design applications and learning environments. If alive today, Vygotsky might also contemplate how the latest telecommunications tools have eliminated physical space as a barrier to social interaction, providing people of disparate cultures and languages the opportunity to communicate and collaborate in order to learn. If, as Vygotsky believed, culture and language have a significant influence on our cognitive development (how and what one thinks), educational technologists will need to consider these influences as they design technology so that it amplifies rather than reduces our ability to communicate and understand across cultural and linguistic borders.

Considering the implications technology has for improving our educational practices and for crossing cultural boundaries, Vygotsky's theories are especially prescient for educational technologists as they design and implement technological solutions to solve our current educational problems, as well as to create and foster genuine understandings among the inhabitants of our global village.

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See also

[Constructivism](); [Learner-Centered Environment]()

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Web Accessibility

Web accessibility is a feature of webpages that accommodates the needs of a broad range of users, computers, and telecommunications systems in accessing the information. Web accessibility also refers to the design principles that support the development of webpages that are accessible. The Internet has the potential to enhance the lives and increase the independence of many people with disabilities. In fact, people with disabilities may have the most to gain from access to the World Wide Web. Webpages should allow for the eventuality that some surfers may not see, hear, be able to use a mouse or keyboard, or have the latest browser version. For example, the typical surfer who is blind does not see any graphics, animation, or text layout on the screen and does not use a visual input system such as a mouse.

Accessible web design extends beyond accommodating people with disabilities to include allowances for low-tech access to high-tech resources. For example, an organization supporting a website may want to do business with underdeveloped countries or populations without state-of-the-art technology. When a webpage or site is accessible, anyone browsing it should be able to gain a complete understanding of the information presented as well as have an undiminished ability to interact with it. Webpages and websites that are accessible to people with disabilities are highly accessible to everyone. The best method for providing equal access to a website is by designing accessibility features into the webpages on a website. Webpages designed for accessibility are also well-designed pages.

Website developers and webpage authors have a mandate to design accessible webpages based on federal regulations related to equal access. For example, the 1998 amendments to the Rehabilitation Act specifically address accessible web design. The amendments strengthened section 508 of the Rehabilitation Act of 1973 and now require access to electronic and information technology provided by the federal government. Section 508 establishes that when federal agencies develop, procure, maintain, or use electronic information technology, federal employees and members of the public seeking information or services from a federal agency who are individuals with disabilities should have access to and use of information and data comparable to that provided to those without disabilities. Section 508 also establishes technical standards for web accessibility that are designed to meet the needs of a broad cross-section of users with disabilities. Section 508 focuses on the overall accessibility of electronic and information technology systems, whereas section 504 of the Rehabilitation Act requires equal access to federal programs and services for individuals with disabilities by providing accommodations that may utilize assistive technologies. Other federal regulations with policies relating to web accessibility include section 255 of the Telecommunications Act of 1996 and the Americans with Disabilities Act of 1990.

In addition to federal mandates, many state governments have adopted their own regulations that apply to state governmental and educational agencies for publishing accessible webpages. For example, Kansas established an official position requiring accessibility for public and inter- or intra-agency access to web-based information available from websites of state government agencies and organizations and formulated a set of accessibility guidelines to reinforce this position. The list of states with accessibility policies is growing. Additionally, many organizational or institutional acceptable use policies commonly contain provisions for web accessibility. For example, the University of Kansas Netiquette Guide recommends that university departments, programs, faculty, and students publish accessible websites, and the university provides campus workshops and online resources for including accessibility features in webpages. North Carolina State University provides online training and resources for accessible design of online courses for instructors who are interested in web-supplemented or online instruction.

In October 1994 Tim Berners-Lee, inventor of the World Wide Web, founded the World Wide Web Consortium (W3C) to promote and manage the evolution of the network and to ensure its interoperability and accessibility. W3C has about 500 member organizations from around the world and is financed by members as well as by public funds. Membership in W3C is available to any organization. W3C supports and promotes a voluntary consensus-building process of interested web users to establish operating standards for the web, and since its inception the W3C has published more than forty recommendations that define standards, specifications, and protocols used for web publishing, including recommendations for web accessibility. Not only does each recommendation build on the previous, it is designed to integrate with future specifications as well. W3C has recognized that millions of people have disabilities that may affect their access to the web and that there are barriers that may prevent access for many types of disabilities. In April 1997 the W3C created the Web Accessibility Initiative (WAI) to address the issue of accessibility. The WAI is supported by a variety of government and industry sponsors. To facilitate efforts for promoting web accessibility, the WAI coordinates with other W3C working groups to ensure that web technologies such as HTML and cascading style sheets support accessibility. In May 1999 the WAI issued its Web Content Accessibility Guidelines (WCAG). These guidelines were established through a consensus-building process similar to that of other W3C recommendations and also incorporated the earlier recommendations for HTML and cascading style sheets. WCAG version 1.0 is intended for use by all web-content developers, including page authors, site designers, and developers of authoring tools. Each of the fourteen guidelines of WCAG 1.0 is comprised of multiple checkpoints or subguidelines. The two underlying design principles of the WCAG 1.0 are ensuring graceful transformation and making content understandable and navigable.

An accessible webpage transforms gracefully when it remains accessible despite any constraints that may include physical, sensory, and cognitive disabilities, work constraints, and technological barriers. For example, a web user may not be able to see, hear, or use a keyboard or mouse or may have a slow Internet connection, an obsolescent version of a browser, a voice browser, or a different operating system. By following the guidelines, webpage authors and site developers can create pages that transform gracefully regardless of the context in which a webpage is accessed. Graceful transformation also means that the structure of a webpage is separate from the format or medium through which it is presented, such as print, computer graphics, text, or synthesized speech. For example, webpages transform gracefully when text or text equivalents (e.g., graphics) are provided because text can be presented in ways that are available to almost all browsing devices and therefore accessible to most users.

An accessible webpage also should be understandable and navigable. The content of each webpage should be clear and simple and provide understandable mechanisms for navigating within and among pages on a website. Not all surfers can make use of visual clues such as image maps, proportional scroll bars, side-by-side frames, or graphics that guide sighted users with graphical desktop browsers. Web surfers may also lose contextual information when they can view only a portion of a webpage, either because they are accessing the page one word at a time, as with a speech synthesizer or a Braille display, or one section at a time, as with a small or magnified display. Without orientation information, some surfers may not be able to understand very large tables, lists, or menus. Providing navigation tools and orientation information in webpages maximizes accessibility and usability.

The following list provides explanations and examples for accessible web design for each of the fourteen guidelines of WCAG 1.0:

1. *Provide equivalent alternatives to auditory and visual content in webpages:* Some people cannot use images, movies, sounds, or applets directly, but they can use pages that include *equivalent* information to the visual or auditory content. For example, a text equivalent of an image of an upward arrow that links to a table of contents might be “Go to table of contents.”
2. *Ensure that text and graphics are understandable when viewed without color:* Some people cannot distinguish between certain colors, and users with devices that have noncolor or nonvisual displays will not receive the information. For example, foreground and background colors should provide sufficient contrast when viewed using monochrome displays or by people with deficits in color comprehension.
3. *Use HTML to control webpage structure and cascading style sheets to control page presentation:* For example, using style sheets rather than HTML to convey text that appears to be a list or table makes it difficult for other devices to present the content of a webpage intelligibly.
4. *Use HTML to clarify changes in the natural language of a webpage including abbreviations and foreign-language text:* Webpage authors should identify the predominant natural language of the content of a webpage and identify any subsequent changes in the natural language of the page to allow speech synthesizers and Braille devices to automatically switch to the new language and to make the document more accessible to multilingual users.
5. *Create tables in webpages that transform gracefully:* Webpage authors should use tables to present truly tabular information (or data) and avoid using tables to lay out pages.
6. *Ensure that webpages transform gracefully when new technologies such as scripting languages are not supported or are turned off:* Webpage authors should use new technologies that solve problems encountered by existing technologies, but they should also know how to make webpages work with older browsers and work for people who choose to turn off browser features.
7. *Ensure that webpages with moving, blinking, or scrolling objects, or objects that automatically update, may be paused or even stopped:* Some

people with cognitive or visual disabilities are unable to read moving text quickly enough, and some people with physical disabilities might not be able to move quickly or accurately enough to interact with moving objects.

8. *Design the user interface of a webpage to be accessible and input device–independent:* For example, programmatic elements or embedded objects in a webpage such as scripts or applets should be accessible or compatible with assistive technologies.
9. *Use features that activate webpage elements through a variety of input devices:* For example, if input fields in a form can be activated using only a mouse or other pointing device, someone using the webpage form with voice input, a keyboard, or some other nonpointing input device may not be able to use the form.
10. *Use interim accessibility solutions that allow assistive technologies and older browsers to operate and function properly:* For example, users with older browsers may not be able to navigate to empty edit boxes, and older screen readers may read lists of consecutive links as one link. Furthermore, changing the current window or popping up new windows may be disorienting to users who cannot see the screen.
11. *Use W3C technologies and guidelines including HTML 4.0, CSS2, and WCAG 1.0, and use them in accordance with the specification or guideline:* Non-W3C formats may require viewing with either plug-ins or stand-alone applications.
12. *Provide context and orientation information to make complex webpages or elements understandable:* The sometimes complex relationships between parts of a page may be difficult for people with cognitive or visual disabilities to interpret. Logically grouping elements and providing contextual information about the relationships between elements, especially when using frames and forms, can be useful for all users.
13. *Provide clear and consistent navigation mechanisms across webpages:* Clearly identify the target of each link, provide information about the general layout of a site such as a site map or table of contents, and use navigation bars to highlight the navigation mechanism.
14. *Create webpages that are clear and simple and can be easily understood:* Supplement text with graphic or auditory presentations when it facilitates understanding of webpage content. Understanding written information may be difficult for some people with cognitive or learning disabilities, and so using clear and simple language benefits them as well as people with a first language different from the webpage content, including people who communicate primarily in sign language.

At the time of this writing, feedback is being solicited by the W3C WAI on a public working draft for WCAG 2.0, the new version. Until WCAG 2.0 is published as a W3C recommendation, the W3C continues to promote and clarify WCAG 1.0 as its official recommendation for web accessibility.

Steven Mills

See also

Assistive Technology; Usability; Web-Based Instruction

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Web Accessibility Initiative (www.w3.org/WAI).

World Wide Web Consortium (www.w3.org).

Web Portals

Web portals are often described as the desktops of the future. Organizations are using portals in new and innovative ways to improve decisionmaking, efficiency, and stakeholder relationships with its employees, partners, and clientele. Increasingly, portals are understood to be an important layer in the overall information technology architecture of any large organization—a layer that integrates information and services consumed or created by corporations, communities, universities, governments, and other organizations.

Most people first encounter the term “portal” when they visit web gateways such as Yahoo! or Lycos. Unfortunately, because of this association, the term has been applied to any website of great significance. Consequently, there are varying definitions, and the term can mean different things to different people.

Web portals gather a variety of useful information resources into a single one-stop shop on the web, helping the user to avoid being overwhelmed by information overload or feeling lost on the web (Looney and Lyman 2000). Since very few people have the exact same interests, portals allow users to customize information sources by selecting and viewing only the information they find personally useful. The resulting portals are frequently referred to as horizontal portals that cover a wide range of content. (See the description of other portal types below.)

The best-known portal providers offer access to a variety of general information services, including news, weather reports, stock prices, web searching, directories, online shopping, chat rooms and discussion groups, and links to other sites. Some of this information is provided via channels—small, content-specific windows that are selected by the user and periodically updated while the portal is displayed. Each type of information provided is customizable by the user (e.g., selecting the cities for which the weather reports are furnished). Some providers allow users to further personalize the interface by including private information (such as a stock portfolio or medical history). The providers (e.g., MyYahoo!, Excite, and NetCenter) all urge users to make their portal page the first page that automatically displays when the web browser is opened (Strauss 2000). The resulting portal is designed to make an individual's web experience more efficient and can be described as:

- A gateway that provides a single point of entry to the information, applications, and data that an individual regularly uses;

  A personalized tool enabling the individual to control how information, data, and applications are filtered, organized, and delivered on their desktop; and

  A place to share information within a marketplace, organization, community, or interest group.

One of the biggest confusions regarding portals is the distinction between a portal and a homepage. Typically a website such as a university homepage will have many static links that an individual might access, only some of which will be of interest, whereas a portal allows each individual to customize what's displayed on his page. The links on a portal will be dynamically created for each user rather than static for the entire population. The user of a portal can specify which links he will pull to his personalized portal page. Portal providers can arrange to push certain links onto his page; they also frequently push advertising onto the portal display to pay for the service.

Most experts agree that a portal should contain the following four capabilities to distinguish it from a normal website or homepage:

- *Personalization*—allowing the user the option to customize the information and layout of the portal interface

  Search—allowing the user to search by keyword or category within the portal domain

  Channels—allowing the user to select and position customizable page containers (small windows) where specific information or an application appears (weather, news, search, reports, stocks, etc.)

  Links—allowing the user to link to other pages within the portal domain

Types of Portals

Although portals continue to evolve, there are four general types of portals. In addition to the major consumer web portals, or horizontal portals, like MyYahoo!, there has been a growth in vertical, affinity, or niche portals; organizational/corporate portals; and industry, or B2B, portals.

Vertical Portals

Vertical portals (also called niche or affinity portals) cover a specific domain. Vertical portals can be industry-specific or functional area–specific but are largely defined by the data, processes, and people it serves. Examples include iVillage (aimed at women) and guru.com (for independent consultants). Demographically focused portals (portals being launched to cater to specific ethnic groups, specific age groups, alternative lifestyles, religions, and other groups that are perceived to form a community or market) are now being called affinity portals.

Organizational Portals

An organizational portal (also called corporate or enterprise resource portals) provides personalized access to information about a particular company or organization. Organizational portals have transitioned from simple intranet homepages into full-function portals that allow personalization and workflow capabilities. Some of these types of portals are provided to assist a company's or organization's partners—suppliers, customers, and members—while others (often termed intranet portals) exist for the benefit of the organization's own employees or members.

A university or campus portal is a variation of the organizational portal. Members of a university community need access to calendars, news, and events but also information specific to their role within the university (student, professor, administrator, alumni, etc.). Students, for example, need to see their course and exam schedules, the books they have borrowed from the library, their grades and grade point average, their financial aid status, information about extracurricular activities, and so forth. Prospective students and their parents, parents of enrolled students, alumni, faculty members, scholars from other institutions, and vendors of the university all have different needs for web information from the same university.

Business-to-Business Portals

Business-to-business portals (B2B or industry portals) are places where persons in particular industries can go for information-sharing and, most important, the completion of transactions. This is a relatively new portal phenomenon but possibly the most significant in economic terms. Imagine the reduced friction of identifying manufacturers and suppliers and buying parts and supplies in a particular industry. Imagine suppliers of textbooks and office supplies bidding to sell their products through an online auction process. For instance, the manager of the campus bookstore could automate the procurement of books, office supplies, and other merchandise from national suppliers through an Internet-based bidding system. This could achieve tremendous improvement in efficiency and costs over the traditional manual-based procurement methods.

Why Would an Organization Want to Build a Portal?

One obvious reason for deploying portals is to improve productivity by increasing the speed and customizing the content of information provided to internal and external constituencies. Portals also serve a knowledge-management function by enabling meaningful organization of information. In some ways, portals offer a technical solution, but not a total answer, to knowledge management. The potential for customers, constituencies, and employees to personalize and tailor their preferred sources of information is a powerful incentive to use a portal over a normal website.

