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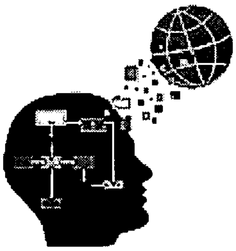
ABSTRACT

This resource provides basic information on five selected topics related to creating and implementing online educational programs. "Adult Learning" (John C. Reid) provides an overview of general learning theories and discusses the characteristics of adult learners, strategies for taking advantage of adults' traits and motivations in creating learning programs, features of ideal adult learning environments, and suggestions for future research. "Computer-Supported Cooperative Work (CSCW)" (Michael Weisberg) examines the attributes of cooperative work, factors that increase team effectiveness, the integration of communication and computer technologies to achieve organizational goals, and computer-mediated communication and "groupware" programs. "Cooperative Learning and Distance Education Online" (Craig Locatis) describes cooperative learning's characteristics, methods, and benefits; examines research that supports cooperative learning; and discusses theories that explain its effectiveness. "Problem-Based Learning (PBL) in the Health Sciences" (Eldon J. Ullmer) analyzes this approach that has a long history in medical education and is staunchly defended by its proponents. A problem-based model is explained, and research on PBL is examined. "Technology Adoption and Diffusion" (Victor Carr) elaborates alternative views and theories of adoption/diffusion, differentiates several categories of technology adopters, and outlines strategies for affecting technology diffusion. (Each article contains 15 or more references.) (YLB)



An Online Education Sourcebook

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Abstract: This resource, a cooperative work by five authors, provides basic information on five selected topics related to creating and implementing online educational programs. The topics are Adult Learning, Cooperative Work, Cooperative Learning, Problem-based Learning in the Health Sciences and Technology Adoption and Diffusion.

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Introduction

The idea that technology is changing the way we work and learn has become a constant refrain in contemporary society. Thus educators, in the health professions and elsewhere, increasingly look to modern technologies to help solve problems that have inhibited learning in the past. Also, advances in cognitive science have altered views of the learning process and of what features effective learning environments ought to embody. And in management circles, collaborative work is now widely seen as a means of improving both individual and group productivity. The mesh of these three forces has provided a modern, and more adult-focused, parallel to education's "three Rs:" the three Ts of technology, thinking, and teams.

The Internet and the World Wide Web, which are the technologies now in the forefront of efforts to improve education, differ markedly from earlier teaching media. They enable users to store, access, display and transmit information in ways never before possible. The Web's multimedia communication and interactive capabilities greatly facilitate the creation of environments for distributed learning and collaborative research and development. Visionaries proclaim its value in creating "knowledge webs," "virtual communities" and "synthetic environments" that enable learners to work independently or cooperatively on distributed simulations or other problem solving programs. Because of these advanced capabilities, expectations that these technologies will meet with more success than previous forms of media did are high.

The effectiveness of a technology-mediated learning system, however, is no better than its embedded pedagogy. Using the World Wide Web or other interactive technology in the manner of "conventional instruction" in which teaching means "covering the material" and assessment means using "objective tests" to measure how much "subject matter" students have "retained" is not a promising prospect. And although the behavioral technology approach places more emphasis on the performance elements of competencies to be learned than conventional methodology does, its dependence on rigorous programmed materials and frequent responses to brief content elements seems a poor fit both for the varied information retrieval and communication capabilities that the Internet and World Wide Web offer.

Not surprisingly, therefore, many educators believe that neither information delivery approaches nor behavior shaping techniques are likely to result in the "robust" knowledge and reflective habits of mind that practicing professionals need to solve the complex problems that are routinely encountered in the "real world."

Fortunately, the insights about teaching and learning gained from recent work in cognitive science seem to provide a much better basis for designing learning environments and experiences. By emphasizing mental processes--thinking, analyzing, creating--and active learning in "authentic" contexts, the cognitive approach has gained wider appeal at the same time that interactive multimedia systems are more able to provide learning environments that facilitate this image of teaching and learning.

Another insight inherent in the cognitive approach is the realization that there is more to instructional design than increasing rigor and redundancy in conventional lessons. Numerous program dimensions must be balanced to achieve an optimum design (cf. Reeves, 1994). A completed learning system thus will manifest a balance between "instructivist" and "constructivist" philosophies, between highly specific goals and broader, general goals, between fixed versus flexible program structures, between limited learner control or extensive learner control, between ignoring or integrating cooperative learning events, and so on. Moreover, cognitive viewpoints have brought about a widely shared image of the ideal learning experience as one that is learner-centered, problem-based, proficiency-focused and situated in an "authentic" context, that is, one that emulates "real world" conditions and requires reflective thinking. Design decisions made with respect to these and other factors have significant implications for student activity, teacher role, and assessment procedures.

Ongoing efforts to reform medical education always face the key questions of what constitutes medical expertise and what mix of subject matter knowledge and patient management skills is essential to becoming an expert practitioner. Those who support a Problem-based Learning curriculum, for instance, hold a markedly different view about when and how subject matter knowledge is best acquired from that held by proponents of the traditional curriculum. The combined thrusts of technology, cognitive science and collaborative work will almost certainly effect current efforts to create a curriculum that better meets the needs of both students and the profession. Not surprisingly, the effort to simultaneously keep the curriculum current, to incorporate new thinking about pedagogy into learning designs, to employ modern technologies to their fullest potential, and to achieve widespread adoption of the resultant innovations is proving to be a formidable one.

The five chapters that follow are intended to support this important undertaking.

In the first, John Reid examines adult education issues. Following an overview of general learning theories, he discusses the characteristics of adult learners and strategies for taking advantage of adults' traits and motivations in creating learning programs. Features of ideal adult learning environments and suggestions for future research are discussed.

Michael Weisberg follows with a general overview of computer supported cooperative work (CSCW) in which he examines the attributes of cooperative work, factors that increase team effectiveness and the integration of communication and computer technologies to achieve organizational goals. Computer-mediated communication and "groupware" programs also are discussed.

Craig Locatis provides an in-depth look at cooperative learning and its implementation issues. His review describes cooperative learning's characteristics, methods and benefits. Research that supports cooperative learning is examined and theories that explain its effectiveness are discussed.

Eldon Ullmer presents an analysis of problem-based learning (PBL) in the health sciences. This approach has a long history in medical education and is staunchly defended by its proponents. A problem-based model is explained and the research on PBL is examined.

Victor Carr concludes the set with a discussion of technology adoption and diffusion. Alternative views and theories of adoption/diffusion are elaborated and several categories of technology adopters are differentiated. Strategies for affecting technology diffusion are outlined.

Eldon J. Ullmer

Adult Learning

John C. Reid

Adult learning theories are based on the belief that adults have had different experiences than children and adolescents and that these differences are relevant to creating ideal learning environments for adults. But while age is certainly a factor that can affect learning, motivation, prior knowledge, the learning context and the influence of situational and social conditions are others. Moreover, most principles of learning derived from studies of children and adolescents also can be applied to adults. And many research findings from cognitive psychology and social learning studies done with adolescents are undoubtedly relevant to the creation of learning experiences for adults. Still, the work of adult learning theorists, notably Malcolm Knowles, K.P. Cross and Carl Rogers, makes a convincing case that those who design adult learning environments should consider both the general principles of learning that apply to learners of any age and those factors said to be unique or especially applicable to adult learners. The following sections examine some general perspectives on learning that apply to both adolescents and adults, describe certain factors that apply to adult learners in particular, and explore factors that motivate adult learners. The chapter concludes with a brief summary of attributes thought to comprise the ideal adult learning environment and a set of questions for further study.

General Perspective on Learning

The worth of a learning theory rests in its capacity to fairly represent the learning process and to give direction to research that, through its findings, can guide the design of instruction. Although dozens of theories that purport to do this to some degree have been proposed, when classified according to an underlying psychology, most appear to be grounded in either a behaviorist, cognitive or social development perspective. Recently Sfard (1998) proposed another basis for grouping theories and categorizing research based on a distinction between acquisition and participation metaphors for learning. The acquisition focus, Sfard claims, has long dominated the study of learning and is evident in such commonly used terms as fact, concept, knowledge, schema, material and contents.

Gagne (1985), for example, based his Conditions of Learning model on the premise that there is a definitive set of learned capabilities which may be the outcomes of instruction. These include verbal information, intellectual skills, and cognitive strategies as well as attitudes and motor skills. These outcome types form the basis for both sequencing learning and devising appropriate conditions for learning. Each item to be learned has its place in a hierarchy, and each requires its particular "event" to ensure learning. Each event, in turn, has its corresponding cognitive process.

Another well-known theorist, David Ausubel (1978), maintained that meaningful material is represented and organized in the mind differently than rote material, and that meaningful content therefore should not be taught by rote methods. Ausubel saw the "subsumption" of newly-received content within existing cognitive structures as a central aspect of verbal learning and recommended the use of "advance organizers," which are inclusive, but general, explanations given in advance of the main body of content. He also emphasized the importance of "anchors," which can be stories, problem cases, key questions, or other statements that provide common reference points for all students. Anchors, he suggested, should be sprinkled throughout a program to help students link new material to what is already known. Designers who follow either a Gagne or Ausubel model organize content in the most rational way possible and present it to the learner. This systematic approach to presenting material differs considerably from the constructivist approach (see below) in which the designer presents a problem and offers resources from which learners are to dig out the material for themselves.

Bandura's (1986) social learning theory holds that people acquire knowledge by observing and imitating others who model procedural or cognitive tasks, attitudes, beliefs, or other behavior. Designers can capitalize on the power of Bandura's social learning theory by first motivating students to recognize the importance of a procedure, then employ videoclips or a classroom model to demonstrate the procedure, and finally have students repeat or model the behavior, either individually or in small groups.