Portals also facilitate the presentation of the organization's many faces. They not only make it easier for the organization to operate; they allow for interaction and collaboration among different groups or individuals. Properly implemented, portals can be strategic assets for institutions by increasing efficiency within an organization, reducing costs, and increasing customer service and sales. In that sense they do far more than traditional websites serving static information.

University portals are just the beginning of portal applications in the education arena. Companies that provide e-learning services and content have also embraced portal technology to deliver online learning content to businesses and individuals. Portals allow these learning companies to deliver individualized content and curriculum tracking to entire organizations. This allows a reduction in the cost of training delivery while providing more targeted and point of need–based training.

Portal technology applied to K-12 education as well as informal learning centers and museums has tremendous potential. Teachers could collaborate with each other more easily by sharing common lessons and ideas, get access to materials and lesson plans based on their specific needs, and communicate with parents in new ways. Administrators could also change the way they manage schools and access information regarding performance, finances, and human resources. Museums and other learning institutions could also rethink how they connect with their members and the community.

Useful Links to Portals

http://my.yahoo.com	http://www.ivillage.com
http://www.excite.com	http://campus.dadeschools.net
http://my.netscape.com/index2.psp	http://www.myucla.com

Keith Collier
Mable B. Kinzie

See also

Campus Computing Project; Web-based Inquiry Science Environment

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Web-Based Course Management Systems

Web-based course management systems are tools that integrate technological and pedagogical features of the Internet and the World Wide Web into a single, template-based authoring system to facilitate the design, development, delivery, and management of web-based courses and online learning environments. Web-based course management systems emerged when web authoring tools like Adobe PageMill, Microsoft FrontPage, and Macromedia DreamWeaver were increasingly used to create web-based courses for online learning. The need for a more integrative structure to manage the delivery of such courses and facilitate the migration from face-to-face classroom instruction to web-based instruction (WBI) resulted in the development of one-stop-shop applications such as WebCT®, Blackboard®, Virtual-U®, and TopClass®, among others, which became known largely as course management systems (in education contexts) or learning management systems (in the industry). Unlike previous web authoring tools, course management systems include instructor tools, learner tools, and technical administration tools allowing for different types of users and for multiple Internet and web-based activities embedded within the tool itself.

Web-based course management systems incorporate various technological and pedagogical features and functions, including weblinks search engines, synchronous and asynchronous communication, course announcement areas, student posting areas, tracking of student records and interactions, management of course information, and web development capabilities, among others. The purpose is to provide a central location for delivery of course content, related information or links, provision of models of assignments, communication between instructors and students, and group process for development of shared projects, as well as development of web-based products. These integrative tools or systems present an opportunity to incorporate various instructional strategies using available features of the software into a holistic course design. Table 1 helps the reader differentiate between web authoring tools and web-based course management systems. (For a more comprehensive list of authoring tools and course management systems and a comparative analysis of their technological features, visit www.edutools.info/course; see also Table 1.)

Below is a brief description of six commercial course management systems. The course management systems featured here are described as they existed at the time of this writing. These descriptions are not intended as user documentation but rather as overviews for presenting pedagogical opportunities for the development of online learning environments and WBI. Readers should check the respective websites for updates and upgrades.

WebCT (www.webct.com)

WebCT currently has two editions, WebCT 3.5 Standard Edition and WebCT 3.5 Campus Edition. The Campus Edition offers a total online learning solution to institutions that wish to integrate their online courses with campuswide portals and student information systems. The Standard Edition is ideal for institutions that want a robust, pedagogically sound course platform but don't need extensive features for enhanced scaling or integration with campus systems. In addition to facilitating the organization of course material on the web, WebCT also provides a variety of tools and features that can be added to a course. Examples include a conferencing system, online chat, student progress tracking, group project organization, student self-evaluation, grade maintenance and distribution, access control, navigation tools, automarked quizzes, electronic mail, automatic index generation, course calendar, student homepages, embedded e-mail, and course content searches.

Blackboard (www.blackboard.com)

Blackboard offers three levels of its online development software. Blackboard.com, a free course-creation tool that includes features such as content organization, class discussions, group communication tools, an online quiz tool, e-mail, an announcement posting area, and a digital dropbox, among others. Blackboard 5, a more comprehensive e-learning software that includes customizable institution-wide portals, online campus communities, and an advanced architecture allowing easy integration of multiple administrative systems in addition to a course management system. Blackboard CampusWide, which allows institutions to manage student registration and accounts, process financial transactions, and control everything from facility access to user identification.

TopClass (www.wbtsystems.com/products/lms)

TopClass is a learning management system (LMS) that enables businesses to provide employees with a single access point to all their training needs

Table 1: Web-Based Authoring Tools and Web-Based Course Management Systems

Category	General Features	Instructional Products
Web-Based Authoring Tools Examples include: *FrontPage, DreamWeaver, Claris Homepage, Homesite, PageMill*	• Browser interface • Utilized with Internet-based technologies • Open system (allows user to go beyond the boundaries through external linking to the WWW) • Extensible • Dynamic content • Enable active, collaborative media • Require a steep learning curve in order to take full advantage of their features • Used by a variety of users to develop websites for multiple purposes • Do not have specific instructor or learner tools	• Single webpages and integrated websites for the purposes of information presentation to support classroom instruction • Structured websites resulting in a variety of formats for WBI • Personal and institutional homepages • Web publishing • Organization of web-based resources • Complex animations and interactions when used with high level scripting languages (Java, Javascript, C++) and other web development tools
Web-Based Course Management Systems Examples include: *WebCT, Blackboard, TopClass, Virtual-U, Lotus LearningSpace, Element-K, Web Mentor, Symposium, TopClass, Convene, Embanet, Real Education, eCollege.com, E-Web, Internet Classroom Assistant, Softarc's FirstClass, Serf, Virtual-U, and Eduprise.com.*	• Browser interface • Utilized with Internet-based technologies • Open system • Easy to use • Dynamic content • Enable active/collaborative media • Have specific tools for instructors, learners, and administrators • Embedded communication tools (e-mail, discussion forums, group tools) • Used primarily to manage and deliver online learning in educational institutions and online training in corporate settings	• Online learning (e-learning) • Distance education programs • Courseware (WBI) • Knowledge networks • Knowledge portals • Asynchronous and synchronous learning environments • Distributed learning environments

Source: Created by the author.

and to streamline the management of instructor-led training. Although TopClass is perceived to be more industry-oriented, 34 percent of its customer base is higher education institutions. The core of TopClass LMS is a catalog that allows learners to find all the learning material in the enterprise from one central source. TopClass provides a virtual environment to manage all aspects of content and class management and to deliver a flexible learning environment built upon web standards. It includes features such as security (unique user ID), online registration and enrollment, waitlist processing, catalog browsing and searching, collaborative tools (e-mail, threaded discussion groups, bulletin board), a testing engine, student progress tracking, content and user searching, summary reporting, and course assembly tools that are platform-independent. For example, it allows integration of online self-study courses, instructor-led training courses, virtual classroom events, and other learning materials such as books, videos, and CD-ROMS.

Virtual-U (vlei.com)

Virtual-U is an online learning application made up of various integrated components. These include the VGroups conferencing system that gives instructors the ability to easily set up collaborative groups and define structures, tasks, and objectives; course structuring tools (the Workspace and the Course Syllabus) that enable instructors to create complete courses online without programming knowledge; student performance tracking (the Gradebook); and system administration tools.

Virtual-U is being tested in many institutions across Canada and internationally, involving more than 150 instructors and more than 230 courses in some thirty disciplines covering all fields of knowledge. The developers of Virtual-U incorporated utilities that capture usage data in order to examine the following processes and considerations in relation to the design, delivery, and management of online learning: instructional design; impact on instructor and learner workload; satisfaction and practice; quality of learning; and assessment issues. Additionally, Virtual-U has a pedagogical advisement layer embedded in the tool to coach instructors on how to effectively integrate active and collaborative learning.

Lotus LearningSpace (www.lotus.com/learningspace)

Lotus LearningSpace Forum runs on the Domino web server. The Domino web server has specific extensions that allow this application to perform its functions. Components of the software include instructor tools such as the Schedule, which provides a means of structuring the course’s assignments; the MediaCenter—a tool for creating the knowledge base of a LearningSpace course that works in conjunction with the Multimedia Library; and the CourseRoom—an interactive, facilitated environment for secure student-within-team, student-to-peer, and student-to-instructor collaboration. There is also a Student Profiles feature and an Assessment Manager.

Organizations without a Domino web server can purchase LearningSpace without the Forum. LearningSpace features the Assessment Manager, Profiles, and the Schedule described above. Instructors can use the Activities component to develop self-study activities or to present live interactive sessions within the Virtual Classroom. LearningSpace 5 and LearningSpace Forum 3.6 can be delivered over Internets or intranets (an Internet network accessible only to an organization's members and employees, residing behind a firewall) and are part of IBM Mindspan Solutions.

WebMentor (www.avilar.com)

WebMentor is a training environment for developing, administering, and delivering web-based training over the Internet, intranets, and extranets (an intranet that is partially accessible to authorized outsiders). The browser-based authoring system supports course authoring and editing. The delivery system supports video and audio from local storage such as a CD-ROM, a customizable interface, integration of large courses with many lessons, individualized instruction, and a flexible, multilevel lesson structure. WebMentor also includes support for administration, assessment, reporting, collaboration, and documentation.

Pedagogical Implications of Web-Based Course Management Systems

Authoring tools have evolved over the last decade based on technological and pedagogical innovations from authoring-bounded, program-controlled learning systems such as computer-based instruction (CBI) to authoring-unbounded, learner-centered environments such as WBI. From a technological perspective, the Internet has revolutionized teacher-to-learner and learner-to-learner communication by making these interactions time- and place-independent through the use of e-mail, discussion boards, and other Internet-based technologies that facilitate asynchronous learning and information delivery. Web-based course management tools now include such features and components under an integrated structure. The web has also changed the nature of instructional content and resources from a well-defined and stable knowledge base to an unfiltered and dynamic information base. CD-ROM-based authoring tools have commonly relied on stable content to organize and structure instruction, which is why the resulting learning system is typically bounded and program-centered. Web-based course management systems now include features and components that allow instructors and learners to modify content and contribute resources, resulting in flexible and active information structures.

From a pedagogical perspective, this means more flexibility in the design of WBI. Depending on how the tools' features are used in a course by the instructor and the learners, the pedagogical philosophy underlying the teaching and learning process can range from a strict instructivist approach to a radical constructivist approach (Reeves and Reeves 1997). A strict instructivist approach typically results in a web-based course that has a tutorial structure in which the content is organized by the instructor and *delivered* or imparted to the students; a radical constructivist approach typically results in a more learner-centered pedagogy where students use web features as tools to construct their own knowledge representations by restructuring content and creating and contributing their own resources to the course structure (Bannan and Milheim 1997; Reeves and Reeves 1997). It is more likely, therefore, that courses initially designed for traditional learning environments and later transformed to a web-based format using a web-based course management system will undergo a *pedagogical reengineering* that is more constructivist and less instructivist in nature (Dabbagh and Schmitt 1998). The presence of Internet-based communication tools, collaborative tools, and web publishing tools in web-based course management systems make such pedagogical implications possible.

In an evaluation of web-based course authoring tools (Dabbagh, Bannan-Ritland, and Silc 2001), it was revealed that the intersection between pedagogical considerations and the attributes of web-based course management systems yields the most educational impact. It was suggested that a comprehensive advisement mechanism included within web-based course management systems, providing guidance in the areas of pedagogical approach, instructional strategy, and online support and resources, will facilitate more effective and engaging instructional designs. Currently the only web-based course management system with such an advisement mechanism is Virtual-U. The Instructor Tools and Support feature of Virtual-U offers instructional design guidelines for instructors to help them shape the online learning environment into a student-centered approach. The developers of Virtual-U profess that their course management system is different from other tools in that it focuses on teaching and learning in the context of educational principles and research (Harasim 1999). The goal of the course management system was "to provide a flexible framework to support advanced pedagogies based on active learning, collaboration, multiple perspectives, and knowledge building" (Harasim 1999, 45).

Another critical factor that could impact the pedagogical use of course management systems is whether the learner is perceived as the *user* or *producer* of hypermedia learning environments. It can be argued (see, e.g., Hedberg et al. 1997) that if the activities of the learner are regarded as the central focus in an educational context, then learners should be thought of as software (courseware) producers rather than as software users in the development of educational software for both bounded CD-ROM titles and unbounded web-based resources. They propose the integration of learner tools that allow users to organize information in a meaningful way by positioning elements on the screen, creating new links, and generating multimedia objects. Such cognitive tools could include a notebook to copy, edit, and format text; a visual graphics tool to create marker buttons that point to multimedia elements such as video, audio, or pictures and enable the learner to manipulate those elements; and a cognitive mapping tool (concept mapping tool) allowing flexible information representation (Hedberg and Harper 1998). The *learners as producers* concept supports a generative approach to learning that aligns with a constructivist epistemology.

Learning objects systems architecture is also paving the way to support the generative use of authoring tools (Bannan-Ritland, Dabbagh, and Murphy 2000). A learning objects system adopts an object-oriented approach for storing and metatagging instructional content and instructional strategies. Uneditable media objects called Primedia can be stored in a database and accessed for multiple uses in multiple contexts. Primedia can range from low to high granularity depending on their relative size as a learning resource, with highly granular resources increasing the efficiency of online instructional support systems due to their greater potential for reusability (Quinn 2000; Wiley et al. 1999). With database-driven websites becoming increasingly popular, it is certain that the future of hypermedia learning environments will be powered by such technologies instead of the static, hard-coded HTML documents. Authoring systems will be designed for the creation of generically encoded reusable information, allowing the design process to proceed by specifying learning resources, creating links among the resources, and authoring content independently of format (Davidson 1993; Robson 2000). The idea is to define learning objects or resources such that each learning resource has specific instructional properties enabling its pedagogic integration with other resources. Depending on who creates, assembles, and links these objects, the pedagogical philosophy of the hypermedia learning environment can vary from an instructivist to a constructivist approach resulting in a directed or open-ended learning environment as discussed above.

Currently several course management systems are beginning to support the construction of learning objects by either teaming up with pioneers in the e-learning industry who have taken on the challenge of managing content through learning content management systems and/or by extending the capabilities of their current course management system to support the creation and delivery of learning objects. Whatever the current state of course management systems may be, the pedagogical goal of an authoring system is "to provide a flexible framework to support advanced pedagogies based on active learning, collaboration, multiple perspectives, and knowledge building" (Harasim 1999, 45). Course management systems include several features and components that enable learners to engage in active learning processes such as reflective and collaborative practices. They also enable instructors to engage in modeling and scaffolding techniques to support the active construction of knowledge.

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See also

Campus Computing Project; Computer-Assisted Instruction; Courseware; Learning Objects; Web-Based Instruction

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Web-Based Inquiry Science Environment (WISE)

The Web-Based Inquiry Science Environment provides a platform for creating inquiry science projects for middle school and high school students using evidence and resources from the web. Projects are typically developed by teams that include teachers, researchers, and scientists. WISE provides a user-friendly interface to facilitate project creation. Developers can include a host of project components, including online discussions, data collection, drawing, argument creation, resource sharing, concept mapping, and other built-in tools. Developers can also include custom tools of their own design. Projects are further customizable by teachers and other end users through the same interface to better meet the needs of their students and the affordances of their local surroundings. The WISE library currently contains more than thirty publicly available projects created by WISE design teams in conjunction with organizations such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the Monterrey Bay Aquarium. Individuals have created thousands of private projects or variations of these projects that they can share with whomever they choose. WISE is freely available to all users and students. The WISE website (wise.berkeley.edu) provides rich descriptions of the WISE learning environment, the project library, the teacher supports, and an introductory slide show.

WISE projects range in duration from two days to four weeks, providing inquiry projects for teachers in every science topic from grades four through fourteen. Typical projects engage students in designing solutions to problems (e.g., building a desert house that is warm at night and cool during the day); debating contemporary science controversies (e.g., the causes of declining amphibian populations); investigating scientific phenomena (e.g., thermal equilibrium in the classroom); or critiquing scientific claims found in websites (e.g., arguments for life on Mars). Table 1 describes examples of these library projects. Figure 1 displays the core WISE learning environment interface, including the pop-up windows for reflection notes and cognitive hints.

Students navigate through activity steps in the left-hand frame of their web browser, called the Inquiry Map. Each step in the project can result in the display of webpages (to be used in support of student designs or debates), in the appearance of the WISE notes window, an online discussion,

Table 1: Sample WISE Library Projects

Investigation Projects

Creek Detectives. This project introduces Pine Creek, its location in the community, and its watershed. The project asks students to compare and contrast the creek at different points along the water path and at different seasons. Students learn about watersheds, what is carried in them, and how to make careful observations and predictions based on their observations at the local creek and online images.

Probing Your Surroundings. Students explore thermal equilibrium in the context of the temperature of objects around them. After making predictions and gathering data, students create and electronically discuss principles to explain that data. Students then go on to explore why objects feel hot or cold.

Controversy Projects

How Far Does Light Go? Can light travel forever until absorbed, or does it eventually die out? Students are introduced to several pieces of evidence that focus on different aspects of the physics of light. Students critique and organize this evidence in an attempt to answer the dilemma for themselves.

Wolves in Your Backyard. This project first introduces students to the basic biology of wolves, addresses some frequently asked questions, and addresses the nature of wolves. The project then presents some biology of predator-prey relations and asks students to think about their own model for the food chain. Students explore the different perspectives of the wolf control controversy.

Critique Projects

New Tabloid Trash or Serious Science Debate. Students study and apply a methodology for evaluating Internet materials to several different articles. Students then discuss and critique the way each group evaluated the articles.

Sunlight SunHEAT. Students learn about the topic of passive solar energy. Students also develop and apply criteria in the process of critiquing information found on the World Wide Web. Who wrote it and why? Are claims supported by evidence? What questions do you have after reading through the information?

Design Projects

Ocean Stewards. This project teaches students about the ocean environment and the reasons for conducting expeditions within this environment. Students can explore six different National Marine Sanctuaries (NMSs) in order to learn about the different marine habitats and the flora and fauna. Students will then prepare a proposal for an expedition within the chosen sanctuary.

What's in a House? In this project students design a house which would be energy efficient in a desert environment. Their design is based on evidence that compares desert weather with their own local weather and how plants have adapted to the extremes of the desert climate.

Source: Used with permission of the director of the WISE project.

Figure 1:

The WISE Environment, Showing the Inquiry Map for the Deformed Frogs Project as Well as Pop-up Windows for Reflection Notes and Hints

Source: Used with the permission of the director of the WISE Project.

or any one of numerous inquiry tools (e.g., Java applets for data visualization, simulations, and causal maps). As students work through the sequence of activities that comprise the project, the teacher circulates within the classroom, interacting with one small group of students at a time and helping them interpret web materials, reflect on the topic, and interact with peers.

The use of Internet materials provides the foundation of WISE. All projects make use of some content from the World Wide Web, as well as additional webpages authored for purposes of the project. In WISE activities, students learn to use the Internet for inquiry, critiquing websites, designing approaches, or comparing arguments. In addition, WISE projects can incorporate Java applets to enable online discussions, data collection, drawing, argument creation, resource sharing, concept mapping, and other built-in components. Developers can also include custom tools. All of the projects take advantage of the standard WISE learning environment features, and most also use one or more of the optional WISE components (see “Learn About WISE” at wise.berkeley.edu for more information about these features). Many of the optional and custom WISE components were designed for specific library projects and adopted by other projects once they became available.

WISE is entirely browser-based, meaning that students only need access to a computer with an Internet connection, with no required software other than the web browser (e.g., Netscape or Internet Explorer). WISE is completely free of charge for use by teachers and their students. All student work is saved on central project servers that enable student accounts and teacher accounts to be coordinated, with special web environments designed to support teachers and students (called the WISE Student Portal and the WISE Teacher Portal, respectively). Students can access their work from any computer on the Internet. Teachers can choose from the library of curriculum projects in the WISE Teacher Portal, each accompanied by a set of materials, including a detailed lesson plan, pre- and post-assessments, connections to national standards, tools for setting up a custom grading scheme, and even a software tool that enables customization of the WISE project for local issues, geographical features, and student populations. Teachers can monitor and grade student work, provide formative feedback during a project run, and manage their student accounts.

The WISE Project Design Process

The WISE design groups collaborate with others both locally and around the world to create new inquiry projects. Many scientific societies, governmental agencies, museums, outreach programs, and educational institutions regularly develop science curricula. There are currently more than thirty English-language projects in the WISE library, along with projects authored by Norwegian, Dutch, and German design teams, representing collaborations with diverse groups, including the 1000 Friends of Frogs, the International Wolf Center, the University of California–Berkeley Pledge, the American Association for the Advancement of Science, NASA, NOAA, the Monterey Bay Aquarium, and the Berkeley Botanical Gardens. These projects focus on compelling questions of local/global concern.

Each project is developed by a WISE design team that includes pedagogical specialists, scientists (i.e., from its various partner agencies and groups), science teachers, and technology designers. WISE offers design teams a flexibly adaptive learning environment that incorporates proven technology features and supports promising instructional patterns. These design teams have produced WISE curriculum for many different topics and student age groups. For example, NASA partnerships designed the Rats in Space project, where high school biology students critique the use of rats as models for humans in NASA's bone-loss studies, as well as the Sprouting Space Plants, where fourth- and fifth-graders design a terrarium to compare the growth of NASA fast plants with regular earth plants. Lawrence Berkeley Laboratory scientists contributed to a project in which students designed a house for a desert climate by critiquing energy-efficient house designs on the web, completing design worksheets, and discussing their design ideas online.

The Research Basis for WISE

Reform movements within the science education community advocate engaging students in the critical scientific processes of scientific inquiry, or the asking of questions and developing the means to address these questions (AAAS 1994; NRC 1996). Policy reports emphasize the importance of fluency with information technology, or "FITness" (Snyder et al. 1999), recommending an emphasis on the use of technology for peer collaboration, testing solutions, navigating complex solutions, and expecting the unexpected. The Tech Savvy Report (AAUW 2000) calls for the integration of technology and inquiry within the science curriculum.

Yet many teachers lack the background for creating and supporting inquiry in their classrooms. Teachers face a host of problems in integrating inquiry into their practice, including understanding the discipline or content well enough to allow students to ask ill-defined questions and understanding how to support science inquiry projects (Ladewski, Krajcik, and Harvey 1994; Marx et al. 1994). Teachers also face a social context where inquiry is not often supported, including demanding content-based curricular objectives, short class periods, lack of materials, and prevalent standardized tests.

WISE has researched the effectiveness of WISE activities for student understanding in a wide range of classroom studies. All WISE activities are assessed by pre- and post-test items, as well as embedded assessments, which show that students develop a deep understanding of the science content and gain important inquiry skills (Linn and Slotta 2000).

WISE builds on the prior achievements of two projects: Computers as Learning Partners (Linn and Hsi 2000), which focused on knowledge integration and teaching as design, and the Knowledge Integration Environment (Linn, Davis, and Bell, forthcoming), which focused on scaffolding knowledge integration with technology. The discussion below refers to the cumulative research of these projects.

The WISE environment and predecessors are built on the Scaffolded Knowledge Integration framework (Linn and Hsi 2000). The framework is based on a knowledge integration perspective on learning and includes four main tenets: (1) making science accessible; (2) making thinking visible; (3) helping students learn from each other; and (4) promoting autonomy and lifelong science learning. From a knowledge integration perspective, students are considered to hold multiple ideas at various levels of connection, contradiction, and organization. These ideas include, but are not limited to, facts, experiences, intuitive conceptions (such as p-prims), and occasional mental models. Students cue and connect these elements depending on context. As students learn, they reorganize ideas and connections. The WISE group has continued to research and refine the Scaffolded Knowledge Integration framework and its tenets to help students learn.

In terms of making science accessible, WISE research has investigated ways to use Internet resources to make learning accessible in terms of setting appropriate scope and goals (Slotta and Linn 2000). WISE has also investigated making science accessible by helping students build from current ideas using richer models and increasing depth within the curriculum (Clark and Linn, forthcoming; Linn, Bell, and Hsi 1998).

In terms of making scientific thinking visible for students, WISE has focused upon questions such as how to support students engaging in scientific learning, how to support students in modeling expert thinking, and how to support students engaging in knowledge integration through debate. This has instigated controversy-based research to introduce ideas about the nature of science, technology scaffolds and visualizations to enable richer arguments, and the use of evidence, peer critique, and argument revision (Bell and Davis 2000; Clark and Jorde, in revision).

In terms of helping students learn from each other, WISE has investigated ways to engage all students in meaningful conversation and debate. In addition to developing multiple technology supports, the research has demonstrated methods to increase student participation through online forums (Hsi and Hoadley 1997), to enhance efficacy through social representation (Hoadley and Linn 2000), and to scaffold inquiry and student-based refinement of understanding (Clark and Jorde, submitted).

In terms of helping students become lifelong science learners, WISE has articulated a set of design principles for knowledge integration activities (Linn, Clark, and Slotta, forthcoming; Linn and Hsi 2000). These supports are designed to help students in conducting their own knowledge integration. This research has shown that a case-study approach benefits students and has explored the use of personally relevant topics (Hoadley and Linn 2000; Linn and Hsi 2000). This work has also explored the nature of effective prompts to support students in integrating knowledge (Bell and Davis 2000; Davis and Linn 2000). Additionally, the research has investigated the impact of perceived evidence credibility in student argumentation (Clark and Slotta 2000), as well as the promotion of critiquing skills through advance guidance (Slotta and Linn 2000).

True to the nature of design research, the WISE effort has informed design, learning, and pedagogy. Continuous improvement of the WISE technology and curriculum has resulted in easy-to-use software that scaffolds students in critique, design, investigation, and debate projects. A growing library of such projects has been developed by partnerships of scientists, teachers, and educational researchers. The WISE database collects all student work and supports teachers in assessment and class management activities. As WISE has matured from its earlier versions in Computers as Learning and the Knowledge Integration Environment, researchers have confronted new kinds of questions focusing on professional development, teacher practice, and the design of curriculum and assessment. To date, thousands of teachers and tens of thousands of students have participated in WISE activities (Slotta 2002). The WISE research program demonstrates the value of intertwining tool development, curriculum design, and theory-building in the same studies. The system reflects student needs and is supported by research that demonstrates the value of the tool or approach in addressing the established need.

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See also

Science and Technology (K-12 Education); Web Portals; Web-Based Instruction

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Web-Based Instruction

Web-based instruction encompasses the integrated design and delivery of instructional resources via the World Wide Web and promotes student engagement with text-based, hypermedia, multimedia, and collaborative resources for the purposes of teaching and learning. Since the advent of popular use of the World Wide Web in 1993, educators have attempted to harness this delivery medium to design, develop, and deliver effective instruction. The unique features of the web when used for instruction permit access to and manipulation of information by learners as well as communication mechanisms that encourage the sharing of ideas and documents. Based on a structure of nodes and links, the World Wide Web provides nonlinear access to hypertext and hypermedia instructional resources, including text documents, images, video, audio, and collaboration tools, as well as access to a vast network of online information. Developers of web-based instruction have capitalized on these attributes of the web to design informal and formal learning environments in higher education, training, and community learning contexts.

Web-based instruction takes many forms and incorporates various types of delivery technologies. Some preliminary uses of the web to support instruction were the posting of resources for students such as syllabi and instructor course notes. With the advent of text-based communication mechanisms such as bulletin boards or computer conference software tools, a second level of use for the web within instruction became apparent in promoting collaborative discussion and shared activities and documents among learners and instructors. Additionally, multimedia resources, including streaming video, audio, and animation capabilities, emerged, providing engaging components for inclusion in web-based instruction. Currently, these and other capabilities have been integrated into specialized software for web-course development, such as WebCT® and Blackboard® CourseInfo, that provide the nonprogrammer with templates for easily posting resources and providing collaborative activities within web-based instructional courses.

Web-based instruction is facilitated by network-based technologies that afford collaborative learning experiences and can provide learners with flexible access to materials at various times and/or locations. Although web-based instruction is primarily associated with a traditional view of distance education depicting only situations when learners are geographically dispersed, this form of instructional delivery may also be effectively used as a supplement to traditional, face-to-face, classroom-based activities. Specific features of web-based instruction provide multiple opportunities for student-to-content, student-to-student, and student-to-instructor interaction (Moore and Kearsley 1996). To facilitate student-to-content interaction, instructors can post course-related resources such as lecture notes, weblinks or URLs, and multimedia files, allowing students repeated access to these materials for learning. Promoting student-to-student and student-to-instructor interaction in web-based instruction is accomplished through various types of communications technologies. Asynchronous communication tools such as computer conferencing permit the student or instructor to provide online responses when convenient. Synchronous communication tools such as Internet chat and instant messaging depict situations when learners are online communicating together with no or very little time delay. Student creation and posting of web-based resources such as text, presentation, and graphic documents is another mechanism for interaction by sharing content in an individual or group-based effort as part of a directed course of study. Other student-to-instructor interaction may be promoted by using asynchronous and synchronous discussion feedback, multiple-choice testing, reviewing of grades posted online, eliciting private e-mail capabilities, and utilizing whiteboard technologies. These types of demonstration technologies allow students to view the instructor’s content and actions as she manipulates specific software applications in real time. Although not exhaustive, the above capabilities exemplify the nature of interaction possible within web-based instruction.

Effective web-based instruction capitalizes on identified components and features to support instructional strategies based on theories of learning. This effort often requires a transformation or redesign of traditional classroom-based teaching materials to capitalize on the attributes of the web as an instructional delivery media. A well-known researcher in this area, Betty Collis, terms this effort as the “pedagogical reengineering” of instructional resources for delivery on the World Wide Web. Recognizing both the technical and pedagogical attributes of web-based instruction is crucial to successful design and implementation of this format of instruction.

The elements of web-based instruction may consist of integral components and related features (Khan 1997). To further understand this distinction, e-mail and computer conferencing are considered basic technical components that are often included in web-based instructional delivery, whereas asynchronous communication represents a feature or characteristic of both of these components. Features help to define the potential instructional attributes of the technical components. Various technical components can afford the same features (e.g., the videoconferencing and Internet relay chat technical components both afford synchronous communication as a feature), but it is the features that help us to examine the instructional strategies that can occur across different delivery technologies. Accordingly, using this distinction between components and features, researchers can begin to distinguish the instructional attributes of web-based instruction such as interactivity and collaborative learning as well as what types of different technologies can support these features. This type of distinction between the delivery technology and the instructional methodology is crucial to promoting effective instructional design in web-based instruction.