Paivio's dual coding theory (Clark and Paivio, 1991), which maintains that humans have roughly equal facility for dealing with imagery and language, is particularly useful to web designers. The recall of images is higher than the recall of words, and when ideas are presented in both visual and textual form, recall is greater than when ideas are presented in textual form only. Mnemonic devices are often built on the power of visualization.

Other theorists whose work reflects an acquisition perspective (Craik & Lockhart, 1972; Van Rossum & Schenk, 1984; Benjamin et al., 1981; Marton, Hounsell, & Entwistle, 1984) explored the difference between learners who process information at a surface level versus those who process it at a deeper level. Surface processors tend to concentrate on facts, while deep processors are superior at retaining the main ideas and the overall organization. Many learners use both surface and deep modes depending on the situation.

Students who are surface processors can be encouraged to develop deeper-processing capabilities by writing summary statements, writing topic sentences, rephrasing content or formulating questions about it, explicitly comparing the new material to what is already known, and explaining the newly-learned material to peers. These activities can be done in groups, or by using listservs, chats, or journals. Designers of instructional material can include prompts that encourage students to do such deeper-processing techniques. And when designing instruction for surface processors, educators could include summaries and check lists to facilitate the acquisition of facts.

Highly didactic acquisition theories may be more applicable at introductory level courses. Constructivist approaches, conversely, may be more applicable in advanced work (Jonassen, Mayes, & McAleese, 1993).

Constructivism has received increasing attention in recent years. In 1932 Bartlett demonstrated that learners distorted or reconstructed prose passages to be congruent with what they already knew. Gardiner (1988) described the generation effect which shows that items that a student generates are better remembered than items she reads. Instructional designers of a constructivist bent make knowledge bases, databases, reference sources, and search tools available to learners so that they may dig out and construct learning for themselves. Learners gather information and then test what they have collected. Through examining what they have learned, they develop metacognitive (reflective) skills. Students get ideas from others, work on problems collectively, and verbalize their findings with each other. Such group discussions ensure that initial misunderstandings that individuals may have acquired in their research are cleared up in the stiff wind of peer comments. The processes of searching, discussing, and assessing are considered as important as knowing facts. Constructivist learning topics typically center around real, authentic problems. Constructivist web pages emphasize resources and collaboration, and deemphasize presenting summaries and explanations.

Cognitive flexibility theory (Spiro, Coulson, Feltovich, & Anderson, 1988) is popular with designers of instructional programs for learning in complex or ill-structured situations. Some problems are difficult to formulate precisely, and some may not have a single correct answer, or any correct answer. In a word, they are "messy." Cognitive flexibility theorists recommend that designers situate problems in multiple settings so that learners may transfer what they've acquired from one setting to another and emphasize knowledge construction over rote learning.

Reviewing learning theories--both those described here and others--suggests that a clean differentiation between acquisition and participation theories is problematic. One can argue that certain covert activities--listening, reflecting--are forms of participation. Moreover, Sfard herself warns of the "danger of choosing just one." Still, the distinction calls attention to some positive aspects of instructional research and design that arguably have not received sufficient emphasis in educational developments.

In response to this perceived need, but without disdaining the acquisition of facts, concepts, procedures and the like as legitimate learning goals, this handbook explores the growing emphasis on learning environments that embody learner-centered education. Inherent in all the papers are the themes of learner initiative, learner choice and learner collaboration in settings that present authentic and challenging problems.

Characteristics of Adult Learners

Adult learners are those who have passed adolescence and include professional or graduate school students plus those who are early in their careers and the elderly.

Investigators have tried to identify attributes that are unique to adult learners, and although some have questioned the results of this effort, others believe that such adult learner characteristics do exist. Four such characteristics are described below: (1) prior knowledge and experience, (2) self-directed learners, (3) critical reflection, and (4) experiential learners.

Prior knowledge and experience. Adults have a greater store of prior knowledge and experiences than adolescents do. Kidd (1973) surmised that adults have more experiences, have different kinds of experiences, and tend to organize them differently than adolescents. Adults typically possess not only more procedural knowledge (knowledge about how to do things) than adolescents, they often have more declarative knowledge (knowledge of facts, concepts) as well, at least in their areas of work and social interaction. Studies indicate that such prior knowledge and experience aids the acquisition of new knowledge and the processing of new information, thus promoting retention. However, in cases where prior learning was erroneous, or long-held knowledge becomes outdated, the acquisition of new knowledge can be hindered by prior knowledge. Cross' Characteristics of Adults as Learners theory (1981) emphasized that adults differ from children both in their personal characteristics (age, life phases, developmental phases, readiness, and self-concept), as well as in situational characteristics.

Because adults' prior experiences vary widely, some teachers bridge the differences in prior experience among their learners by providing anchoring events, realistic problems, case studies, or other situations that provide a common reference for all learners to discuss and analyze. Anchoring events that have a vivid visual metaphor help students build mental models for organizing new ideas. Anchoring events may or may not have a single 'correct' solution.

Differences among adults include cultural, gender, ethnic, and racial differences. This can result in unequal power relationships among members of a learner group with some adults excluded from the "inner" circle. To counter this possibility, designers should ensure that instructional materials exhibit diversity validity by representing a broad spectrum of cultural and gender thinking. This is especially important if lessons are to be appropriate for the potential world audience of the internet.

Students are more apt to learn and retain content when it is meaningful to them. Obviously, material that is outside the realm of learners' experiences and knowledge will be less meaningful. And since prior knowledge and experiences of adults will be more diverse than that of college youth, some adults may lack the expected prerequisite knowledge. Learners should be afforded the means to overcome such deficiencies through access to knowledge bases, introductory material, detailed explanations and links to search engines and external knowledge resources. Links might include suggestions or help of the type that a mentor might offer to an apprentice. Designers should identify what remedial content will be needed by adult learners during the formative stage of developing the web pages. A convenient way to identify difficult areas in the material is to use think-aloud techniques (Ericsson & Simon, 1980).

Instructional designers can facilitate learning by creating programs that draw on students' prior knowledge and experiences, and that help learners connect existing concepts and skills to current needs or problems. Inserting questions in a lesson can enable learners to apply what they have learned to practical, realistic situations. Such questions can elicit factual recall, comparing or contrasting, categorizing, synthesizing, or predicting. Presenting specific problems or applications can connect theory to practical situations. Also, designers may facilitate transfer by encouraging learners to relate verbally what they've learned to prior experiences or to other settings. This verbalization should be an active process involving reflection on and elaboration of the new material.

Self-directed learners. A second supposedly unique feature of adult learning is that adults desire to be self-directed learners. This is a cornerstone of Knowles' (1980) andragogy. Self-directed learning exists when the learner plans and directs the learning (Tough, 1966). Tough (1979) surveyed 66 adults and reported that they planned 70% of their learning activities themselves. Adults, however, do not always follow the explicit steps of a problem-solving model. Brookfield (1986), and Merriam and Caffarella (1991) cited research showing that adult learning is often random and unplanned. Brookfield took strong exception to "institutional" learning in which goal-driven faculty prescribe objectives and instructional modalities with no involvement by the learners. Adults epitomize Tolman's (1932) purposive learning; that is, their learning is strongly purposive and reinforces the value of self-directed learning.

Self-directed learning is related to humanism, the concept that humans can make "significant personal choices within the constraints imposed by heredity, personal history, and environment" (Elias & Merriam, 1982). Maslow's well-known concept of self-actualization and Carl Roger's efforts to let clients work out therapy for themselves are two efforts rooted in humanism and self-direction (Hiemstra & Brockett, 1994).

Several strategies can enhance self-directed learning; Brookfield (1986) recommends the contract as the most effective. Contracts involve the learner in diagnosing needs, planning activities, selecting resources, and evaluating progress.

In addition to learning contracts, a second strategy is to specify clearly what is to be learned and what is expected from learners.

A third strategy to strengthen environments for self-directed learning is to provide activities and techniques for socialization and communication. In a distributed learning environment, students will be geographically dispersed. Brookfield (1986) reported that adult learners rely on others, rather than on their own analytic ability, for much of their information. They prefer peer learning groups for support, stimulation, and new ideas. Designers should add communication features (email, bulletin boards, etc.) to stimulate group support. If the distributed environment is also a cooperative learning environment, then adult learners may actively participate, may verbalize their own opinions, may revise their own learning upon hearing others' views, and may learn disparate perspectives from other students.

A fourth strategy is to provide a democratic atmosphere that encourages participation in making decisions, defining goals, exploring alternatives, specifying activities, and self-evaluation.

A fifth strategy to enhance self-direction is to make the learning available at times convenient to the learner. Some adults work during the day, others work at night. Distributed learners may be spread over several time zones. For adults, some months may be 'slow' while during other months work or family may make heavy demands.

A sixth strategy is to provide access to ample resources for learning. The designer should provide links to selected, filtered information resources. Such resources include the relevant literature, reference works and other salient resources from government, professional associations, universities, and corporations.

Although adults may desire to manage their own learning, their prior experience with didactic, classroom-based instruction may not have prepared them well for self-management. Learning in an environment that is networked, problem-based, and incorporates group participation may be a new experience for many older students. Consequently, a seventh strategy is to enable adult learners to feel confident in this new environment. The teacher or instructional designer may need to incorporate coaching or scaffolding techniques. Various learning devices such as concept mapping, outlining and summarizing can be demonstrated to adult learners.