Considering the pedagogical dimensions of web-based instruction is also crucial to the design of instructional environments on the web. Thomas and Patricia Reeves present a model that represents ten dimensions of web-based instruction. Each dimension is represented by a continuum of contrasting values at either end. This model is useful for guiding the review of existing courses or for designing effective applications of web-based instruction. The ten dimensions assist developers of web-based instruction in considering the broad range of instructional attributes and the orientations that can be included in web-based instruction. The dimensions by Reeves and Reeves are briefly summarized here:

1. *Pedagogical Orientation—Instructivist to Constructivist:* The instructivist perspective places emphasis on objectives determined independently of the learner and strictly sequenced learning materials (e.g., computer-based tutorials that deliver preconfigured material to the learner). The constructivist orientation stresses the learner’s background, prior knowledge, experience, and intentions, viewing learning as an individual and socially constructed activity (e.g., computer-supported intentional learning environments that support the individual determining his own goals and posting a representation of his learning in a communal database to share with others).
2. *Learning Theory—Behavioral to Cognitive:* Behavioral psychology provides the foundation for many interactive learning environments, including web-based instruction, and focuses on shaping observable behaviors through transmitting instructional material and providing feedback and reinforcement (e.g., Pavlov’s shaping of a dog’s behavior by salivating when a bell was rung). By contrast, the cognitive perspective places emphasis on the learner’s internal mental states and learning strategies, such as memorization, repetition, elaboration, and organization, to facilitate cognitive processing of information by the learner (e.g., drill-and-practice strategies of repetition of math concepts).
3. *Goal Orientation—Sharply Focused to General:* The goals for applications of web-based instruction vary widely from specific, highly structured, and accountable training outcomes (e.g., certification in computer technology) to informal, directed general knowledge-sharing

related to a particular topic (e.g., a discussion group related to a specific disease or medical treatment) or a combination of these approaches.

4. *Task Orientation—Academic to Authentic:* An academic task orientation to web-based instruction focuses on traditional academic exercises such as reviewing grammatical structure. An authentic task orientation provides a realistic context for that activity such as preparing a cover letter for a job application.
5. *Source of Motivation—Extrinsic to Intrinsic:* Extrinsic motivation for the learner consists of providing impetus for learning from sources outside of the learning environment such as job advancement or a reward of some kind. Intrinsic motivation demonstrates a drive for learning inherent to the instruction or learner. Reeves and Reeves recommend that instructors not rely merely on the extrinsic motivation and technological appeal related to web-based instruction but rather strive for including vehicles to promote intrinsic motivation such as permitting learner-directed outcomes rather than the instructor specifying the exact result of the instruction.
6. *Teacher Role—Didactic to Facilitative:* Web-based instruction can be designed to primarily present information to learners and follow with initiating recall of this information on tests in a didactic fashion or, alternatively, progress toward a more facilitative role for instructors in presenting authentic problems and then acting as a guide or mentor for learners.
7. *Metacognitive Support—Unsupported to Integrated:* Applications of web-based instruction can include opportunities for learners to reflect on their progress, plan strategies, and assess their own learning needs and make adjustments to their learning processes.
8. *Collaborative Learning Strategies—Unsupported to Integral:* Many of the components and features of the web such as asynchronous or synchronous communication inherently support collaboration between learners in pairs or in small or large groups. Other applications are individually based, such as multimedia tutorials.
9. *Cultural Insensitivity—Insensitive to Respectful:* Web-based instruction should consider the diverse backgrounds of the targeted learners and attempt to incorporate cultural sensitivity (e.g., icon representation, graphics, language) whenever possible.
10. *Structural Flexibility—Fixed to Open:* The web provides attributes for the production of an open learning environment that can be time- and place-independent, thus permitting great flexibility for learning events, such as an asynchronous discussion on a particular medical issue where patients and their families can learn about the

> symptoms of a specific disease. However, many current applications of web-based instruction still rely on time, place, or location restraints related to traditional academic contexts.

It is important that these dimensions are considered in relation to web-based instruction to ground the development of these courses in sound instructional approaches. For example, among the more powerful instructional strategies that have been applied to web-based instruction are those from a constructivist orientation such as active learning, generative learning, and project-based learning. These strategies promote active participation by and increased responsibility of the learner for her own learning process. Students participating in web-based instruction that employ these strategies are often engaged in analyzing, synthesizing, or designing and developing online and offline materials in conjunction with instructors and/or other experts related to the field of study. Web-based instruction affords multiple ways of creating and sharing materials (e.g., webpages, presentations, papers, software programs), with either a class or a worldwide community of practice.

A significant topic of debate among theorists involved in instructional technology encompasses the issue of whether the attributes of technology can promote learning or whether it is the instructional strategies regardless of the delivery medium that cause learning to happen. For example, many educational theorists believe that web-based instruction provides a medium particularly suited for the creation of constructivist learning environments. The attributes of web-based technologies such as hypertext and asynchronous communication afford opportunities to support multiple perspectives on specific topics and to promote real world examples and information provided by web resources, as well as opportunities for reflection and collaborative construction of knowledge prevalent in asynchronous communication. Other researchers are convinced that the attributes of the technology do not by themselves provide the maximum impact for learning. According to this view, deliberately designing instructional strategies based on the needs of the audience and only then incorporating the technological attributes of web-based instruction primarily to support these strategies can provide the most effective and meaningful learning experience.

With current software tools making it fairly easy to develop web-based instruction, the academic community in particular is experiencing significant pressure to publish online courses. With the push toward technology delivery of instruction and distance education, higher education officials are concerned with maintaining instructional quality in relation to increasing instructional access. A National Education Association survey of more than 400 higher education faculty who use distance learning technologies conducted in June 2000 indicated that one of ten NEA faculty use some form of distance education or online delivery. The survey indicated that 44 percent of those 400 faculty members use the web as the delivery medium for their courses, primarily incorporating synchronous chat (62 percent) and threaded asynchronous discussion groups (62 percent). The study also indicated that faculty who teach web-based courses gave their distance learning courses better ratings than their traditional courses on five education goals, including access to information, high-quality materials, mastery of subject matter, evaluative course effectiveness, and addressing learning styles. The U.S. congressional Web-Based Education Commission report (*The Power of the Internet for Learning: Moving from Promise to Practice*) also emphasizes ensuring the quality of web-based instructional materials as well as establishing new research frameworks to investigate how people learn using the web. Despite faculty concerns with quality and workload in developing web-based instruction, trends indicate that the features and components of the web, along with attention to instructional strategies, can provide a quality learning experience, according to a sample of higher education faculty who teach using these materials. However, there is much more to learn about how learning occurs in web-based instructional environments, and future research in this area is sorely needed.

New technologies such as database-driven instructional materials and object-oriented software components are beginning to have a significant impact on the design and delivery of web-based instruction. These technologies support dynamic retrieval of information for instruction such as instantaneous test scores or compiled teaching tips that are stored in a database and then reproduced in a readable form on a webpage. Database-driven instructional websites allow for the capturing of knowledge into a reusable, dynamic form. Collaborative filtering provides another web-based approach that assists learners in making choices based on the opinions of others. One can imagine the use of this type of system in rating instructional materials and courses on the web and determining their best use. Similarly, learning objects technologies that are based on XML (extensible markup language) programming provide a mechanism for cataloging and storing small, independent web-based instructional components to allow them to be called up instantaneously and used across many different instructional programs. This reusability of instructional components across a shared network holds great promise for capitalizing on the best web-based instruction modules and for truly creating a distributed knowledge community.

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See also

Distance Education; Hypertext; Learning Objects; Virtual Universities; Web-Based Course Management Systems

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Web-Based Surveys

Web-based surveys are self-administered data-collection instruments that participants complete while using the World Wide Web. The move from administering questionnaires on paper or by telephone to delivering them on the web has greatly increased the efficiency and cost-effectiveness of research for private-sector, government, and educational use. With the newness of the research method, however, comes concerns for the validity of data collected through electronic means and questions on the relationship between web design and participant responsiveness.

Advantages of Web-Based Surveying

Despite questions about the validity of data collected through web-based surveys, many organizations and researchers are drawn to electronic surveying because of its advantages over other methods. These advantages include:

- *Reduced costs:* Electronic surveys avoid postal mailing costs, telephone charges, and travel costs of in-person interviewing.
- *Faster collection of data:* Online surveys reduce lag time between delivery of survey and collection of data.
- *Easier access to larger potential pool of respondents:* Widespread Internet use has led to new ways of identifying potential survey respondents, from volunteer panels of Internet users who are

paid or earn prizes to answer surveys (e.g., Surveys.com) to self-selected participants who answer opinion polls for fun.

- *Promotion of surveys and reminders are easier through electronic means:* Survey administrators can promote surveys through website advertisements and automatically send e-mails to a pool of participants reminding them to complete a survey.
- *Reduced data entry errors:* Web-based surveys eliminate the need to interpret handwriting on a paper questionnaire or transcribe interviews, thereby reducing data entry errors.
- *Error control:* Through web programming, survey participants can be restricted in their entries, such as forcing a numeric range for entries or mandating item completion. Navigational aids, such as help specific to an item, can be offered through pop-up windows and other web methods.
- *More efficient data analysis:* Most web-based surveys are programmed to enter responses immediately in a database, thereby reducing time needed for coding, entry, and checking of data.

Limitations of Web-Based Surveys

Despite the many advantages of web-based surveys, common limitations are often cited, among those:

- *Privacy perceptions:* While some users may feel more anonymous completing a survey on the web, others who have heard stories of unauthorized collection of personal information over the Internet may be concerned with privacy, thus leading to nonresponse.
- *Limited population sampling:* Delivering a web-based survey precludes reaching a wide population sample since it necessitates participants having access to a computer and the Internet, which is not universally possible.
- *Mode bias:* As discussed below, studies have suggested differences in responses (compared to paper, telephone, etc.) due to layout and operation of online survey forms.
- *Technical errors:* Care must be taken with computer programming to prevent errors such as allowing multiple submissions from participants.

The Web versus Paper Debate

When looking at the effectiveness of web-based surveys, researchers are concerned with disparities in responses (or nonresponses) caused by mode, or method of delivering the survey (e.g., electronic, paper), and design (e.g., hypermedia features such as dropdown menus, tables, and links).

Although an increasing amount of research is being done on the effect of mode on survey effectiveness, the results are mixed (Carini 2001). A number of studies show that few significant differences occurred between responses to a survey administered on the web versus paper, whereas other studies suggest that a web-based survey influences responses (Carini et al. 2001). These reported mode influences range from a tendency to give more forthright responses on the web (assumedly because of a feeling of anonymity) (Turner, Ku, and Rogers 1998) to a tendency to be more positive over the phone (Biemer 1997; Groves et al. 2000) or more positive over the web (Dillman et al. 2001). Similar variable results can be seen from studies comparing response rates of electronic surveys (e-mail) to postal mail surveys (Smith 1997). A common reason given for differences in response rates is the additional requirements imposed on participants of web-based surveys, who self-select based on access to computers and the Internet and comfort level using electronic forms.

In recent years studies have examined variations in response behavior as a result of web design issues (Bosnjak and Tuten 2001). Researchers have looked at how this response behavior has resulted in missing data, both for entire surveys (called unit nonresponse) and for particular questions (called item nonresponse) (Groves and Couper 1998). Web-based survey design experts note that design choices can affect unit nonresponse as well as item nonresponse because both influence the participants' comfort level with the electronic medium, improve access through faster download time, and minimize confusion with navigating the items in the survey. Researchers (Dillman and Bowker 2001) have identified specific guidelines for the design of web surveys to reduce nonresponse and measurement errors:

- Provide a motivating welcome screen and clear instructions on how to navigate the survey.
- Allow scrolling through questions (versus one-by-one display of questions) unless order is important or there are other methodology requirements.
- Lead the survey with an interesting question that can be answered by most participants.
- Limit bandwidth-heavy web features such as large graphics to reduce access time.
- Limit the use of dropdown boxes or provide clear instructions for their use.
- Ensure that use of color, fonts, tables, and symbols enhance readability and give visual clues for navigation.
- Limit use of open-ended questions.

Use of Web-Based Surveys in Education

Despite debates about the effectiveness of web-based surveys, educators, students, and school administrators are increasingly using them in numerous ways. For example, web-based surveys are being used:

- For teaching exercises in research, mathematics, and statistics courses or other learning activities where data analysis and graphing are required (TeachersFirst.com 2001).
- To collect data to share among educators, parents, and students (Koufman-Frederick et al. 1999).
- For community-building in a class setting by allowing opinion polling on course topics such as historical events (TeachersFirst.com 2001).
- As an efficient research methodology for postgraduate studies.
- As an efficient mechanism for collecting evaluations of courses and educational resources such as schools and programs.

Teaching Exercises

Web-based surveys facilitate student collection and analysis of data during teaching exercises (Baron and Siepmann 1999). The authors suggest that students can learn about a course topic by individually completing a questionnaire and later analyzing collective responses. Alternatively, students may be tasked with designing their own questionnaires and collecting data from a larger sample through a web-survey hosting service, such as Zoomerang.com (see below for more details on web-survey hosting). In either learning situation, students come away with a real-world experience in data collection and analysis.

Collecting Data to Share

Web-based surveys offer a way to collect data to be shared by educators across geographic boundaries (Koufman-Frederick et al. 1999). For example, the National School Network (NSN) maintains a database of critiques of the educational value of websites. Using a web-based survey form on the NSN website, teachers, students, and community members can enter their evaluations of websites and web-based courses according to their usefulness and quality. Another database reflecting entries from a geographically disparate group is the Integrated Postsecondary Education Data System (IPEDS), maintained by the National Center for Education Statistics. The IPEDS is a system of surveys designed to collect data from all primary providers of postsecondary education to contribute to a searchable database accessible over the web.

Community-Building

Opinion polls, with their accompanying results graphs, have become commonplace on commercial websites, such as CNN.com, seeking to create a feeling of community and active participation for visitors. Similar polling is beginning to be used by teachers to foster discussion among students on course topics and also for midterm feedback to help teachers determine the effectiveness of course materials and lectures.

Research

The advantages of web-based surveys discussed previously attract academic users performing research for dissertations or preparing scholarly papers. Advertisements on commercial websites such as StudentResearcher.com, a web-survey hosting website, suggest that even younger students are being targeted as potential users of this type of service to perform research for term papers.

Course Evaluation

Educators, particularly those facilitating distance education courses, are increasingly using web-based surveys for course evaluations with varying degrees of success. Researchers (Kolasa et al. 2001) reported a low response rate (30 percent) for an online course evaluation of a virtual seminar on medical nutrition education, even when course participants had agreed beforehand to participate in the research. The authors note that other similar efforts to conduct course evaluations online have resulted in low response rates, perhaps pointing to the need for increased motivation of participants.

Development Tools

Survey administrators are using a number of technology approaches to create and manage web-based surveys. The approach they choose depends on their comfort level with computer programming and the need for customization of the survey form and data repository.

1. *Manual development.* Survey administrators with web development skills may choose to manually develop a web-based survey using hypertext markup language (HTML, the markup language for display of webpages) and scripting (such as CGI scripts or Javascript) to transfer responses to a database. The manual development approach requires knowledge of markup language and/or programming languages and access to a computer or account with an Internet provider that can host the survey and database, but it allows the greatest flexibility for customization of the survey form and database format.

2. *Survey software.* A growing number of software packages and systems are becoming

available that will run on a desktop computer or server to automate many survey administration tasks (Solomon 2001). Some of the processes that are automated by these systems include distribution of e-mail cover letters and tracking of respondents. Examples of these systems include Perseus's Survey Solutions for the Web, Survey Said™ Survey Software, and Apian SurveyPro. Delivery of surveys also requires hosting on an Internet-connected server.

3. *Web-survey hosting services.* Web-survey hosting services are Internet service providers that store web-based or e-mail surveys and data on their servers. Setting up surveys usually involves little more than selecting a template or look of the survey, choosing question types, and typing questions and options. Usually no programming skills are needed. Collected data are stored in a database on the host server and usually can be downloaded in a variety of formats (e.g., spreadsheet, comma-delimited files) or received by e-mail. Web-survey hosting services such as Zoomerang.com often provide a choice of a free service with scaled-down features (e.g., limits on the number of questions, duration of data storage) or a for-fee service with more extensive capabilities. In addition, some services offer access to a pool of potential respondents for an additional fee (similar to paying for a mailing list).

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See also

Collaborative Technologies; Distance Education; Web-Based Instruction

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Webcast

A new development in broadcasting technology, webcasts are multimedia events delivered via the Internet. Webcasts are accessed through web browsers with the help of media players. Similar to satellite broadcasts and interactive television, webcasts deliver audio-visual content to Internet customers worldwide.

The first steps toward streaming media over the Internet occurred in radio in the mid-1990s.

Gradually, other components were added, such as video, photos, and other still graphics, as well as feedback forms, each in its own frame. Webcasts can be live events, but they can also be archived for later viewing. Many webcasts are reserved for a limited audience, such as students enrolled in a course, and require logins. On the other hand, many government sites, such as the National Aeronautics and Space Administration, and media sites, such as the Corporation for Public Broadcasting, offer public webcasts.

Webcasts can range from very simple to very complex. For instance, they can include a single piece of audio or a video of a speaker delivering a presentation or a performance. However, most webcasts utilize a variety of media packaged into one event. A typical webcast appears on a webpage that consists of three or four frames: one with a streamed video; one with a set of graphics, photos, or charts; one with an input window for the questions and comments from the audience; and one with ancillary background material.

Webcasts and livecasts are significant because they have affected the way information is presented in the traditional media formats, such as television programs, which have began to emulate the multidimensional organizational structure of webcasts. CNN, the popular news channel, has redesigned the original screen layout, and focused exclusively on the anchor or the live footage, to resemble a webcast page. The news segments now consist of a live broadcast with a sidebar for textual information pertaining to the live broadcast; however, the breaking-news headlines continuously scroll at the bottom of the screen. Webcasts, therefore, pose important questions about the validity of traditional, organizational patterns of communicating information.

Development of a webcast is similar to a television production. It requires a director, a camera crew, and a producer, but it also requires networking specialists, computer operators, web editors, and other support personnel who digitize the obtained video and integrate it with the other components of the event, such as the still graphics and the viewers’ input. Corporate clients often rely on commercial vendors for production facilities, whereas academic institutions, such as colleges and universities, may be able to employ their local media resources divisions.

Webcasts are utilized by a variety of organizations. Many radio stations today are broadcasting via the Internet in addition to the traditional broadcasting, which makes them available worldwide instead of locally. Others include businesses, educational institutions, and any other constituencies that wish to broadcast live or archived video.

Webcasts are gaining popularity in education, particularly in distance education. Webcasts offer learning environments that are similar to interactive television. However, lectures and demonstrations delivered via a local area network or the Internet require less hardware for the recipient and are thus more accessible to students who can obtain the broadcast from a variety of locations, including their homes, instead of having to travel to a satellite or an extended campus equipped for interactive TV. Additionally, webcasts can be broadcast from any site, not just from a TV studio, which gives the instructor more flexibility in utilizing lab settings and other environments not easily replicated inside a TV studio.

Furthermore, placing the broadcast within a website allows for better display of still graphics and ancillary background materials, such as links to websites that students can peruse prior to the synchronous live event. Streamed videocasts can be archived, together with the ancillary materials. The asynchronous version can be used for reviewing the material as well as for future course enhancements. Webcasts also allow students to participate in conferences and workshops online, where they can interact with world experts in their disciplines as well as have access to the latest developments in the subject under study.

Educators have found new opportunities to collaborate in real time with the help of webcasting; for example, faculties can team-teach courses at different institutions. Students simply tune into the joint course website and participate in lectures, demonstrations, and discussions delivered from different campuses. One of the groundbreaking collaborative events occurred at the Computers and Writing 2000 Annual Conference, where a group of dance students gave a joint performance with another group whose performance appeared streamed, via the Internet, onto a television screen.

Barbara Szubinska

See also

Collaborative Technologies; Digital Video; Distance Education; Interactive Television

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Weblog

Weblogs began to emerge in 1997 as web-accessible information distinguished from what had come to be called a "homepage." A weblog is similar to an annotated bookmarks list available for public viewing and typically includes a "log" of journeys around the web with links and commentaries. An early and avid publisher of this type of information (Barger 1999) coined the term "weblog" (*web* plus *log* = "weblog," or "blog" for short) to describe the new type of website, and the term stuck. As with any relatively new term, there remains some disagreement about precisely what is and what is not a blog. J. Barger (1999) offered this definition:

> A weblog (sometimes called a blog or a newspage or a filter) is a webpage where a weblogger (sometimes called a blogger, or a pre-surfer) "logs" all the other webpages she finds interesting. The format is normally to add the newest entry at the top of the page, so that repeat visitors can catch up by simply reading down the page until they reach a link they saw on their last visit.

D. Winer (2002), another blogging pioneer, provides another definition:

Weblogs are often-updated sites that point to articles elsewhere on the web, often with comments, and to on-site articles. A weblog is kind of

> a continual tour, with a human guide who you get to know. There are many guides to choose from, each develops an audience, and there's also camaraderie and politics between the people who run weblogs; they point to each other in all kinds of structures, graphs, loops, etc.

Winer argues that in retrospect the very first blog was the web's first site (Berners-Lee 1992). He traces the early history of the blog from T. Berners-Lee's site through the National Center for Supercomputing Applications' "What's New" page (NCSA 1993) to Netscape's "What's New" page (Netscape 1995).

The 1997 emergence of the weblog corresponds to the growth of a group of individuals self-defined as a "personal web publishing community" that identifies its own work as separate from other types of web publishing.

The meaning of the term "blog" broadened somewhat during 1999, as Eatonweb began creating a comprehensive index of weblogs. The only criterion for listing in the index was that the candidate site contain dated entries. This allowed online diary and journal-type sites into the Eaton index, resulting in dispersion of the broader definition of blog currently in use in 2002.

With the introduction of technology that allows people without HTML expertise or Unix server accounts to be bloggers, such as blogger.com, the popularity of this type of website has increased dramatically. There were approximately 1,000 blogs in 2000, but that number has grown to an estimated 500,000 or more in 2002 (Paquet 2002). Users of logger.com, a popular system providing free and easy-to-use blog management tools and storage, create a new blog approximately every forty seconds—over 60,000 per month (Paquet 2002). Slashdot (Malda 2002), one of the web's most popular blogs, posted 4,088 dated entries in the first half of 2002, to which more than 350,000 registered readers posted 967,573 comments. The increase in blogging is likely due to extremely easy to use technology and the growing popularity of the blog-style website, but no systematic survey of bloggers' motivations has been carried out to date.

We can, however, make some general statements that point to the current and future uses of blogs. W. Richardson (2003) maintains a list of ideas for using blogs in formal education that is updated frequently. Some of the ideas in his list include:

- Weblogs are a personal writing space—easy, sharable, and automatically archived.
- Weblogs are easily linked and cross-linked to form learning communities. The school logs projects are examples. The school logs also enable a teacher to evaluate a student's thinking by reading explanations and assignments.
-

- Weblogs can become digital portfolios of students' assignments and achievements.
- Weblogs are a novice's web authoring tool.
- Accumulated weblogs become a content management system.
- Via digital storytelling, weblogs play a role in professional development.
- Weblogs can serve as an online portal for lecture notes, assignments, links, and so on.

David Wiley

See also

Cyberculture and Related Studies; Hypertext; Online Learning Communities

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WebQuests

A WebQuest is “an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the Internet” (Dodge 1997). WebQuests were developed by Bernie Dodge of San Diego State University in 1995 in response to the need “to help teachers integrate the power of the Web with student learning" (March 1999). WebQuests were developed based on several key educational principles, including: constructivism, critical thinking, cooperative learning, and authentic assessment. Since 1995 WebQuests have been one of the most popular Internet-based instructional strategies used in schools. WebQuests vary depending on learning goals, content area, student age, and teacher preference, but six components compose all WebQuests: (1) introduction (2) task, (3) process, (4) resources, (5) evaluation, and (6) conclusion.

Introduction

WebQuest introductions orient the learner to what is coming and motivates her to want to participate. Introductions can accomplish this by giving students roles to play or mysteries to solve, invoking prior experiences, relating to personal interests, and encouraging teamwork.

Task

The task is the most important part of the WebQuest and provides "a goal and focus for student energies" (Dodge 2001). Although tasks are limited only by teacher imagination and creativity, eleven common tasks have been identified that encourage learning beyond rote comprehension. These tasks are not mutually exclusive and are most successful when used in combination. Examples of WebQuest tasks include design tasks, persuasion tasks, and journalistic tasks. Design tasks require students to create a product or plan to accomplish a goal while working with certain constraints. For example, some WebQuests involving design tasks have students design vacations to regions being studied or use mathematical skills to design a home within budgetary constraints. Exemplary design tasks encourage development of a useful product, require realistic constraints, and encourage creativity, collaboration, and authenticity. Persuasion tasks require students to develop a case for a certain perspective based on their research and to present this case to an audience. For example, one WebQuest involving a persuasion task asks students to explore the issue of wolves in Yellowstone National Park. Students are required to research the information and make a persuasive report designed to influence government policy. Exemplary persuasion tasks involve presentations to authentic audiences, real-world situations with multiple opinions, and the need for students to develop group consensus. By contrast, journalistic tasks require students to act as news reporters by gathering and organizing facts. WebQuests involving journalistic tasks might ask students to report on design and development of the Vietnam Memorial and the Mexico City earthquake. Exemplary journalistic tasks encourage students to recognize the bias inherent in all media coverage, to explore facts from multiple avenues, to incorporate multiple perspectives in their report, to provide substantial yet concise background information, and to report in a way that shows fairness and accuracy.

Process

The process describes how students are to go about accomplishing the task. The process may break the task into subtasks, explain the roles or perspectives to be taken by different learners, provide advice, suggestions, or things to consider when completing the task, and include concrete, step-by-step directions or general guidelines depending on learning goals and grade level. The process description should be concise, relatively short, and easy for students to follow.

Resources

The resources include predetermined resources the students will use to accomplish their task. Resources are usually referenced in the process section, and different students may be asked to explore different resources depending on their role or perspective. Although the primary emphasis of WebQuests is on Internet-based learning, resources often include a variety of sources, including books, videos, and newspaper articles. The key component is that all resources have been carefully identified by the teacher in advance so that students spend time exploring rather than searching for relevant information.

Evaluation

Since WebQuests are designed to facilitate higher-level thinking skills, traditional assessment measures such as multiple-choice tests are often insufficient. Most WebQuests use evaluation rubrics in this component. These rubrics vary greatly depending on learning goals and tasks, content area, and grade level. The rubrics should allow students to understand expectations without stifling their creativity and imagination.

Conclusion

The conclusion section allows for summary of the experience, reflection about the activity, and extension of learning. Conclusions may range from a whole class discussion, to a presentation, to a field trip. The key point is that the students are given an opportunity for closure through a positive and motivating experience.

The Webquest Page, also developed by Bernie Dodge, provides a compilation of WebQuests organized by content and grade level, descriptions of the theoretical frameworks behind WebQuests, a collection of related articles, suggestions, tutorial, and templates for creating WebQuests, and information about how WebQuests are being used in schools and universities. It is a thorough and well-designed site for those interested in further exploring WebQuests.

Kara Dawson

See also

Computer-Assisted Language Learning; Computer-Supported Collaborative Learning; Curriculum Integration

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Western Governors University (WGU)

Western Governors University is a collaborative virtual university founded with the explicit goal of changing the fabric of higher education. It serves as an example of how the convergence of technological, instructional, and pedagogical developments is impacting U.S. higher education. WGU's principal mission is to expand access to postsecondary education for individuals to learn independent of time and place and to award competency-based degrees and credentials. The university outsources to third-party course providers and serves as a broker for distance education courses and programs to minimize costs of duplication in higher education. WGU itself does not offer courses; distributed faculty from a consortium of state and private higher education institutions and businesses design courses for WGU students and deliver them at a distance. Approximately fifty colleges, universities, and commercial providers offer more than 1,200 courses for WGU. The role of WGU is to provide centralized governance, policy guidance, and quality control to these affiliated educational providers.

Currently, eighteen states and Guam are participating in the implementation of Western Governors University (Alaska, Arizona, Colorado, Hawaii, Idaho, Indiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming). Among the corporations and foundations partnering with WGU are America Online, Apple, AT&T, Cisco Systems, 3Com, HP, International Thomson

Publishing, Microsoft, IBM, Novell, Oracle, Sun Microsystems, the Bill and Melinda Gates Foundation, Drake International, Convergys, and Sallie Mae. In addition, WGU collaborates with international institutions such as the Open University in Great Britain, the Open Learning Agency in British Columbia, the Tokai University Educational System in Japan, and the Universidad Virtual del Instituto Technologico y de Estudios Superiores de Moterret in Mexico.

Described initially by its founders as the next-generation university, the establishment of WGU resulted from a 1995 meeting of the Western Governors Association (WGA), an organization consisting of the governors of twenty-one states and U.S. Pacific Islands territories. Members of the WGA shared a concern for finding ways to encourage member states to utilize information technologies to collaborate in education, industry, and government. Governor Mike Leavett of Utah suggested that western universities needed to collaborate in the development and delivery of distance education courses to provide expanded educational opportunities to a growing number of students. Governor Roy Romer of Colorado pointed out that there was a lack of methods available to measure and certify competencies based on individual learning experiences to meet the demands for new skills and knowledge in the workforce. Ten members of the WGA proposed a joint-venture virtual university that would utilize the potential of new information technologies to meet the educational needs of a broader audience at a lower cost and enable formal recognition or certification of learning achieved regardless of the source.

In June 1996 fifty members of a regional advisory group representing thirteen states presented a work plan for the proposed virtual university. The governors appointed a team to design a plan for a virtual university that would be “market-oriented, independent, client-centered, degree granting, accredited, competency-based, non-teaching, high quality, cost-effective, regional, and quickly initiated” (Western Governors University 2002). The parameters that the governors outlined for the design team are important in understanding the idea behind the project and the purpose of the institution. The proposed institution would be market-oriented, client-centered, and responsive to the changing needs of the citizens and employers. It would grant degrees based on competency accredited by accreditation institutions. The institution would be cost-effective through sharing of regional resources and needed to be immediately accessible to a potential student market.

Initially, each partnering state contributed $100,000 to continue planning, with the full startup costs pegged at $6 million to $10 million. The majority of the startup financing came from eleven of the corporations and foundations aiding the strategic planning and implementation of WGU. Representatives of these corporations and foundations embody the WGU national advisory board, which aims to foster a global and visionary perspective consistent with the successful implementation of WGU.

Potential students for WGU include traditional students, nontraditional learners, teachers wishing to earn continuing education credits, high school students desiring an early start in college, homebound individuals, and senior citizens. Professionals in business and industry represent another potential market for WGU. WGU's first degrees and certificate programs were opened to students in September 1998. The initial four programs offered from sixteen WGU institutions were a master's in learning and technology and associate's degrees in general education, network administration, and electronics manufacturing. As of 2003, WGU was offering three associate's, three bachelor's, and eight degrees for educators.

One of the unique advantages of studying at WGU is that students can complete courses from any WGU institution without having to transfer credentials from one institution to another. A student can take an English course from a Colorado university, study biology through an institution in Washington state, and complete another course through a faculty member based in Idaho.