Critical reflection. In addition to prior experience and desire for self-direction, a third characteristic often attributed to adult learning is the employment of critical reflection. Reflection, or meta-thinking, is thinking about strategies to achieve a goal. An important form of reflection occurs when learners compare their ideas to those of their mentor or to those of other students. Over time, people acquire basic cultural beliefs and ways of interpreting the world. Often such knowledge is assimilated uncritically. Adults can be encouraged to reexamine their basic meaning structures. Educators, for their part, should go beyond teaching factual content and should help adult learners reflect critically on the assumptions and attitudes that underlie their knowledge. Such reflection helps learners become deeper processors. Reflection can be enhanced by group discussion, and by having students write in journals.

Experiential learners. Knowles (1980) contends that adults learn most effectively by experiential techniques; that adults would be better served by discussion, problem-solving, role-playing, case studies, or cooperative environments than by lectures or reading didactic text. Kolb (1984) saw learning as the process (rather than the outcome) through which knowledge is transformed by experience. Typically, those who stress the efficacy of experiential learning also advocate situating learning in authentic environments. Constructivist environments, which are particularly suitable for advanced topics, enhance adults' ability to learn through experience. In a distributed learning environment, necessary communication and group support can be provided via email, newsgroups, and so on. Assuming that adults prefer to learn experientially, then problem-based case studies, simulations, and role-playing are excellent strategies for designers to incorporate. Transfer can be enhanced by having students suggest different situations or applications.

Adult Motivation Factors

Various factors may motivate adult learners. Personal advancement, self-esteem, professional development and pleasure are adult motivators. Well-designed materials that consider these motivating factors are likely to be popular. But social factors, such as making new friends, establishing new relationships and improving one's ability to serve society also can be strong motivators. Learning for the sake of learning, and concomitantly developing a sense of self-efficacy, are other motivators for many adults. A search for stimulation and relief from existing routines of home or work may motivate some learners.

Being aware of the discrepancy between their current proficiency and the desired level of performance can motivate adults to seek additional knowledge or skills (Knox, 1980). Unlike competency-based learning, which emphasizes attaining minimal standards, proficiency emphasizes the attainment of optimal standards of proficiency (Knox, 1986). Adults are also motivated by material having an immediate and practical application.

Mature adults usually have endured marker experiences, such as marriage, divorce, getting a job, being fired, changing careers, etc. These marker experiences (Sheehy, 1976) can provide intrinsic motivation for learning that may be stronger than that of the typical youth. Adults' experiences may create a desire to learn specific skills or knowledge that will be immediately useful. Following Ausubel's advice, useful instruction will build on what the learner already knows, and will be seen to bridge the proficiency gap between what the learner now knows and the desired standard.

Designers who create adult learning programs for internet applications should draw on relevant principles of cognitive psychology and remain sensitive to social and environmental influences in the design process. But the inclination of adults to manage their own learning suggests that they may be more motivated to become self-directed and accomplished learners if they are involved in the planning of the programs and in establishing outcome goals and evaluation methods.

Adult Learning Environments

An ideal learning environment should accommodate various learners' backgrounds and learning styles, and should provide resources to overcome or equalize differing prior knowledge and experiences among adults. These resources could include introductory explanations, on-line references, search engines, dictionaries, and so forth. The environment should provide contracts, objectives, and opportunities to develop social affiliations and to increase participation. In the final course evaluation, educators may find that adult students say that working together and social contacts were the greatest things they got out of a course. Learning environments also should reflect an awareness of the common motivators for adult learners. These motivators include a realization that what is being learned will immediately help in life situations, a feeling of accomplishment, a sense of being appreciated and valued by others, a perception that new knowledge helps close the gap between present skills and the desired standard, and an ability to communicate with others. Such environments should provide authentic, problem-driven learning experiences to help adults to become reflective, self-directed learners with a commitment to life-long learning.

Suggestions for Further Research

The most fruitful questions for technology and distributed learning are likely to build on the solid foundation of previous research in learning. For example, how can we identify the characteristics of effective anchoring events for particular subjects for adult learners? How can we estimate the meaningfulness of new material in our presentation? What tools can we use to help learners elaborate on new material? How can we make the drawing up and evaluation of progress on contracts more automated? What are the most effective implementations of peer communications that we design to enhance participation? Answers to these questions would contribute to the current knowledge as well as make technological presentations more effective.

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Computer-Supported Cooperative Work (CSCW)

Michael Weisberg

Introduction

Significant changes are occurring in the workplace as the result of global economic competition, the emergence of information as a valued product and commodity, and the rapid advances in information technologies, particularly those comprising the Internet and the World Wide Web. These changes generally reflect recognition that: (1) required worker skills and knowledge are frequently in flux; (2) networked communication is increasing organizational flexibility; (3) teamwork and cooperation, rather than competition, enhance the achievement of individual and organizational goals; and (4) work is an environment in which individual, group and organizational learning should occur as an ongoing process. Many organizations are therefore seeking to achieve their goals through the use of computer-based technologies and collaborative tools that amplify the ability of individuals and groups to work together in a process widely referred to as computer-supported cooperative work (CSCW). According to Wilson (1987), "CSCW is a generic term which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques."

This review explains the concept of computer-supported cooperative work and identifies tools and techniques that can enhance the ability of groups to work effectively. The terms cooperation, collaboration and teamwork are used interchangeably. This avoids specifying narrow and restrictive definitions of the group work process and, also, promotes the understanding that the ultimate goals of individuals or groups working together, irrespective of what the process is called, are: (1) to create a product or solution that results from the synergistic powers of an effective group process, and (2) to achieve a measure of new learning (Senge, 1990; Schrage, 1995).

Attributes of CSCW

The various definitions of computer-supported cooperative work share three attributes: (1) individuals or groups engage in teamwork; (2) common goals or tasks are pursued; and (3) computer-based tools or techniques are utilized. These attributes are necessary for collaboration to occur in the workplace. Additionally, for collaboration to be effective, certain conditions regarding the work environment, team effectiveness and the integration of technologies and tools being used must exist (Zack & Serino, 1996).

Work Environments

Work environments that are conducive to teamwork emphasize team efforts over individual competition and foster "shared understanding" of goals. They also support risk-taking behavior, reward creativity, and encourage criticism and debate. Such environments should also recognize and reinforce the crucial link between work-related tasks and the improvement of performance through learning. Work and learning are inextricably bound together within the socio-economic context of contemporary organizations. The notion of stable knowledge/skill sets among workers will soon be outdated and "situated learning" will be the norm as organizations address the need to upgrade workers' skills (Drucker, 1992). This need will require innovative applications of technology-based, work-related learning that occurs in the work environment. Continued involvement in lifelong learning should be encouraged and supported through collaborative networked technologies (including distance learning). The integration of work and learning in the workplace is a subtle but important link that results in mutual benefit for individuals and organizations.

Today's organizations will benefit greatly from encouraging team learning; teams now make almost all important decisions in organizations (Senge, 1995). This occurs either directly or through the need for teams to translate decisions made by individuals into action. As teams learn, they become microcosms for learning throughout an organization. Cooperation and learning among teams can set the standard for learning together for the entire organization.

Team Effectiveness

Team effectiveness is determined by how well group members communicate their shared understanding of crucial tasks, allocate their resources and develop appropriate work strategies. Effective teams apply maximum effort to their work, integrate each member's special skills and knowledge, and monitor progress for continual improvement. Effective team members exhibit behaviors which reflect mutual respect, resource sharing, openness to different viewpoints, high performance standards, and a sense of shared responsibility for the team outcome (Hertz-Lazarowitz, 1992). And most importantly, team members must be able to learn, to develop professionally, and to experience a sense of accomplishment and well-being.

Both individual learning and team learning occur in teams. Team learning is the capacity of the team as a unit to create the results that its members desire through the discipline of shared vision (Senge, 1995). Within an organization, team learning has three critical dimensions. First, team members need to think insightfully about complex issues and to cooperate in ways that exploit the potential synergism of many minds interacting. Second, teams need to engage in innovative and coordinated actions in which team members remain conscious of other team members' activities and strive to complement them. And third, members of a work team may have responsibilities on other teams (Senge, 1995). As a result, work teams can have the responsibility for implementing decisions made by other teams. In this way, cooperative work is instilled as a regular practice within the organization.

Integration of Communication and Computer Technologies

Computer-supported cooperative work invariably involves the integration of general communication technologies and specialized software tools (called "groupware") developed specifically to support the collaborative process. Groupware programs are "computer-based systems that support groups of people engaged in a common task or goal and that provide an interface to a shared environment" (Ellis, 1991). (For a comprehensive list of groupware relevant to computer supported cooperative work, see Brinck, 1997.) Integration results when groupware is used in combination with either asynchronous (delayed) communication applications--voice mail, electronic mail, computer bulletin boards--which store messages, or with synchronous conferences--chat-rooms or MUDs (Multi-user Dimensions--which represent virtual space in which people send messages to each other with an almost imperceptible time delay (Kraut, 1996).

The extent to which the functionality of the technologies and tools augments the ability of people to work together is extremely important. Thus the existing institutional network infrastructure and the integration of tools in the workplace are also very important. Some other important but often overlooked variables that affect the efficacy of communication technologies and groupware for collaboration include: (1) the usefulness of tools (the extent to which they achieve what they purport to do); (2) the usability (ease of use) of the tools; (3) the skills of the participants in using them; and (4) unanticipated effects of using technology (Landauer, 1995).

Computer-mediated Communication

Computer-mediated communication (CMC) is an umbrella term that covers all Internet, intranet and World Wide Web services and applications, including the migration of analog video conferencing to the digital computer desktop. CMC thus embraces all of the communication technologies with the potential to support collaborative work--electronic mail, Internet Relay Chat (IRC), USENET, LISTSERVS, MUDs and MOOs, videoconferencing, virtual reality environments and World Wide Web-based hypertext applications. These communications technologies, which are distributed throughout local and wide area networks, are the most prevalent in use today.