Participating faculty from colleges, universities, and corporations offering WGU courses select the mode of delivery of instruction. WGU instruction and training are accomplished through compressed video, videoconferencing, Internet, CD-ROM, audiotapes, and videotapes. Students select courses utilizing technology to which they have access. Each participating WGU state must provide at least one local center for student access to technology, counseling, advising, and assessment and for students to log into their online courses or take tests. Student support is streamlined by centers for administrative, technical, and instructional services, as well as proctored exams at existing institutions such as public libraries, small businesses, and community colleges.

WGU adopted a competency model to shift the focus of education to the actual competence of students rather than seat time in the classroom. The competency model allows students to earn degrees based on performance and assessment. Unlike traditional higher education institutions, the degrees are not awarded based on accumulation of credit hours but through standardized testing and independent projects or portfolios. Competencies are "skills or knowledge identified by professionals in a particular field as being essential for mastery of that field." (Western Governors University 2002).

The faculty members at WGU do not develop content or deliver instruction in a traditional sense. WGU's faculty includes the program council, the assessment council, and mentors. Each degree and certificate program has a set of competencies developed by the WGU program council faculty. These competencies consist of the knowledge, skills, and abilities that students completing the program need to possess. The university's assessment council faculty, in cooperation with the program council faculty, determine what vehicles are to be used to assess performance, competency, and adequacy of the assessment methods. In addition, the council solicits assessment instruments from third-party content providers, provides oversight for the assessment process, and periodically reviews assessment activities of local WGU support centers.

Before a student is admitted into the program, she completes a preassessment, a skill survey, and an intake interview. Upon admission, a WGU mentor—an expert in the student's field of study—is provided. WGU mentors are to provide academic guidance, advising, and tutoring to students throughout their programs. The mentoring is conducted via e-mail, listserv, threaded discussion, and telephone. The student and the assigned WGU mentor together develop an academic action plan based on the student's entry level, educational goal, and time frame. The academic action plan is an individualized plan that sets out the steps a particular student should take to earn a WGU competency-based degree or certificate (Western Governors University 2002).

Demonstration of skills and knowledge based on work experience, college work, or individual effort is recognized through competency-assessment examinations. The competency-based model doesn't mean students do not need to take any courses. Students have to pass a required number of standardized tests and complete enough independent projects to demonstrate mastery of the course and curriculum material. If the student cannot demonstrate competency on a series of assessments, even if she has several years of college experience, she will not be able to earn a WGU degree.

Implications and the Future

Western Governors University is one of the most publicized virtual universities among the dozens that proliferated in the 1990s. The policymakers and founders of WGU promoted the university's educational and organizational model as revolutionary and as the future of higher education. Due to political support at both the state and federal levels, its numerous corporate, foundation, and educational partnerships, its organizational structure and competency-based model, and accreditation, WGU could not be ignored by the academia.

Advocates applauded the governors for taking the initiative in creating WGU. Opponents criticized its model and predicted failure soon to come for the university while closely watching its enrollment numbers. And WGU, a completely online institution, after investments of millions of dollars and years of preparation, had an enrollment of only ten students in its first semester (Noble 1998). Initial enrollment at WGU was quite a bit lower than expected. Potential students may have been lost to other institutions due to the long planning time that WGU has taken. In 1998, organizers projected that they would have 500 students enrolled in degree programs, 3,000 students in certificate programs, and 10,000 students taking classes from other institutions through WGU. As of 2003, WGU had 750 students in its degree and certificate programs, 450 in nondegree programs, and 36 graduates (Carnevale 2003).

One of the design parameters for WGU was that the university should be an accredited institution. The creation of a university without walls raised questions regarding accreditation. Traditionally, granting accreditation to higher education institutions is conducted by regional accreditation associations. However, because WGU spans four regions, no single accreditation institution could involve itself with the accreditation process of WGU. The Inter-Regional Accreditation Committee (IRAC), composed of four regional agencies, was formed to assist with the accreditation of WGU.

IRAC established standards and methods in its process of evaluating and accrediting WGU with a unique structure. After two years of assessment, IRAC awarded the online institution candidate status in November 2000. The accreditation process has three steps: eligibility, candidacy, and full accreditation. During a candidacy review, accreditors determine whether an institution is set up and runs properly. After two years of assessment, IRAC awarded the online institution candidate status in November 2000 and accreditation in February 2003. The creation of IRAC and its granting of accreditation to WGU have implications on the prior understanding and practice of accreditation. IRAC's interregional requirements and standards for accreditation represent a new way of thinking about accreditation and quality standards that cross geographical and traditional boundaries. IRAC allowed for the possibility of flexibility and openness to innovation by acknowledging competency-based learning as opposed to credit-hour requirements and for the role of third-party educational providers in implementation of postsecondary curricula and courses. WGU challenged accreditation practices to accommodate its unique structure and mission; a WGU-style academic model now is recognized by the written policies of every regional accreditation commission and is a model for the accreditation of future nontraditional institutions (Kinser 2002).

The WGU model has inspired educators, administrators, and policymakers to reexamine commonly accepted assumptions and practices about how a higher education institution works, how student learning and assessment is conducted, and how instruction may be financed. A key question is whether WGU can be considered a university with no traditional sense of faculty employed, an institution that does not itself teach but brokers courses from third-party educational providers and certifies learning with competencies rather than the credit-hour requirements. WGU provides access to its students through the online Smart Catalog/Advisor, thus functioning as a type of portal to courses offered in other affiliated colleges, universities, community colleges, and business partners. The founders and advocates of WGU claim that it is an institution of higher education offering degrees and certificates, not merely a gateway to distance education courses.

In 2001, the Accrediting Commission of the Distance Education and Training Council (DETC) granted WGU accreditation. DETC serves as a distance education clearinghouse and conducts accreditation reviews of distance learning institutions throughout the world. DETC accreditation is important for WGU because it may help increase enrollment numbers, allowing tuition assistance possibilities from the military, employers of potential students, and other financial aid programs (WGU 2001). Accreditation by DETC and IRAC legitimizes WGU as a higher education institution. The legitimacy of WGU, whether or not it is successful in its endeavor, reflects an alternative organizational pattern for higher education (Kinser 2002).

One WGU affiliate notes that the faculty role at WGU is unbundled. The teaching faculty members are not the same individuals who assess student competency; thus the assessment of students and the teaching of students seem to be separated. WGU reconstructed the role of faculty by dividing the tasks of faculty among groups. Therefore, the changes in the faculty role suggest changes in the faculty reward structures. Unlike traditional four-year universities, WGU emphasizes teaching over discipline-based research or university governance service.

Leaders of Western Governors University have sparked both criticism and praise by adopting a unique competency-based model of education. Critics argue that the competency-based model of WGU is probably its most radical aspect. This model can be interpreted by some as supporting WGU’s mission to be a student-centered institution and by some as a constructivist approach to learning. However, it is also questionable whether the competency-based model is different than standardized testing and whether it can effectively measure higher-order thinking that universities have traditionally aimed to foster. On the contrary, supporters of WGU argue that seat time—the fact that students sat through enough credit hour courses and crammed for tests—can hardly ensure that students have learned the material.

Observers question whether WGU significantly offers anything new because traditional universities have used some of WGU’s methods for decades. WGU has inspired debates and discussion about how it works, its connection to private industry, its teaching quality, whether it’s the next-generation university, or whether it’s an example of legitimizing the expansion of the technology market in higher education. Nevertheless, WGU seems to have achieved its goal: to facilitate the use of existing institutional resources and to overcome the institutional and regional barriers by being a centralized governance and policymaker for a distance education institution.

Selma Vonderwell

See also

Distance Education; Open University; Virtual Universities

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Who Built America?

The *Who Built America?* series emerged out of a collaboration between the Voyager software company and the American Social History Project (ASHP). *From the Centennial Celebration of 1876 to the Great War of 1914* (*WBA I*) was published by the Voyager Company in 1993; it was one of the first works in educational multimedia grounded in serious scholarship. Appearing at a time when multimedia CD-ROMs were just emerging into public consciousness, *WBA I* garnered a very large audience (more than 100,000 disks were sold); won major awards, including the American Historical Association's James Harvey Robinson prize; and attracted controversy over its content. The sequel *Who Built America? From the Great War of 1914 to the Dawn of the Atomic Age in 1946* (*WBA II*) was published in 2000, but it received less attention, in large part because CD-ROMs had by that time been superseded by the World Wide Web. Although the web rather than CD-ROM became the dominant format for delivering educational multimedia, the two *WBA* CD-ROMs helped pioneer new ways to present historical ideas and information in digital media.

WBA I was a joint venture between Voyager, an innovative software company, and the American Social History Project, an academically affiliated group based at the City University of New York (CUNY). Robert Stein and his colleagues founded the Voyager Company in 1985. Initially, it focused on publishing laserdiscs and was known for its Criterion Collection, which produced more than 250 interactive videodisks of such major films as *Mean Streets* and *Blade Runner.* In the late 1980s Voyager began experimenting with the possibilities of developing CD-ROMs using Apple's HyperCard software program, and in 1989 the company released what many regard as the first consumer CD-ROM, the *CD Companion to Beethoven's Symphony No. 9.*

Eight years earlier, in 1981, historians Herbert Gutman and Stephen Brier created the American Social History Project to revitalize interest in history by challenging the traditional ways that people learn about the past through the production of innovative print, visual, and multimedia materials about the role of workingmen and workingwomen in U.S. history. In the late 1980s Roy Rosenzweig, a historian at George Mason University and a longtime collaborator with ASHP, began talking with Brier and Joshua Brown, the ASHP media director, about extending ASHP's educational and public history work into the digital realm. Coincidentally, it was around that same time that Stein read the first volume of ASHP's textbook history of the United States, published by Pantheon under the title *Who Built America?* In spring 1990 Stein approached the American Social History Project about a possible digital collaboration. Brier then spent a week in July 1990 working with Voyager staff in California to develop a prototype of a project to put the *WBA I* text, accompanied by video, text, image, and sound enhancements, on a laserdisc that would be controlled by an Apple Macintosh computer. But in the fall of 1990 the laserdisc setup was abandoned as too cumbersome, and the project was shifted to a newly emerging medium: CD-ROM.

In the spring of 1991 the ASHP group began full-time work on the *WBA I* project. The work was centered both in northern Virginia under the supervision of Rosenzweig, aided by a team of graduate student research assistants, and in ASHP’s New York office at CUNY, where Brier and Brown were assisted by ASHP staff members who helped develop the multimedia resources for the disc. The project then had to overcome a number of technical, conceptual, and financial challenges, which absorbed a great deal of the next two and a half years. In some ways, the delays benefited the project because computer technology continued to improve rapidly during that time (e.g., 14-inch color monitors and CD-ROM drives became ubiquitous in personal computers). Following an extended production process at Voyager’s California offices during 1992 and 1993, the ASHP-Voyager group formally released *WBA I* in August 1993 at MacWorld in Boston.

Briefly summarized, *WBA I* provides an interactive multimedia introduction to American history in the late nineteenth and early twentieth centuries on a single CD-ROM. The core of this electronic book is a basic survey of American history from 1876 to 1914 that is drawn from the second volume of ASHP’s book *Who Built America?* published in 1992. To this textual survey is added nearly 200 excursions, or side trips that branch off from and complement the main body of the text and, in the process, enhance and transform it. Those excursions contain about 700 source documents in various media that allow students as well as interested general readers to go beyond (and behind) the printed page and immerse themselves in the primary and secondary sources that professional historians use to make sense of the past. In addition to about 5,000 pages of textual documents, *WBA I* includes about four and a half hours of audio documents (oral histories, recorded speeches, and musical performances), forty-five minutes of films, more than 700 photographic quality pictures, and about seventy-five charts, graphs, and maps.

The advantages of the computer and CD-ROM for presenting the turn of the twentieth century to students are many and varied. One advantage is the vast storage capacity offered by the CD-ROM. Whereas the print version of the four chapters of *Who Built America?* could only include forty primary documents of 250–750 words each, the CD-ROM includes not only many more documents but also much longer ones. For example, the disc includes dozens of letters written home by Swedish, English, and Polish immigrants rather than just one or two.

The second key advantage of the CD-ROM is its ability to locate and keep track of vast quantities of information very efficiently. The computer tracks which instances users look at and keeps markers for the ones that they want to return to later. The program also offers many other ways to locate and link things quickly. By using the find feature and the resource index, those who want to can learn about American history in a nonlinear fashion. A related advantage of the computer’s ability to access and keep track of information is simultaneity, or the ability to move very quickly from one body of information to another. In effect, readers can instantly move behind the page to see the primary source materials out of which the basic textual analysis has been crafted. In addition, they can quickly locate information that will help them understand what they are reading.

The third key advantage provided by the electronic book is its multimedia elements. For historians, the advantages of multimedia are obvious. The past occurred in more than one medium, so why not present it in its multiple dimensions? The ability to add oral histories was particularly valuable because the print version of *Who Built America?* had emphasized "history from the bottom up" and social history. Now, the multimedia CD-ROM could literally incorporate the diverse voices of ordinary Americans and merge form and content.

Despite the unconventional nature of this electronic book, it retains some of the traditional features of a printed book. It looks much like a printed book on screen, with two columns of type and frequent pictures, presented in black and white. The reader can page through the book briskly using the arrow keys, accessing not only text but also hundreds of high-quality images that include detailed captions and source information. Other traditional book features are also retained. Users can, for example, take notes in the margin or in a separate notebook. A resource collector also serves as a sort of multimedia notebook in which readers can assemble their own compilations of specific sound and film clips and pictures as well as text documents. Users can select and highlight, boldface, or underline any amount of text electronically. The user can even electronically dog-ear the corner of a page so that the computer will rapidly locate that marked page.

Historians, educators, and those involved in multimedia greeted *WBA I* enthusiastically when it appeared in fall 1993. It received praise from computer magazines and newspapers. *WBA I* received the American Historical Association's James Harvey Robinson prize for its "outstanding contribution to the teaching and learning of history." It was also one of the twenty-seven finalists for the first Interactive Media Festival Awards.

Although initially priced at $100, sales of *WBA I* were good. But the real breakthrough in distribution came in the fall of 1994 when Apple agreed to bundle *WBA I* with computers sold to schools. At that time, the CD-ROM was only available on the Macintosh computer platform; a Windows version of *WBA I* using the ToolBook authoring program was not released by Voyager until the fall of 1995.

The successful Apple bundling deal, however, led to controversy. In January 1995, after selling 12,000 copies of *WBA I,* Apple told Voyager that it had received an unspecified number of complaints from some school districts about the inclusion of materials on homosexuality, abortion, and birth control in the CD-ROM. Apple asked for a special edition of *WBA I* that would eliminate topics deemed not appropriate for classroom use.

ASHP and Voyager declined. At the end of January, Apple announced it would stop selling the title. The controversy focused on the inclusion in *WBA I* of a small number of primary, historical documents about birth control, abortion, and gay Americans at the turn of the century.

In early February 1995, Voyager issued a press release about Apple's attempt at censoring the past. Although some of the initial press coverage was favorable, prominent media outlets depicted the controversy as another battle in the culture wars that were raging in the mid-1990s.

At this point, the authors decided to fight back. The board of directors of the ASHP asked people to e-mail and write to Michael Spindler, the president of Apple, suggesting that the company reconsider its decision. The *WBA I* e-mail campaign proved effective, and Apple did continue *WBA I* in its bundle for the next several months until it quietly dropped it in the fall of 1995. By that point *WBA I* CD-ROMs had been bundled with more than 80,000 Macintosh computers ordered by school systems across the United States.

But the more long-lasting threat to CD-ROM projects like *WBA I* turned out to be technical and commercial rather than political. Voyager, the pioneer publisher of high-quality CD-ROMs, experienced sharp losses, part of the overall demise of CD-ROMs as a publishing medium. In 1997 it stopped producing new titles and sold its existing list, including *WBA I,* to a New York–based new media company, Learn Technologies Interactive. Even more important was the emergence in the mid-1990s of the World Wide Web as a new venue for digital works. In June 1993 there were only 130 websites in the world; soon enough there were thousands, then hundreds of thousands, and then millions of websites and webpages.

Despite the shift to the web, ASHP (in collaboration with the Center for History and New Media at George Mason University) continued its work on a sequel to *WBA I,* which would cover the years 1914–1946. That project got under way in 1995 with support from the Rockefeller Foundation and the National Endowment for the Humanities, and the original authorial and production teams began research and writing. The project moved slowly for a combination of technical and commercial reasons. It was no longer viable to produce a CD-ROM exclusively for the small (and shrinking) Macintosh market or to develop a product simultaneously in two different programming environments (HyperCard and ToolBook). At the same time, no sophisticated cross-platform tool yet existed that would work with a complex multimedia-rich and text-rich electronic book like *WBA I.* In addition, the demise of Voyager required ASHP to find another publisher. Finally, in the fall of 1998, Night Kitchen (headed by Robert Stein, formerly of Voyager) began to release alpha versions of TK3, a cross-platform electronic book authoring tool. In December 2000 *WBA II* was published by Worth Publishers (a traditional publisher that also brought out a second edition of the *Who Built America?* textbook) almost simultaneously with the release of TK3. The *WBA II* authors were able to take advantage of significant improvements in color monitors, chip speed and storage capacity, and the ability to compress and play large multimedia files.

The *Who Built America?* series had a broad impact on educational multimedia, including resources, interface, and reader tools. The notion that multimedia resources and excursions can deepen and broaden student and public learning about the past has become the conventional wisdom.

Roy Rosenzweig
Steve Brier

See also

Crossroads Project; Social Studies and Technology (K-12 Education); Technology in K-12 Schools

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Wireless Networks

Wireless networks allow computers and other electronic devices to communicate with each other using signal transmissions through the air rather than through a wire or other physical link. Information such as voice, video, and data can all be transmitted over wireless networks. Cellular telephone networks, wireless local area networks, satellite-paging networks, radio networks, and even cordless phones with a base station are common examples of wireless networks. Wireless networks most commonly use radio waves of specific frequencies. But other frequencies in the electromagnetic spectrum are also used for wireless networks, including infrared. Wireless networks have opened new mobility options for people as they move about the world as long as they stay within the coverage area of their wireless network.

Wireless networking is not new. Cavemen uttered sounds to communicate over short distances. Indians used smoke signals to communicate over longer distances. Wireless communication started in 1898 with the first wireless telegram system. What is new is the use of wireless networks to transmit data in digital form over radio waves. When wireless networks are mentioned today, people are generally referring to systems that use radio waves to carry information between two devices using a transmitter and a receiver. Cellular telephone systems are the most common wireless network today. Growing in popularity is the use of wireless technology for computer networks forming wireless local area networks (WLANs). The remainder of this entry is specific to WLANs.

Wireless local area networks have been commercially available for more than a decade and have now reached mass-market adoption due to several factors, including the standardization of the technology, plummeting costs, increased communication speed, and the mobility it provides users. WLANs are not yet replacing wired networks in schools and businesses, but they are extending the wired local area networks that are already in place. It is common today to find wireless area networks as the only network medium in homes and some small businesses.

The most common WLAN standard is the IEEE 802.11 Ethernet standard that allows computing devices to communicate using the Internet protocol just like over a wired network. Standards allow wireless devices from multiple manufacturers to work together. Today North American and European wireless standards for computer networks and for cellular telephone networks exist independently, but international standards are expected to emerge, allowing people to roam about the planet in a more seamless communication system.

Wireless networks can be deployed almost anywhere using access points and wireless network cards. Wireless access points are installed to form the coverage area, much like cell towers, but are generally within 50–200 feet of one another. Each access point is attached to a power source and generally to a wired Ethernet. Wireless network access cards are installed into computers and other mobile devices to allow people to communicate wirelessly with the access points. Wireless devices can even be made to form ad hoc networks between themselves, not involving an access point.

The speed of the first WLANs a decade ago was only 1 to 2 megabits per second (Mbps). The next generation and still common WLANs are based on the IEEE802.11b standard operating at 2.4 gigahertz (GHz) and providing a communication speed of 11 Mbps, about one-tenth the speed of wired Ethernet at 100 Mbps. The speed of these wireless networks is fast enough for e-mail, web surfing, and voice transmissions. The newest WLAN speed using the IEEE802.11a standard can transmit at the rate of 20 Mbps on a 5 GHz frequency band, enough speed for flicker-free digital video. However, the total available bandwidth of a wireless network is shared among the number of users on the network at any one time. Rules of thumb exist among WLAN designers revealing practical limits on the number of concurrent users of each wireless access point (e.g., fifty casual users checking e-mail or five power users downloading files).

Security is a serious issue to consider when deploying wireless networks. Limiting who can access the wireless network and keeping the information secure as it is transmitted are of primary interest. Security technologies exclude casual use by people who move through the wireless coverage area and continue to be developed to outpace network hackers. Data encryption techniques, called wireless equivalent privacy, are built into wireless networks to keep information secure. Wireless networks can be made to be reasonably secure for schools and businesses by using multiple and layered forms of security to make unauthorized access more problematic and less likely.

Because wireless networks use electromagnetic waves to transmit information, the frequency of the wave and the power of the transmitter are defined within strict safety regulations in the United States and in other countries. The 2.4 GHz and 5 GHz transmitters operate at extremely low power (no more than 1 watt and typically about 100 milliwatts in the United States) and are not considered to be a health risk.

One of the most visible technical challenges to users of wireless devices is battery life in powering the mobile wireless devices. Plugging into a network may be a thing of the past, but frequent battery changes or charges will become a commonplace need of wireless mobile users. The need for increased battery life is being addressed as incremental improvements are being made (Wiberg and Ljungberg 1999).

The technical challenges of wireless networking are being addressed. User acceptance is accelerating. The next challenges brought about by wireless networks will likely involve social and behavioral issues brought about by the technology. We have faced some of these issues. For example, a mobile phone call is technically possible whenever a wireless connection can be established by the phone, but social mores now limit the times and places in which a cellular call is acceptable and when it is not. Just as users of e-mail now understand when e-mail is and is not appropriate as a communication medium, users of wireless networks will learn the difference between when access is possible and when it is appropriate. As access to people and information become disassociated with our location in space and time, we will need to place nontechnical limitations on our use of wireless networks to suit the contexts in which we live.

The future of wireless networks is bright. Wireless networks in general are fueling a second digital technology revolution to follow the Internet revolution of the 1990s. Wireless devices will not only allow people to move about their environments while maintaining connectivity to information and other people; they are allowing people to invent new ways to interact with others using software applications on mobile wireless devices. The rate of adoption of wireless products is increasing exponentially and may grow at least twofold by 2007; millions of people will adopt wireless local area networks every year.

The idea of ubiquitous computing through wireless mobile devices allows people to communicate with each other and to access information without having to be in a specific location. The major implication is the decoupling of one's location (e.g., an office, home, or classroom) from the information needed. Prior to wireless networking the only reason to fix the location of people and the information needed was the fixed location of the communication tools linking the user to the information (Perry et al. 2001).

In the world of wired computers and phones, users had to plan ahead when traveling away from the devices by remembering to bring needed information with them on paper printouts (for visually accessed information) or on digital media (magnetic disks, CD-ROM, DVD, memory sticks). In a wireless environment, users instead will need to think about what wireless-enabled devices may be needed to access and view the information transmitted across the network. Part of this planning process will be the user's knowledge of what type of wireless networks are available and the extent of the coverage area of the networks. With this information ahead of time, users of wireless devices will be able to plan on what information and required access and display devices will suit them best before leaving the desktop in a process of "planful opportunism" (Perry et al. 2001). Users of cellular phones know this planning process well, particularly in the past when they had to remember where the cellular network was not available during travel (and, of course, to bring the cell phone along).

Wireless networks can connect many types of devices in an ever-growing set, including desktop computers, printers, laptops, tablet PCs, personal digital assistants, printers, projectors, and telephones. Users will now need to think about what wireless device suits their information and communications needs. The decision of what device to use when will depend more on the type of information being retrieved or transmitted. Some information can be accessed and understood with audio only (e.g., a voice call), whereas other information (e.g., an image or a spreadsheet) will be better accessed through a wireless devices with a large, color display (O'Hara et al. 2001). The merger of features and forms in wireless devices is happening today. Wireless networks may soon link a myriad of devices embedded in light switches (to monitor power consumption), in bread wrappers (to monitor shelf life and pantry stock), and across lawns (to measure moisture content). What wireless devices will look like in the years to come is difficult to speculate, but it seems clear that multiple, overlapping, and intercommunicating wireless networks will be a more integral part of our future.

Christopher Starr

See also

Handheld Technologies

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Glossary

asynchronous communication Literally, not synchronous, not at the same time. Asynchronous communication is characterized by time-independence, which means that the sender and the receiver do not communicate at the same time or when there is a time delay between a message being sent and received. E-mail and voicemail are two popular examples, but the term is also used to refer to the digital communication between computers, where data is transmitted and received via packets at different times. Asynchronous learning networks are education and training modules or courses where students learn in a self-paced manner, in contrast to synchronized communication in traditional classrooms or electronic classrooms.

bandwidth The data-carrying capacity of an electronic channel such as network wiring, fiber-optic cable, or wireless transmission. Bandwidth is measured in terms of how much data the channel can transmit in a given amount of time; in computers, this is measured in bits-per-second, and in telecommunications frequency, measured in cycles per second (hertz). The greater the bandwidth, the faster the rate of data transmission.

bot Short for “robot”; an automated software program used to carry out programmed tasks. Bots are often found in electronic chat rooms where they assist visitors in carrying out routine tasks. A WebBot is a smart object that can be inserted into a website to perform automated tasks that otherwise would require actions from the user. WebBots can help set up interactive chat rooms, record and verify activity, and perform calculations, among other things.

broadband A common but loosely defined term referring to digital channels capable of conveying data at very high rates; examples include broadband wireless and Internet, digital subscriber line, and cable TV. Broadband typically means a channel with a capacity to transmit data over 256 kilobits-per-second or frequencies greater than telephone lines. Sometimes referred to as "wideband," both terms are the opposite of "narrowband," such as a typical telephone line. Broadband is also used to refer to the networks capable of delivering high bandwidth. Broadband networks are used by cable television and range from 550 megahertz to 1 gigahertz. A single TV channel requires 6 megahertz. In a digital format, all content is digitized, and so bandwidth is usually measured in bits-per-second.

CD-ROM Compact disc-read only memory; a storage medium that uses digital and optical laser technology for writing and reading data. The CD-ROM has a smooth surface with pits in it, read by a laser. Data is created in a binary format by depositing material to the pits to dull reflectivity, creating contrast that can then be read by the laser. Most CD-ROMS can only be read and used, not erased or modified. A typical CD-ROM is slightly more than five inches in diameter and capable of storing about 650 megabits of text, images, audio, and video data. Note that "disc" is spelled with a "c" not a "k," as in floppy disk, indicating it is read-only. Newer disc drives called burners are capable of writing to CD-ROMs (known as CD-Rs for compact disc-recordable) or rewriting to CD-RWs (compact disc-rewritable).

chat room A virtual space (not physical but with the appearance of reality) that allows users to have synchronous conversations that take place using the Internet. A chat room is a website, part of a website, or part of an online service such as America Online that provides a venue for communities of users with a common interest to communicate in real time. Chat-room users sign up for a selected chat room, create a user name and password, and then log in to a chat room of their choice. Usually there is a list of the people currently "in the room," who are notified that a new visitor has entered. To chat, users type a message into a text box, which becomes immediately visible in the larger community message area; other users can then respond.

digital formats Digital formats exist in only two discrete states, on and off (binary; charged or not; positive or negative; one or zero). A digital signal is transmitted using discrete steps in voltage rather than frequency, as in an analog signal. An analog signal varies in proportion to what is being represented, compared to digital signals, where information is coded into discrete numerical values Voice and video sources (microphones, cameras) produce analog information; computer equipment produces digital information. Common telephone networks and transmissions are analog, with modems needed to convert or modulate digital computer data to analog form for sending over the network. Digital formats allow synchronous transmission of voice, data, or video through wire, fiber-optic cable, or satellite or over the air.

DSL Digital subscriber line; technology for transmitting data up to fifty times faster than current analog or dial-up modem and integrated services digital network (ISDN) alternatives. DSL services are usually provided by local telephone companies that are in competition with cable and satellite service providers. At present, there are two major DSL technologies: asymmetric digital subscriber line (ADSL, or ASL) and high rate digital subscriber line (HDSL). ADSL technology provides higher download speeds (6 megabits per second) than upload speeds (640 kilobits per second).

e-mail Electronic mail, or the electronic exchange of messages to and from computer users. E-mail has grown exponentially since its origin as one of the original features of the Internet, and it has become a primary communication method for personal and business use. Using an e-mail program, users can write, send, receive, forward, store, and delete e-mail messages. A mail server is a computer or portion of a computer that is dedicated to users' mailboxes and messages and is usually maintained by an Internet service provider.

Ethernet A network protocol created by Robert Metcalf at Xerox's Palo Alto Research Center and developed jointly by Xerox, Intel, and Digital Equipment Corporation. The Ethernet allows computers to communicate and share software, data, and peripherals, and it is the most widely installed local area network (LAN) technology. An Ethernet LAN typically uses coaxial cable or special grades of twisted pair wires (similar to telephone lines but containing eight rather than two wires). The most popular Ethernet systems are called 10BASE-T and provide transmission speeds up to 10 megabits per second (Mbs). Fast Ethernet or 100BASE-T provides transmission speeds up to 100 Mbps and is typically used for LAN backbone systems (the main network that carries the majority of the traffic). Gigabit Ethernet provides a higher level of backbone support at 1 gigabit per second (1 billion bits per second).

feedback Broadly, the way that information concerning activity in one area of a system is "fed back" to another area, where, if necessary, actions can be taken in response to this feedback. In the educational technology field, feedback is used to refer to communication between the instructor or system and the learner resulting from an action or process. Using various types of computer-mediated communication such as e-mail, bulletin boards, and discussion groups, instructors can provide immediate feedback to learners' questions, submitted work, and conversations.

FireWire FireWire is an industry standard for data transmission, also known as IEEE 1394 (the Institute of Electrical and Electronic Engineers is an organization responsible for many network protocols). FireWire technology allows very fast: 400 megabits per second (Mbs) transfer rates, compared to the universal serial bus, which has transmission speeds up to 12 Mbs, and the small computer system interface, which has transmission speeds of 2–40 Mbs. FireWire is popular for attaching external devices such as digital video cameras, scanners, and hard drives and for its ability to allow sixty or more devices to be daisy-chained together. It is also gaining popularity because it allows a single plug-and-socket connection and hot swapping or connecting/disconnecting devices without turning off the computer. The first products to use FireWire include digital cameras, digital videodisks, digital videotapes, and digital camcorders.

FTP File transfer protocol is an Internet standard that allows the exchange of files with other computers by specifying the formation of data packets, addressing schemes, and routing behaviors that make interconnection within computer networks possible. An FTP program is an application program that uses TCP/IP protocol to allow users to move files from a distant computer to a local computer using a network like the Internet. An FTP server is a computer that allows users to upload and download files using FTP. An FTP site is a collection of files including text, graphics, audio, video, and program files that reside on an FTP server.