Collaborative Groupware

Although the term groupware is widely used to refer to a form of computer software designed to enable two or more persons to work together in a "shared space," some have extended the definition to include the associated electronic technologies. Either way, CSCW systems, like other communication technologies, are categorized according to a time/location matrix based on distinctions between same time (synchronous) and different times (asynchronous), and between same place (face-to-face) and different places (distributed). For all CSCW systems, however, the key issues encompass group awareness, multi-user interfaces, concurrency control, communication and coordination within the group, shared information space, and the support of open environments which integrate existing single-user applications (Koch, 1997). The effectiveness of groupware programs depends on the extent to which they consider and support these key issues and on how well they facilitate the time/location dimensions of communication.

Groupware should have the capacity for amplifying the potential of shared spaces (Schrage, 1995; Hills, 1997). As the computer becomes the medium for shared space, collaborative computing will have the potential for becoming more persuasive than personal computing. The model of personal computing will shift to interpersonal computing with significant implications for how people interact with computers (Schrage, 1995). An example of this shift is embodied in the notion of the team interface concept referred to as WYSIWIS ("What you see is what I see"). This interface takes us beyond the traditional teleconferencing and whiteboard applications to a new dimension where shared understanding is visual and oral, icons are ideas/objects that can be manipulated, writing and speaking can occur simultaneously, and all participants have equal access to data. Prototype tools based on WYSIWIS have been developed at Xerox PARC, General Motors/Electronic Data Systems, IBM, and NTT Labs in Japan (Schrage, 1995; Honeycutt, 1997).

There are many examples of CSCW on the Internet and World Wide Web that combine general communication technologies and groupware. Some of the most interesting involve medicine or science and embody the concept of a "collaboratory". A collaboratory can be "a center without walls, in which widely separated researchers can perform their research without regard to geographical location, interacting with colleagues, accessing instrumentation, sharing data and computational resources and accessing information in digital libraries" (Barnett, et al., 1996). Collaboratories are also "open meta-laboratories spanning mutliple geographical areas where collaborators interact via electronic means--working together apart" (Kouzes, et al., 1996).

The InterMed Collaboratory is a collaborative project involving six participating medical institutions. One of the main goals of the InterMed group is to demonstrate the feasibility and utility of distributed, network-based collaboration in the field of medical informatics. They will utilize the Internet plus new technologies such as multimedia video conferencing, parallel search, and 3-D modeling running over high speed networks. A primary goal is to develop new collaborative methodologies and tools for advanced clinical medicine, education and research.

Many other collaboratory prototypes for grades K-12, university and professional levels are being developed for doing science on the Internet and World Wide Web (Kouzes, et al., 1996). They may use peer-to-peer collaboration, mentor-student collaboration, interdisciplinary collaboration, and producer-consumer collaboration. Much of the collaboratory technology they utilize is cross-platform compatible. It consists of audio/video conferencing, chat box, shared computer display, shared electronic notebooks, file sharing, online instruments, computation, and visualization, shared whiteboard, and WWW browser synchronization.

Challenges to Computer-Supported Cooperative Work

Developing methodologies and tools for CSCW presents many challenges; some technical and others sociological or organizational in nature. One technical challenge involves demonstrating the functionality required for effective CSCW tools as outlined in this review. The tools that do exist are sometimes immature, lacking in integration, difficult to support, and exorbitant to maintain. Often software tools fail because of lack of user input into the interface design. Some software developers have admitted that their most useful feedback comes from the user. Groupware developers could solve this problem by adopting the concept of "user centered design" as proposed by such eminent design experts as Landauer, (1995), Norman, (1988) and Shneiderman, (1987). Other technical challenges involve lack of standards, cross-platform incompatibility, and low bandwidth. For example, it is difficult to convince users to invest in digital videoconferencing technologies if they are not compatible with systems owned by their collaborators, have insufficient bandwidth for adequate frame rate, and produce low fidelity sound.

Sociological or organizational challenges usually occur when demonstrable proof of the efficacy of collaborative software products and sufficient organizational and monetary support for teamwork and innovation is lacking. If a software product is perceived as adding little or nothing to achieving a desired outcome, or if it has a steep learning curve, it will not be used. The problem of efficacy is inextricably tied to the issue of usefulness and usability. Without organizational support for a robust network infrastructure, tolerance for risk taking and innovation, and peer to peer motivation, useful experimentation with new collaborative technologies will not be forthcoming. And finally, vigilance is required on the part of groupware developers and users to ensure that there is some accountability for the unanticipated and unpredicted effects of technology on individuals and organizations.

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Cooperative Learning and Distance Education Online

Craig Locatis

Introduction

Cooperative learning is one of the most thoroughly researched teaching methodologies. Studies conducted over the past twenty years indicate that the approach has several important benefits. Most cooperative learning research, however, has been conducted in classroom settings and has not involved the use of computers. Cooperative learning studies that have employed computers mainly have focused on their use in classrooms where students interact face to face. And while some studies of online learning have been done, few have employed formal cooperative learning strategies. Consequently, the effects of cooperative learning in contexts where computers mediate communication are largely unknown. The Internet poses new opportunities and challenges for implementing cooperative learning online because it provides utilities that enable students to access information resources and to communicate with each other. Increasingly, computer mediated communications systems and distributed networked information systems, such as the Internet, are being used as ways to provide instruction to individuals who are either geographically dispersed or who need to learn at varied times. But questions remain as to how cooperative learning strategies based on interaction in classrooms can be realized in online settings where students in different places may communicate at different times and interact by means other than face to face. The varied ways that cooperative learning might be implemented in these online settings need to be evaluated.

This review of cooperative learning was conducted to identify implementation issues related to using cooperative learning strategies in online distance learning environments, such as those made possible by the Internet. Cooperative learning's characteristics and methods are described and its relationships to other education constructs are discussed. Cooperative learning's benefits are identified and research supporting the approach is presented. Theories that explain cooperative learning's apparent superiority are discussed and online collaborative learning is differentiated from cooperative learning. Factors that may affect communication and learning cooperatively online are described. Finally, issues and research questions that might arise in implementing cooperative learning in online, distance learning contexts are addressed.

Cooperative Learning Characteristics

To many, cooperative learning means teamwork, but researchers in the field offer more concise, operational definitions. Cooperative learning refers to a compliment of methods and techniques that require students to work with and to support each other, while also discouraging competition (Slavin, 1996; Johnson and Johnson, 1992). Cooperative learning does involve teamwork, but in ways that hold all group members accountable for an individual member's learning (Slavin, 1996). Moreover, cooperative learning can be viewed as both an end and a means of education. Because students must learn to cooperate in the workplace and in everyday life, cooperative learning is a valued educational goal apart from other outcomes. And, as a means, cooperative learning is a way to bring about other educational objectives, such as attaining higher achievement levels. In practice, cooperative learning may be both an end and a means. Students seldom cooperate for the sake of cooperating, but in the process of acquiring knowledge and skills, they also can learn how to work together.

Cooperative learning methods have key common characteristics, namely, group goals, group heterogeneity, and individual accountability. Most cooperative learning methods compel individual members to work together to achieve teams goals (Slavin, 1995; Johnson and Johnson, 1992). They encourage the formation of heterogeneous groups on the grounds that ability grouping only encourages those with higher abilities to exercise their competitive advantage. The idea is to downplay competition while encouraging students with background, ability, gender and ethnic differences to work together (Slavin, 1995; Johnson and Johnson, 1992; Cooper and Muek, 1990). Finally, team activities and assessments are designed so members are accountable for both their own learning and for that of their peers (Slavin, 1995; Johnson and Johnson, 1992). Precautions are taken in structuring assignments and monitoring and assessing performance so those with the most ability, motivation, or conscientiousness do not do all the work. Higher achievers may be required to help lower achievers.

There are additional cooperative learning attributes that are found in only a few methods. Some methods attempt to set equivalent expectations for both low and high achievers by giving all students equal workloads and equal opportunities to contribute. Task specialization in which individuals are assigned different sub-tasks that must be performed to achieve group goals is one means of accomplishing this (Slavin, 1995). Other methods may allow for individual adaptation. While most cooperative learning is paced by the team's shared activities, adapting the sequence and the pace to meet the needs of individual members by, for example, augmenting group work with peer tutoring or individualized instruction is always an option (Slavin, 1995). Some methods may have warm-up activities that reinforce the benefits of working together, or that enable learners to practice social and communication skills that promote trustful, supportive, and helpful relationships (Johnson and Johnson, 1992).

Cooperative Learning Methods

Slavin (1995), King (1993), and Millis (1990) have reviewed the many cooperative learning methods available. The following four representative techniques illustrate cooperative learning's more salient attributes.

Student teams-achievement divisions (STAD). Students are assigned to four-member teams that are mixed on the basis of gender, ethnicity, and performance level. Lessons are presented in a traditional manner, but students work together to ensure that all team members master the material. Students are tested individually and each individual student's score is compared to his or her past average. Team points are awarded based on the degree to which members exceed their earlier performance.

Teams-games-tournaments (TGT). This approach is identical to STAD, except students compete with those in other teams who are at the same performance level. Low and high achievers from each team compete with their counterparts, and the top scorers in these "tiered" tournaments win points for their teams.

Jigsaw II. This approach is like STAD except that each student is assigned expository material and each team member is randomly assigned to become expert in some aspect of the assignment. If the topic is a country, for example, one member might specialize in history, another in geography, another in economics, and so on. Students interact with members of other teams who have the same specialization and then return to impart the content that they have gathered to their teammates.