Gopher A menu-based system for browsing Internet information that allows an inexperienced user to access various types of data residing on multiple hosts in a relatively effortless fashion. Popular for several years, especially in universities, Gopher was a step toward the World Wide Web's hypertext transfer protocol (HTTP). With hypertext links, the hypertext markup language (HTML), and the arrival of the graphical browser Mosaic (which later became Netscape), the World Wide Web quickly surpassed Gopher. Many of the original file structures, especially those in universities, still exist and can be accessed through most web browsers because they continue to support the original Gopher protocol.

groupware Programs that allow people to work together collectively without sharing the same location. Groupware programs can include the sharing of calendars, collective writing, e-mail, databases, electronic conferences with each person able to see and display information to others, and other activities. There are four facets of groupware technology that distinguish the types of programs from one another. Groupware users can work together at the same time (real-time, or synchronous) or at different times (asynchronous). Groupware users can also work together in the same location (collocated, or face-to-face) or in different locations (noncollocated, or distance).

GUI Graphical user interface (pronounced “gooey”); a picture-like control panel or screen (as opposed to a text-based screen such as DOS) that makes a computer or presentation system easier to use. Both Macintosh and Windows desktop environments are example of GUIs. GUIs are designed to allow the user to execute commands by pointing and clicking on icons or text rather than typing in commands and codes.

HyperCard An easy-to-use yet powerful multimedia authoring program. Created by Macintosh, it enables users to author hypertext pages, known as cards, without any programming knowledge. A set of cards, known as a stack, can be linked together to allow readers to navigate through the stack in a nonlinear manner by clicking on buttons or objects associated with an action script. Not to be confused with HyperStudio, a similar multimedia authoring program created by Roger Wagner.

hyperlink On the web and other hypertext systems, the term “hyperlink” is a synonym for both “link” and “hypertext link.” Hyperlinks function like a built-in bridge to another location, are activated by a click with the computer’s cursor, and allow the user to navigate quickly through a website or page. The hyperlink can take the user to a webpage on a different website (absolute link), to another page within the current website (relative link), to a location within the current page (anchor/tag), or to an e-mail program opened with a new message addressed and ready to write and send.

hypermedia A term derived from “hypertext”; magnifies the meaning of the hypertext link to include links among any set of multimedia objects, including text, audio, graphics, video, and virtual reality. A hypermedia document is an electronic document that contains hyperlinked multimedia objects that connect to other documents or locations within the document. Hypermedia allows the user more control over the interaction with media, permitting nonlinear progression through the material.

Internet The world’s largest electronic network; often confused with the World Wide Web. The Internet connects millions of educational, government, and business institutions as well individuals and smaller organizations using modems, telephone lines, and other communication devices and media. Originally developed as a project named ARPANET by the U.S. Department of Defense Advanced Research Projects Agency, it enabled scientists at separate locations to share information with one another. Essential to its operation was the feature that it could continue to operate even if part of it was disabled or destroyed. The Internet is the virtual space in which users send and receive e-mail, log in to remote computers (telnet), browse databases of information (Gopher, WWW, WAIS), and send and receive programs (FTP) contained on these computers. It is also the physical collection of networks interconnected by a set of routers that allows them to function as a single, large virtual network.

Internet videoconferencing Internet videoconferencing, in contrast to compressed video or microwave satellite feeds, utilizes the Internet infrastructures to synchronously send and receive transmissions. Most Internet videoconferencing programs offer full-color video feeds, chat windows for instant messaging, and a whiteboard for nontyped communications (e.g., drawings, diagrams, etc.). Because potentially a large amount of data is transmitted both ways, bandwidth—the amount of data that can be transmitted in a given amount of time—will be the main determinant of audio and video quality.

intranet A private network that is contained within an enterprise that utilizes Internet protocol for in-house data, voice, and video distribution. It may consist of many interlinked local area networks and also use commercial lines in the wide area network. The main purpose of an intranet is to share an organization's information and computing resources among its members. Like the Internet, an intranet can also be used to facilitate working in groups and for teleconferences. An intranet uses transmission control protocol/Internet protocol (TCP/IP), hypertext transfer protocol (http), and other Internet protocols and in general operates like a private Internet.

ISP Internet service provider; an organization that provides Internet users with access to the vast infrastructure of the global network via telephone lines, cable, and wireless modems. Many ISPs also provide technical assistance to educational organizations looking to become Internet information providers by helping them place information online and providing other services to connect schools to the Internet. There are two basic types of ISPs, local and national.

listserv A software program for connecting and automating mailing lists and discussion groups on a computer network over the Internet. Strictly speaking, a listserv is a software program used to manage mailing lists, not the list itself, which it is often confused with. A mailing list is an e-mail address that is actually an alias for a “reflector” that automatically distributes received e-mail to a list of “subscribers.” Users often say they belong to a listserv when actually they are subscribed to a mailing or “distribution” list being operated by any one several listserv programs.

microwave technology The term “microwave” refers to electromagnetic energy having a frequency higher than 1 gigahertz (billions of cycles per second), with a wavelength shorter than 30 centimeters. Microwaves are used for data, voice, and potentially all types of data transmission. Microwave signals propagate in straight lines and thus do not readily diffract around barriers such as large objects. Some degradation or attenuation of the signal occurs when microwaves pass through trees and buildings. The microwave band is well suited for wireless transmission of signals having large bandwidth, which translates into high-speed data transmission. The short wavelengths allow the use of dish antennas having manageable diameters.

multimedia In the context of educational technology, typically the combination of text, sound, and/or motion video for instructional purposes. Multimedia can be distinguished from traditional media by the scale of the production (multimedia is usually smaller and less expensive) and by the possibility of user interactivity or involvement (interactive multimedia). Interactive elements can include voice commands, mouse manipulation, text entry, touch screen, or video capture of the user.

newsgroups An online discussion about a particular subject consisting of notes written to a central Internet site and redistributed through Usenet, a worldwide network of news discussion groups. Newsgroups are divided into subject hierarchies, with the first three or four letters of the newsgroup’s name identifying the major subject category, with subcategories represented by a subtopic name. Many subjects have numerous levels of subtopics. Some popular subject categories are alt (alternative), biz (business), rec (recreation), sci (science), and comp (computers). Users can post to existing newsgroups, respond to previous posts, and create new newsgroups. A list of frequently asked questions (FAQs) is provided and basic rules (netiquette) can be found when one enters the newsgroup. Some newsgroups are moderated by a designated person who decides which postings to allow or to block, but most are not.

online discussion “Online” is the state in which a computer is connected to another computer or server via a network, in contrast to offline, when it is not. An “online discussion” is one that uses a computer communicating with another computer, usually at the same time (synchronous) but may be delayed (asynchronous). Online discussions are designed to facilitate interaction and collaboration among people who share common interests and needs and allow users separated by time and space to communicate.

online instruction The delivery of educational content via a web browser over the public Internet or a private intranet. Online instruction often utilizes other learning resources such as reference materials, e-mail, bulletin boards, and discussion groups. Online instruction also may include a facilitator who can provide course guidelines, manage discussion boards, deliver lectures, and so forth. When used with a facilitator, online instruction offers some advantages of instructor-led training while also retaining the advantages of computer-based training.

PDAs Personal digital assistants; also known as handhelds or personal information managers. PDAs are handheld computers that contain software such as calendars, address books, and notepads to help users organize information such as appointments and task lists; they provide computing and information storage and retrieval capabilities for personal or business use. Most PDAs have a small keyboard; some have an electronically sensitive pad on which handwriting can be received. PDAs are often combined with telephones and paging systems.

presentation software Software used to create electronic presentations that are used to communicate ideas, messages, and other information to an audience. These presentations can be viewed as slides and displayed on a larger monitor or on a projection screen. Presentations can take advantage of multimedia and hypertext, creating richer displays of information and engaging more viewers in more dynamic ways.

print technologies There are two basic types of printers: impact and nonimpact. Impact printers, such as dot-matrix printers, work like typewriters: Tiny pins strike an ink-soaked ribbon and transfer the ink to paper. Nonimpact printers include inkjet/bubble jet and laser printers. Inkjet/bubble jet printers work by spraying ink onto a page out of tiny nozzles that are activated by either heat (thermal) or electricity (piezoelectric). Laser printers operate similar to a copying machine, using a powdered ink (toner) dispensed from a cartridge. When electrically charged, the toner adheres to a rotating drum from which it is then transferred to paper.

Dot-matrix printers are inexpensive, usually using continuous-form sheet paper, but lack the speed and quality of nonimpact printers. Inkjet printers are relatively inexpensive, and some are capable of printing photograph quality images on standard paper. Laser printers produce the highest-quality prints at high speeds, but laser printers and replacement cartridges can be expensive.

programming language A series of instructions and actions that tells the hardware of the computer (e.g., logic board, CPU, hard drive, memory, etc.) how to perform a specific task. Programming languages are artificial languages in which very strict syntax and semantics are used to communicate software actions and instructions to the machine, providing the interface between the computer hardware and the software applications the user works with. Simpler programming languages can be used to teach problem-solving skills, such as Seymour Papert's Logo, which can be used by children to create personal learning environments.

satellite A specialized wireless receiver/transmitter that orbits the earth in altitudes ranging from 200 to 2,000 miles. They are used for such diverse purposes as weather forecasting, television broadcasting, Internet communications, and the increasingly used Global Positioning System. There are two basic types of commercial satellites: geostationary and low-earth-orbit (LEO). A geostationary satellite orbits the earth at an altitude of 2,237 miles directly above the equator. At this altitude, one complete trip around the earth takes twenty-four hours, enabling the satellite to remain over the same spot at all times. One geostationary satellite can scan about 40 percent of the earth's surface. Three geostationary satellites, spaced at equal distances apart, can provide coverage of the world's entire population. A LEO satellite system employs a large fleet of "birds," each in orbit at a constant altitude of 200 miles or so. Each orbit takes approximately an hour and a half to a few hours. The fleet is arranged in such a way that, from any point on the surface at any time, at least one satellite can be accessed from the ground.

SGML Standard generalized markup language; an international standard created by the International Organization for Standardization for the publication and delivery of electronic information. SGML was created to extend the depth and breadth of HTML (hypertext markup language), the default language of the World Wide Web. SGML is considered a metalanguage, which means a language capable of describing another language, in this case, a markup or encoding language such as HTML. SGML is commonly used for publishing printed documents and commercial data CD-ROMs and is considered to be a very efficient way to store and retrieve data, with the promise of greater longevity for archival purposes.

storage devices Hardware devices used to record, store, and retrieve data, instructions, and information to and from a storage medium. Common storage devices using removable media (in contrast to nonremovable media, such as hard disks) include floppy disks, ZIP disks, CD-ROMs, DVD-ROMs (Digital Versatile [or Video] Discs), and magnetic tapes. With current laser-guided heads, or “flopticals,” much greater accuracy and capacity are possible during both read and write sessions. Original floppy disks were 8.5 inches and were capable of storing only 200 kilobits of data, whereas current DVDs can store an average of 4.7 gigabits, with newer double-sided versions storing up to 18 gigabits (in contrast to 650 megabits on a typical CD-ROM or 1.4 megabits on a 3.5-inch high-density floppy disk).

streaming media The most common way to play media files (audio and video) from the Internet is to download them to a local computer and then launch a plug-in or applications program to execute the media file. With streaming media, audio or video files play in real time without having to wait for full downloads of the files. In general, streaming media playback is of lower quality than download playback, but streaming eliminates the need for storage space in a local computer. “Pseudo” web streams are a hybrid of the two options: streaming and download playback. Pseudo-streaming downloads a portion of a file to the computer’s memory (called buffering) sufficient to play it back in better quality than with real-time streaming. Popular video pseudo-streaming programs can be launched as plug-ins to browsers, allowing users to watch the streaming media files without launching a separate program from their browser.

streaming video The transfer of video data in a continuous and even flow (in contrast to downloading the data and saving it to a local drive), allowing a user to view video images as they are being downloaded. Streaming video is a sequence of dynamic images that are sent in compressed form over the Internet and displayed by the viewer as they arrive. The user needs a player, which is a special program that uncompresses and sends video data to the display and audio data to speakers. A player either can be an integral part of a browser or downloaded from the software maker’s website.

synchronous communication Occurring or happening at the same time (in contrast to delayed, suspended, or asynchronous communication). Synchronous communication allows a user to see what another person is writing as he is writing it. Popular programs utilizing synchronous communication include Internet relay chat (IRC) and virtual communities created using MUDs (multiuser domains) and MOOs (MUD, object-oriented application). Synchronous communication also refers to the medium of communication in which data are sent in blocks or packets, as with e-mail and navigation of webpages, without the need for start and stop bits between each byte. Synchronization is achieved by sending a clock signal along with the data and by sending special addressing to denote the start of each block.

Telnet A program or command that enables a user to connect to a remote computer on the Internet by entering a user name and password. Once connected, the user's computer acts like a terminal directly linked to the remote computer, where all of the computer's operations take place. Telnet then allows users of one host to log in to a remote host and interact as normal terminal users of that host.

touchscreen A monitor that has a built-in touch-sensitive panel on the screen; interaction with the computer occurs when the user touches an area of the screen with a finger or stylus. With a touchscreen, a keyboard and mouse are no longer necessary to enter data and commands. Touchscreens are popular in information kiosks found in large public areas such as museums and airports, where users can touch words, pictures, numbers, and maps on the screen to retrieve information.

voice recognition Voice (or speech) recognition refers to the ability of the computer to interpret continuous speech or other audio commands along with keyboard, mouse, and joystick commands. With the necessary high processor speeds constantly increasing, memory becoming more inexpensive, and the rising sophistication of software, voice recognition software is becoming practical and easy to use. The accuracy of many programs has reached well over 90 percent after training the program to recognize a user's unique voice and dialect, which it stores as a personal profile.

VRML Virtual reality modeling language; an Internet standard for 3-D animations designed to be a more powerful extension of hypertext markup language standard, which has become the default language of webpages. VRML is intended to be supportive of virtual reality in its ability to immerse participants into simulated 3-D worlds for education and entertainment, or the increasingly popular field of edutainment. VRML can bring animation, audio, and 3-D reality to imagined environments and worlds. It can also be used in commercial simulations, allowing a user to be virtually inside and operating a product such as a new model of automobile or in a home that is being remodeled.

World Wide Web A hyperlinking system that creates a point-and-click mode to connecting within documents, link to other documents, and search the Internet. Whereas the Internet was created in 1969, linking the Pentagon to four supercomputing centers at universities, the World Wide

Web was conceived in 1990 by particle physicists (notably Tim Berners-Lee) at the European Organization for Nuclear Research (CERN) in Switzerland. The CERN group developed hypertext markup language (HTML), the web coding language, and the hypertext transfer protocol (http) for reading HTML at websites.

In 1993 there were only fifty websites, used mostly by scientists; this exploded to nearly 10 million sites shortly after Mosaic (later Netscape) added http to its browsers. Web use has grown exponentially in business, entertainment, and education since its advent. Currently, millions of individuals and organizations are setting up websites or homepages, and web publishing is overtaking hard-copy publishing.

XML Extensible markup language; an offspring of standard generalized markup language (SGML). XML is quickly becoming the universal format for structured documents and data on the World Wide Web. Unlike HTML, XML allows creators of webpages and sites to define their own tags and attributes, which are what dictate how webpages appear and act. XML is a subset of SGML but is much simpler to learn and write and promises to take webpage authoring to new levels.

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