Team accelerated instruction (TAI). Students study individually but are assigned to teams whose members check and help each other. Students are tested individually, but team rewards are given based on the number of individual assignments and tests that members complete. The method is useful in highly structured subjects where success depends on mastering pre-requisites.

Cooperative Learning and Other Educational Constructs

Although cooperative learning has its own research tradition, it has much in common with several other educational constructs, including constructivism, situated cognition/problem based learning, mastery learning, and adult learning.

Constructivism holds that students learn by constructing their own knowledge and interpretations of the world, and that the constructions are based on publicly shared and agreed upon understandings and meanings. Constructionists see knowledge as a social artifact, not as objective reality, as logical positivists do (Berieter, 1994; Prawat and Floden, 1994). Cooperative learning and constructivism share a focus on socialization in the learning process.

Situated cognition and problem based learning focus on the acquisition of knowledge by solving problems in real world situations, rather than in the abstract contexts. Advocates of situated cognition contend that learning in context provides richer experiences that make knowledge less likely to be forgotten and more likely to transfer to similar situations. Although group work is not a necessary ingredient, those adopting the approach often employ teamwork. Problem based learning in medicine, for example, uses a case-based method in which students are often divided into teams and are held individually responsible for researching and explaining different content (e.g., anatomy, physiology, pathology) relevant to solving a case (Albanese and Mitchell, 1993; Vernon and Blake, 1993). The approach mimics at the professional education level many of the attributes of the Jigsaw II methodology for lower grades.

Mastery learning seeks to ensure that all students master prerequisite skills before progressing to new topics. The method typically provides flexibly paced, individualized instruction so that all students can achieve at high levels. And, to determine when students are ready to progress, it employs criterion-referenced tests that measure what students actually know-- i.e., their degree of mastery--rather than norm-referenced tests that compare students to each other (Block, 1971; Bloom, 1971; Popham, 1978). Cooperative learning shares many of mastery learning's features-- non-competitive assessment methods, accounting for individual differences--but without the emphasis on individualized instruction.

Adult learning focuses on minimizing teacher guidance, maximizing autonomy, and building upon the rich experiences adults already have to help them acquire new knowledge (Knowles, 1980). Even though most cooperative learning techniques have been developed with younger learners (Cooper and Mueck, 1990), they have much in common with adult learning methods that stress exchanges with peers in an environment that is facilitated, not directed, by teachers. Cooperative learning puts more responsibility on students, and some techniques require teachers to assume facilitator roles.

Cooperative Learning Benefits

Cooperative learning approaches are advocated, in part, to overcome the deficits associated with competition and, in part, to provide better learning strategies and attitudes (Slavin, 1995). When norm-referenced testing and "grading on the curve" are used in competitive learning settings, several negative outcomes result. Because students are compared and graded based on a class average, some will pass and some will fail regardless of whether the mean is high or low, and regardless of how much or little they know (Popham, 1978). When some students fail, others look better in comparison. Thus competition establishes win-lose conditions for learning in which success for some comes at the expense of others. The fact that some may continue to fail makes it easier for achievers to succeed, since they only have to perform at a level at or above average. Resentment toward those who constantly overachieve builds and peer norms that impede academic success develop. Students have the predicament of being rewarded by teachers for achievement and by peers for mediocrity. Low achieving students are especially punished because attempts to learn more, if they induce higher achievers to compete harder, will not earn a higher grade. Aspirations then falter, academic work is avoided, and a lower self-image and even antisocial behavior result (Slavin, 1995: Haines and McKeachie, 1987).

Cooperative learning establishes conditions where students must succeed as a team. The criteria for success are defined so students encourage teammates to excel and to assist each other if necessary. This results in more effort to achieve, improved interpersonal relationships, and better psychological health (Johnson and Johnson, 1992). In addition, the techniques take advantage of higher achievers' unique abilities to help lower achievers. Since higher achievers have recently learned the material, they can provide explanations based on the mental elaborations and relationships that they used in learning. These explanations can be more meaningful to their cohorts than those that teachers offer. Since teachers have internalized and compiled content, they often are no longer conscious of the intervening concepts that they generated to mediate their initial learning.

Research Findings

Much research has been done to assess cooperative learning's effects on achievement and other variables. Most studies were done in classroom settings, and only a fraction have employed computers. Slavin (1995) reviewed ninety cooperative learning studies involving significantly long interventions (those lasting longer than four weeks) and employing truly experimental research designs that compared achievement of students learning cooperatively with those learning alone. Over sixty four percent of the studies strongly supported cooperative learning, while only five percent favored controls. Other studies were equivocal and there were wide variations depending on how cooperative learning was implemented. The arrangement of rewards and the structuring of interaction were factors that produced the greatest effects.

Perhaps the greatest achievement effects occur when there are group goals with individual accountability; i.e., when groups are rewarded on the basis of the individual learning of their members (Slavin, 1995; 1996). If only a group grade is given, one or two team members do all the work and there are "free rider" or "social loafing" effects. The free rider effect can be controlled in two ways. One is to assess performance individually and to assign every member of a group a grade that is an average of the performance of all its members. This gives overachievers an incentive to help underachievers rather than do all the work themselves. The second method is to divide the labor and make each member responsible for some component of the work. In this situation, underachievers have social incentives to make contributions to the group. The two approaches can be combined to encourage underachievers to do more and overachievers to provide help.

Structured interaction also effects achievement, even when individual accountability is absent (Slavin, 1995). For example, if teachers model cognitive processing techniques, such as summarization, or if "think sheets" with suggested learning activities or discussion questions are provided, most students learn more. The assignment of roles and the provision of orienting activities can affect the level and quality of interaction, time on task, and other outcomes that also promote learning (Cavalier, et al., 1995; Klein & Pridemore, 1992; Hooper et al., 1993; Singhanayok & Hooper, 1998). Cooperative effort can lead to more synthesizing of content and cooperative learners can correct each other and provide valuable feedback that directs learning (Hall, et al., 1988). Cues, advice, and orienting activities can encourage cooperative learners to engage in these achievement promoting behaviors (Cavalier, et al., 1995; Sherman & Klein, 1995). High ability learners tend do better when they control lesson sequence and pace while low ability learners tend to do better when there is program control, regardless of whether they learn alone or in groups (Singhanayok & Hooper, 1998). Since high ability students have the metacognitive skills to learn on their own (Snow and Lohman, 1984), the way interaction is structured can have varied effects on different types of learners.

While research supports the claim that both high and low ability learners do better when learning cooperatively than when learning on their own (Dalton et al., 1989; Singhanayok & Hooper, 1998), the question of which students gain most. Is unresolved. Since most cognitive learning approaches favor heterogeneous grouping, one position contends that this holds back advanced learners who spend time helping cohorts. Another position holds that since those providing explanations learn more than those receiving them, the advanced students still benefit most. Although the advanced learners may not move on to new topics, the act of teaching others results in their making elaborations that are at least as good as those they would have developed if homogeneously grouped. One study showed that dyads made up of low ability students performed worse than dyads composed of high ability students. There were no performance differences between the high ability and mixed ability dyads, however, lending credence to the claim that heterogeneous grouping does not penalize high ability students (Sherman & Klein, 1995). Group size (Kutoba, 1991), absenteeism, too varied performance levels, efficiency of time use, and other implementation factors (Slavin, 1995) can drastically effect team interaction and achievement. Student characteristics and dispositions also may affect learning outcomes. For example, students with lower and higher need for affiliation perform the same in cooperative learning, but those with higher need for affiliation do worse when learning alone (Klein & Pridemore, 1992).

In addition to achievement, cooperative learning has been demonstrated to have positive effects in the following areas (Slavin, 1995):

Academic group norms. Students in cooperative learning groups feel more obligated to teammates and more peer pressure to achieve more.

Locus of control. Students in cooperative learning believe that their academic success is attributable more to their own efforts rather than external circumstances, and these attributions have been shown to affect motivation and success.

Attitude toward education. Students in cooperative learning tend to like schooling more, although this finding is somewhat inconsistent. One reason is that most students respond favorably to questions measuring this attitude, regardless of treatment. If questioned at the beginning and end of instruction, the initial response will be so favorable that little change can be demonstrated.

Attitudes toward others. Cooperative learning tends to promote more positive relationships among students. They are more likely to name more friends and to feel that they are liked by others.

Altruism and other perspectives. Students in cooperative learning are more likely to assign rewards to classmates than to themselves, and are more likely to take another person's perspective and to identify feelings in conversation.

Cooperative Learning and Computing

Studies of cooperative learning with computers have employed essentially the same strategies as those found in studies not using the technology. They have examined the same variables and have produced the same results (cf., Brush, 1997; Dalton et. al., 1989; Rysavy & Sales, 1991; Hooper et al., 1993; Sherman & Klein, 1995; Singhanayok & Hooper, 1998). The research has been conducted in classroom settings and students usually work in dyads or triads. There is random or heterogeneous grouping, mutual dependence, and individual accountability. In these studies, group size is often smaller and students interact with the computer as well as with each other. Students are randomly assigned to either individual or cooperative treatments, and in some cases the cooperative treatments involve heterogeneous or homogeneous groups for comparison purposes. Students generally work on computer-based lessons originally designed for individual use (cf., Hooper, 1992), although in some cases materials are modified to contain instructions to guide group interaction (cf., Sherman & Klein, 1995). Generally, students working with computer-assisted instruction in groups perform better, have better attitudes, and spend more time on task than those working alone.

Theoretical Foundations

Both motivational and cognitive theories support cooperative learning's superiority (Slavin, 1995; 1996). Motivational theories focus on incentives for learning resulting from structuring group goals and rewards for achievement. Learning settings can be structured to establish individualistic, competitive or cooperative environments. In competitive conditions, an individual's effort to succeed may frustrate others; in individualistic conditions it has no consequence; in cooperative conditions it contributes. Because cooperative learning establishes conditions where all benefit when each individual succeeds, it provides social incentives for learning. Cognitive theories focus on the inherent benefits of working together. If information is to be retained in memory, it must be related to information already held there. This is facilitated by "cognitive elaboration" or the reinterpretation and re-organization of material (e.g., writing lecture summaries versus taking notes). Peer discussion is one means of elaboration. In peer discussion, students interact with the material and with each other, generating more information processing than interacting with the material alone. The level of interaction is higher even when some students are predominantly explainers and others mainly listeners, although explainers might derive the greater benefit (Slavin, 1995). Moreover, the expectation of having to teach others also might provide intrinsic motivation (Benware and Deci, 1984). It is difficult to prove which theory accounts more for cooperative learning's effects, since both social incentives and elaboration are endemic to cooperative learning methods.

Collaboration Online

The term collaborative learning is employed in the literature on using online computer conferencing systems for teaching, and collaboration is often cited as a benefit of teaching online (Berge, 1995; Collis, 1996; Eastmond, 1995; Harasin et al., 1995; Marttunen, 1994; Naidu, 1988). The term collaborative learning, rather than cooperative learning, is used for good reason. Collaborative learning is generally defined as group activities or any activity where two or more people work together to create meaning, explore topics, or improve skills (Eastmond, 1995, p. 15; Harasin, et al., 1995, p. 4 and p. 30). Collaborative learning implies learning together, but without being held accountable for the learning of others. Like cooperative learning, it is considered an important educational goal and is regarded as a methodology affecting other outcomes such as achievement.

There is evidence that online and face to face collaborative learning is superior to individual learning (Jehng & Chan, 1998). The positive effects of online collaboration are attributed partially to online conferencing systems that enable participation to extend beyond class time. The time extension, in turn, makes it possible for more students to participate. The positive outcomes are also attributed to the fact that students have to compose messages, since composition requires more reflection than extemporaneous speech (Hansen, et al., 1991; Harasin, et. al., 1995; Hiltz, 1994). Managers and researchers of conferencing systems report problems in insuring that students have appropriate access, technical competence, self-learning skills, confidence, and ability to interact socially online, and these factors affect attrition (Berge, 1995; Eastmond, 1995; Hiltz, 1994; Marttunen, 1994). Research indicates that online conferencing systems introduce technical overhead and more cognitive load in processing and responding to information (Cheng, et al., 1991; Eastmond, 1995; Hiltz, 1994). Similar findings have been reported in settings where communications modes other than messaging have been employed, and students have reported difficulties working in teams when communication is not face to face (Holland, 1996).

The Internet and Online Learning

Online networks marry two unique utilities that can potentially affect learning. The first are utilities for interpersonal and group communication and the second are those for representing, linking, and publicly sharing knowledge. For example, the Internet not only supports asynchronous communication via email and bulletin board/discussion forums, but also synchronous communication via chat, point to point and multi-point audio and videoconferencing. It provides access to multimedia files and enables users to receive audio and video broadcasts. Users have the potential of creating and posting their own content and linking it to that developed by others. While the ability to use these utilities depends on the telecommunications infrastructure that users have, their combined capabilities exceed those available in earlier computer conferencing systems that had only the capability to display text and to accommodate written asynchronous communication. The newer teleconferencing capabilities, the ability of marrying older conferencing utilities with online information sources (including those that students create), and the varied ways that these resources can be combined provide a richer environment for studying cooperative learning at a distance.

The Internet's distributed online learning environment may offer more potential for reaping the benefits of cooperative learning strategies than applications in the past did. Like other computer mediated conferencing systems enabling collaborative discussion, the Internet's communication utilities make it possible for students to interact outside of the classroom, when learning is on-site, and in distance learning contexts. But unlike some earlier conferencing systems, the Internet couples communication utilities with online information/learning resources and provides more options for both synchronous and asynchronous communication, both written and verbal (Locatis & Weisberg, 1997). The computer's capacity for accommodating hypertext, hypermedia, and relational databases may be as important as its communication facilities, since the technology enables learners to contribute to communal databases and to create and share their own knowledge representations. The fact that these knowledge representations are public, sharable, and open for discussion may have greater impact on attitudes and learning than just providing online communication alone (Scardamalia et al., 1992).

Communication and Cooperation Online

The use of mailing lists and discussion forums on the Internet shows that they easily can be used to implement collaborative learning techniques that are linked to online content. Employing more formal cooperative learning strategies may be more problematic, however. At first glance, it seems difficult to make a case that various Internet utilities and affordances would have any affect on motivation in cooperative learning. The motivational aspects of cooperative learning stem more from how teachers elect to use computing (and other) resources to promote social interaction and mutual support, rather than from the intrinsic capabilities of the technology itself. For example, they can elect to make grades contingent or non-contingent on mutual learning regardless of whether learning is in classrooms or online, and whether interaction is synchronous or asynchronous. Online learning environments may have more direct impact on the way interaction is structured, including the kind of information accessed, the amount of learner control, the mode of interaction, and the immediacy of interaction. The online utilities available, the ones teachers choose to employ, and the ways teachers choose to employ them can directly affect the structure of interaction and, consequently, learning outcomes.

Unlike classrooms where interaction is face to face, the computer mediated online environment acts to constrain and structure interaction. The medium employed for communication may have profound effects on conversation mechanics and, possibly, the enjoyment and benefit that learners derive from interacting. Written communication may induce more reflection, but there are rules for normal conversation that are difficult to implement in some asynchronous and synchronous communication environments. In face to face interaction, usually one person talks at a time, often for short duration, and turn taking is negotiated through subtle verbal and non-verbal cues (Haslett, 1987). But disjointed discussion in mailing lists and discussion forums and cross talk in chat rooms can impair the quality of conversation. On the other hand, these technologies may encourage more equal levels of participation than when communication and learning is face to face (Scardamalia, et al., 1994) and more critical thinking (Newman et al., 1997). While desktop audio and videoconferencing may allay some of the disjoint/cross talk problems, it has its own costs. Students may be less reflective than with written composition. The non-verbal cues in videoconferencing may distract message receivers from concentrating on message content, resulting in unequal participation levels and less critical thinking than is found in face to face learning. When audio and video conferencing is employed on the Internet, cross talk problems are still possible because of network speed and message latency.

While the motivational benefits of cooperative learning are more attributable to contingency management, and the cognitive benefits are more attributable to the nature of interaction, in online learning contexts the distinction may not be so clear-cut. If, as has been reported, online environments introduce technical overhead and cognitive load that encumbers collaborative learning, it is likely these factors would become exacerbated in cooperative learning contexts that add shared responsibility for mutual learning to the more modest collaborative goal of building shared meaning. This review failed to identify a single study of cooperative learning online. Perhaps the reason is that implementing the paradigm without face to face communication may be difficult. It may be more or less difficult for students to help each other, depending on the communications tools available, and the communication modalities employed add a dimension to the process and mechanics of cooperating that is not present when communication is face to face. There may be antagonisms between the way interaction is structured and the contingencies employed to encourage students to cooperate. Comparisons showing advantages of conferencing over face to face interaction in what have been essentially collaborative learning situations (Scardemalia et al., 1994; Newman et al., 1997) may not hold in cooperative contexts. Some preliminary evidence suggests that students in classrooms collaborating with peers at remote sites feel more engagement with local than with remote classmates (Holland, 1996).

Course Development and Evaluation Issues

Online course developers wishing to employ cooperative learning on the Internet confront a number of implementation issues for which there is little research. But the videoconferencing, broadcast, and other features of the Internet that they choose to adopt may make it possible to investigate the efficacy of cooperative learning online and the effects of various communications modalities on learning outcomes in both collaborative and cooperative distance learning contexts.

Issue 1: The staging and offering of learning events. Developers can offer learning events that are synchronous and live, that are asynchronous and "canned," or a combination. For example, a live broadcast can be made on the Internet and students can phone or email questions to presenters. The broadcast event can be recorded and archived and communication can be continued among students and presenters via discussion forums. Although practical considerations may dictate which methods might be employed to reach different student populations, questions remain about how effective and enjoyable learners may find synchronous and asynchronous learning. Which form do they prefer and which is more effective? Do learners feel more engagement when learning is synchronous?

Issue 2: Communication directionality and channel management. Communication in most traditional classroom contexts originates from a single source (teacher) to many receivers (students) and most of the communication from receivers is usually directed back to the source. Alternatively, communication can be one to one, many to many, or between sub-groups within a class. Communication options are multiplied when email or discussion forums are employed online, but there are online situations involving use of broadcast and email distribution lists in which receivers have no opportunity to communicate with the source or with each other. While almost all communication in classrooms is public, that in online learning does not have to be. To what extent does uni- or bi-directional communication affect enjoyment and achievement? When should communication be directed only to the teacher or to others? Is the quality of communication and participation affected by online group size? By whether discussion is public or private? By the imposition of rules governing what and how topics can be discussed? If many to many communication is used, is there a point of diminishing returns where the volume of messages exceeds that which students can assimilate? How do these factors affect attitudes and achievement in collaborative and cooperative online learning contexts?

Issue 3: Computer mediated communication modalities. Some modalities are synchronous (e.g., chat) while others are asynchronous (e.g., email). And some (e.g., videoconferencing) more closely approximate the realism of face to face communication than others. Decisions about communication modality have to be made whether communication is to be one or two way. Print or video, for example, may be used to communicate content to learners. While varied presentation forms may affect learning, there may be additional effects when different modalities are employed for two-way communication. Does the fidelity of the message exchange medium relative to face to face interaction have an effect? Do the mechanics and immediacy of communication have different effects in collaborative and cooperative learning contexts? Alternative synchronous/asynchronous computer mediated communications mechanisms and their varied levels of fidelity are shown in Table I. What are the effects of these communication modalities, either alone or in combination, on attitudes and achievement? Are there varied effects when everyone uses a single communication mode or combination of modes or when different students choose different modes?

Table I: Computer-Mediated Communication Mechanisms

	Low fidelity	Medium fidelity	High fidelity
Synchronous	Chat	Audio conferencing	Videoconferencing
Asynchronous	Email, Bulletin board	Voicemail	Video archives

Issue 4. Computer mediated communication and cooperative learning methods and formats. Some cooperative methods let learners work independently and check their own work, while others require more concentrated, ongoing cooperation. Situations where students check or comment on each other's independent work, may require less immediate, synchronous communication than those where they must jointly solve problems or create a product. Does computer mediated communication differentially affect different methods? Does the degree and kind of interaction necessitated by the cooperative learning context require use of alternative communication methods?

Issue 5. Computer mediated communication and the curricular context. Online environments may serve as the main mechanism for instructional delivery and interaction, as an adjunct to classroom instruction or to instruction delivered via other media, or as an optional tool that students can elect to use. Is computer mediated communication used differently when it is required for a course than when it is an option? Requiring students to contribute and communicate online may lead to more conversation, but will it lead to better conversation? Do those who lurk or eavesdrop on others' conversation learn as much or less than those who are more active?

Issue 6. Computer mediated communication and cooperative learning in institutional contexts. The Internet makes it possible for faculty at different institutions to collaborate in offering courses and for students at different institutions to enroll in them. Even if collaboration is lacking, it may be possible for students at a given institution to access materials at other institutions and to informally collaborate with other institutions' students online. It may be possible to employ cooperative learning methods that team students from different institutions. Are there differences in communication and learning outcomes when computer mediated communication for cooperative learning is employed with students within a single institution in contrast to when it is employed with students at different institutions? How can contingencies for group goals and individual accountability be applied across institutions and at a distance? Administrative factors such as course schedules and credits can be barriers, as well as the technology infrastructure (Holland, 1996). How do these factors affect attitudes and achievement?

Issue 7. Knowledge sharing, communal databases, and cooperative learning. Many universities allow students to post personal pages on the Web and it is possible to use the technology for publishing and sharing knowledge as part of formal coursework. Authorship may be individual or joint, and review by others may be formal or informal. How does providing access to individual knowledge representations augment computer-mediated communication and cooperative learning? Are exchanges richer when online communication is employed with the requirement to share individual knowledge representations or to build a communal knowledge base? Are exchanges richer when spontaneous or when planned? Does authoring and publishing material on the Web lead to better writing and greater satisfaction than doing such work only as a class assignment? Is the Web, as public forum, a more authentic, realistic environment than the classroom?

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Problem-based Learning in the Health Sciences

Eldon J. Ullmer

The attitudes that various educators hold toward instructional innovation would seem to divide them into three groups. One group thinks that conventional teaching methods are just fine and has in effect hung out a "Do Not Disturb" sign. A second is open to "improvements," but within the conventional model. The third maintains that nothing less than "systemic change" can provide the type of education that students now need.

Educators in the third group argue that the drawbacks of conventional classroom instruction are so serious that a total rethinking of the teaching-learning process is needed. In the health sciences, problem-based learning is perhaps the most visible manifestation of efforts to achieve that end. In general education, two other innovative approaches--situated cognition and anchored instruction--are more recent approaches that share with problem-based learning quite similar images of what conventional schooling's deficiencies are, and what might be done to overcome them.

Situated Cognition

Situated cognition's advocates maintain that conventional didactic instruction tends to treat knowledge as "an integrated, self-sufficient substance, theoretically independent of the situations in which it is learned and used" (Brown, Collins and Duguid, 1989). But recent learning research, they contend, shows that the activities in which knowledge is acquired and used are "not separable from or ancillary to learning and cognition" but are "an integral part of what is learned." They suggest that by ignoring the ways that "situations structure cognition," education undermines the "goal of providing useable, robust knowledge." Further, they argue that school activities traditionally do not reflect what practitioners in various fields actually do. They describe much of what students do as "ersatz activity." The result, they claim, is that success in school "often has little bearing on performance elsewhere."

Anchored Instruction

As with situated cognition, the concept of anchored instruction is largely a response to problems perceived in traditional instruction, especially what A.N. Whitehead termed the "inert knowledge" problem (The Cognition and Technology Group At Vanderbilt, 1990). Whitehead claimed that traditional schooling tended to present information in ways that made it inert, that is, knowledge that people can recall in response to a specific inquiry but "is not used spontaneously in problem solving even though it is relevant." Within this framework, proponents of anchored instruction see it as a way to incorporate the emphasis that situated cognition places on "everyday cognition, authentic tasks, and the value of in-context apprenticeship training" into "formal educational settings involving groups of students." This invariably involves creating a learning environment that serves as the "anchor" for promoting "sustained exploration by students" and understanding of "the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools." In this sense, one can envision a videodisc-based story involving mathematical concepts or a simulated patient encounter as the anchor of a learning experience.

Problem-based Learning

Problem-based learning (PBL) in medicine reportedly began in the 1960s at McMaster University in Canada. The McMaster model for student-centered, small group, problem-based learning took hold slowly in other institutions during the 1970s and 1980s (Camp, 1997). Recently, however, an increasing rate of adoption has prompted the observation that PBL "shows signs...of becoming a successful innovation" (Camp, 1997). This would be remarkable not only because successful innovations in professional education are rare, but because, as Camp asserts, PBL is so significant a change in the teaching-learning model as to constitute a genuine "paradigm shift."

That PBL is problem-based is self-evident. But the fact that it is "learner-centered" is also important. In addition to facilitating knowledge acquisition, PBL seeks to develop students who possess certain attributes--an enthusiasm for engaging complex problems, the ability to reason effectively, the ability to monitor and assess their own progress while attempting to solve a problem, and a willingness to work as a member of a team.

There are sound reasons why PBL appeals to both faculty and students. While students in traditional formats may excel at learning medical content, their facility for remembering it, applying it, and their disposition to continue learning after formal schooling ends are often less than ideal. Proponents claim that PBL, by emphasizing meaning over facts and "higher level" skills--analysis, assessment--over memory and simple procedural tasks, alleviates these concerns. Also, students appear to prize the autonomy that PBL gives them as well as the opportunity to apply knowledge immediately in more authentic contexts. Some also believe that PBL offers a better fit with contemporary theories of learning than conventional instruction does. In particular, those who embrace a "constructivist" view of learning argue that situating learners in realistic, problem-oriented environments that promote frequent interaction and collaboration among peers favors the development of robust, useful knowledge. Finally, Camp reports, both faculty and students perceive PBL as being "very successful."

A Problem-based Learning Model

Definition and aims. Barrows defines problem-based learning as "the individualized learning that results from working toward the solution or resolution of a problem" (Barrows and Tamblyn, 1979). He differentiates problem-based learning from those exercises in which a problem is presented after relevant knowledge has been learned by emphasizing that in true problem-based learning, the learner "takes on the problem first" and, in the process of resolving the problem, learns "the related facts, principles or procedures in...basic or clinical science." The aims of problem-based learning, Barrows asserts, are to actively involve learners in their own education and to provide situations in which learners "can integrate information from many areas of science into a meaningful construct for use in solving future problems." This is intended to facilitate the development of clinical reasoning skills and the acquisition of information about human biology and disease "in a manner that enhances the usefulness of this information in future work with patient problems." Another objective of problem-based learning is to develop "efficient and effective self-study skills" by, as Barrows puts it, "putting the task of determining what is to be learned and how it is to be learned directly on the learner's shoulders."

Phases of a general problem-based approach. Problem-based learning, as practiced at the Southern Illinois University School of Medicine, involves three phases. In the first, students engage a patient problem and proceed as far along the problem diagnosis and management path as their present knowledge permits. At that point, they identify the additional knowledge needed to complete the process. The second phase consists of self-study by group members to gain this knowledge. The group works independent of the tutor and decides when it is ready to return to the problem. In the third phase, students resume work on the problem armed with the new knowledge. This phase concludes with students assessing themselves on their problem solving skills.

Developing clinical reasoning skills. A basic premise of problem-based learning is that the elements of the clinical reasoning process are well-established, and that experience with patient-problem exercises is the preferred method of developing them. The clinical reasoning process begins with gathering information both before and during a patient encounter and devising a "management system" to aid in the subsequent analysis of the patient's condition. This management system, Barrows says, includes "two mechanisms: Problem Distillation and Multiple Hypotheses."

Barrows describes problem distillation as "a concise formulation or summary of a patient's problem" that involves synthesizing all significant information and excluding irrelevant data. He sees it as "an active and formative process" in which the summation changes as new facts are derived.

Although multiple hypotheses generation is regarded as the "second mechanism" of the clinician's management system, it, like problem distillation, begins with the initial patient contact. Barrows suggests that an experienced clinician will typically generate three to five hypotheses following problem distillation and they serve to guide the course of further inquiry with the patient. The formulation of multiple hypotheses is valuable in two ways; it precludes narrowing the scope of inquiry too soon and provides the clinician with "an organizational structure to hold the tremendous amount of data that continues to emerge from interaction with the patient."

The clinical reasoning process must end with a patient diagnosis that verifies the most likely hypothesis. The learner (as clinician) must decide when sufficient information has been gathered to make the diagnosis. In some cases, the need to take immediate action, or other circumstances, may make gathering additional information impossible.

Evaluating clinical reasoning skills. Various techniques can be used to assess learner performance in the different stages of clinical reasoning. Barrows discusses several stages, the first being information base evaluation. How adequate was the diagnostic information base constructed by the learner during the clinical encounter? Ways to judge this include having the student develop a written database after interacting with the patient problem; have the student make an oral presentation to someone who is well acquainted with the patient problem, or documenting the series of steps taken by the student and comparing it to that of classmates or experts.

Evaluating problem distillation and hypotheses formulation can be judged by either immediate or delayed recall methods. Immediate recall involves having fellow students or a teacher who is observing the learner's interaction with the patient problem stop the learner and request a description of the patient's problem as it appears at that moment. Barrows suggests that a group of students can gain valuable experience in problem distillation this way as they discuss differences and try to reach agreement.

Delayed recall typically involves having the learner watch a playback of the encounter with a patient problem and while an interviewer asks questions to elicit the learner's thinking during the clinical reasoning process.

Various factors can play a role in determining when to bring a patient assessment to an end and to proceed with diagnosis and management. As with information gathering, problem distillation and hypotheses generation, specific criteria are needed to judge the skill with which the learner verifies the most likely hypothesis, makes a diagnosis and decides on a management plan. Barrows calls this stage formulation and management evaluation and he suggests that the learner be required to keep a written problem-oriented record and management plan as a basis for this assessment.

Because implementing problem-based learning in a medical school environment is neither easy nor inexpensive, it is vital for schools contemplating such an innovation to have answers to several fundamental questions. As PBL has been adopted by various schools over the last 25 years, the amount of research to determine its utility has likewise increased. An extensive review of this research is impossible here; instead, several major questions concerning PBL's effectiveness will be examined.

Research on PBL, Albanese and Mitchell (1993) note, is made difficult by several factors. First, definitions of PBL and of a "problem-based curriculum" are not uniform from place to place. Moreover, PBL programs tend to be implemented differently at different schools, thus combining studies for statistical purposes is unreliable. And study design weaknesses also can dilute results. Participant "selection factors" also pose problems for data interpretation because PBL student populations generally represent individuals who applied for that track. And the fact that among medical schools there exists no uniformly accepted set of standards for outcome measures also makes comparisons difficult.

Albanese and Mitchell (1993) reviewed PBL research covering the years 1972-1992. Using meta-analysis techniques, they examined studies related to numerous outcome areas, including (among others): basic science performance; clinical science performance; learning environment promoted; study behaviors promoted; student satisfaction; faculty satisfaction; and, graduates' perception of their preparation. A few months later, Vernon and Blake (1993) also published a meta-analysis of studies done from 1970 to 1992. They reported results relative to four major factors: program evaluation, academic achievement, academic process, and clinical functioning, the last category embracing both clinical knowledge and clinical performance. Data from both studies are here summarized under several of these headings.

Academic achievement. Data in this category is typically drawn from tests of content knowledge such as the NBME I. Vernon and Blake (1993) state that data from NBME I (eight reports involving 28 samples) "suggest a significant trend favoring traditional teaching methods" (p. 556). They seem reluctant to assign great significance to this finding, however, because most of these studies employed "static-group designs" rather than randomized groups. Albanese and Mitchell (1993) confirm that lower basic science test scores by PBL students are the rule. They add, however, that this is not always the case and identify three instances in which PBL students outperformed those in conventional programs. They speculate that this could be a result either of differences in students at different institutions or variations in PBL programs that tend to produce students that score as well on basic science examinations as students in traditional programs do.

Academic process. Studies in this area mainly focus on the learning process and learning resources utilization. Vernon and Blake (1993) report that some findings indicate "that students in PBL programs place more emphasis on `meaning' (understanding) than on `reproducing' (rote learning and memorization), and that the opposite pattern prevailed among students in traditional programs" (p. 556-7). Vernon and Blake (1993) also report that studies of student use of learning resources indicated that PBL students, compared to traditional students, placed more emphasis on journals and on-line searches, made greater use of the library and tended to rely more on self-selected reading materials. Albanese and Mitchell (1993) also reported that a study of cognitive behavior done at Harvard University found that PBL students were "more likely to rely on conceptualization as a learning method" and also "much more oriented toward studying by reflection on material" than traditional students were. All these findings appear to support the popular notion that PBL students are more independent and self-directed than those in traditional programs.

Clinical functioning. Under clinical functioning, Vernon and Blake (1993) examined three types of data drawn from tests of clinical knowledge, ratings of clinical performance, and the so-called "humanism" measurements made at Harvard University. Results from clinical knowledge tests, e.g., NBME II, show a slightly better performance by PBL students (a reversal of the condition with tests of content acquisition). But although PBL students consistently outpaced traditional students on tests of clinical performance, in studies of "logic processes" used during clinical problem solving exercises, PBL students did not perform as well. These results raise the question that PBL students may lack the "fund of knowledge" necessary to develop an adequate "cognitive scaffolding" to solve problems effectively.

Program evaluation. Studies of student satisfaction after taking PBL courses or modules, Albanese and Mitchell (1993) report, "almost uniformly show high levels of satisfaction" (p. 63). The proportion of entering students who select a PBL track (when both PBL and traditional tracks are available), studies show, varies widely, but generally between 15% to 50%. They also report very favorable attitudes toward PBL by students, "even where they participated in PBL against their wishes. And generally, PBL graduates consider themselves to be equal or better prepared than other graduates. And studies indicate that faculty, too, hold positive attitudes toward PBL.

Some Concerns With Problem-based Learning

Some questions about problem-based learning have been answered. Most students who try it like it. Faculty, too, have favorable perceptions of PBL. Still, changing to a problem-based curriculum is a momentous undertaking. It affects the roles and skill profiles of both teachers and students. Students must assume responsibility for becoming independent learners and able members of a team. And not all faculty will have developed the interpersonal skills that are so vital to successful cooperative learning in problem-oriented settings. Implementing a PBL curriculum entails new management challenges and will likely lead to increased costs. And beyond problems associated with PBL's acceptance, adoption, implementation and cost, three curriculum-related concerns should receive the careful attention of those considering or using PBL programs. One is the extent to which PBL students, being more self-directed, gain an adequate amount and proper selection of content. Secondly, there is the related concern that PBL students who acquire a less than complete understanding of the basic sciences will experience difficulty keeping abreast of new developments and performing adequate diagnoses in practice. A third concern is the degree to which the small-group, collaborative approach to problem solving that PBL embodies prepares a physician to work alone in handling patients, or to work as a member of a real-world health care team where individual roles may differ from those practiced in school.

Problem-Based Learning: Research Questions

The concerns that have been expressed about problem-based learning, plus those that attend placing problem exercises on the Internet, suggest that additional research on both curricular and operational questions is indicated. Some basic questions include: (1) Is problem solving a general skill and, if so, does problem-based learning really promote its attainment? (2) What types of learning outcomes does problem-based learning best facilitate? (3) Does group learning actually enhance learning of problem solving skills, or merely serve as a mediator of group thinking? (4) When faced with a problem, can learners accurately discern what knowledge they will need to solve it? (5) Does problem-based learning ensure that students will develop an adequate knowledge base to become well-rounded practitioners? (6)How can collaborative work be accommodated when students are at distant locations? (7) How can students and teachers best communicate with each other? (8) How can learners at various locations be evaluated fairly?

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Web Resources On Problem Based Learning

Southern Illinois University School of Medicine
http://www.siumed.edu/pblc/DEPT/Index.html

Queen's University MD Program
http://meds.queensu.ca/medicine/pbl/pblhome.htm

University of Delaware Problem-Based Learning
http://www.udel.edu/pbl

University of Maastricht Problem-Based Learning
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Technology Adoption and Diffusion

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Introduction

Had technological change and innovation proceeded at today's rate in fifteenth century Europe when printing technology was introduced, one can only speculate on the economic and political effects that its adoption and diffusion might have had on that era and subsequent history. And, if Internet technology is the "printing" technology of today, its potential effects on modern society might be compared to those of that centuries-old innovation; that is, momentous, but difficult to foresee. Fortunately, we now know more about the adoption/diffusion process.

This review examines that process and the social and other factors influencing the diffusion of Internet/World Wide Web technology. Attributes of Internet technology that differ from those of traditional instructional technologies and that modify the adoption and diffusion process are discussed, as are characteristics of the potential adopters and strategies that contribute to successful technology adoption and integration within an organization.

Within this context, "adoption" refers to the stage in which a technology is selected for use by an individual or an organization. "Innovation" is similarly used with the nuance of a new or "innovative" technology being adopted. "Diffusion" refers to the stage in which the technology spreads to general use and application. "Integration" connotes a sense of acceptance, and perhaps transparency, within the user environment.

Typically, past adoptions of a new technology for education have signaled a confidence in its potential to alleviate a particular problem or to make a job easier or more efficient. Rarely has bringing about new social and functional conditions been a consideration. Internet and World Wide Web technology, however, may provide a means of creating totally new learning environments, and it may be to that end that adoption is initiated. In such instances, "innovation" and "adoption" may be seen as virtually synonymous elements of the adoption/diffusion process.

Technology Adoption/Diffusion: Two Views

Since early in this century, various "new" educational technologies have been touted as the revolutionary pedagogical wave of the future. Classroom films, programmed learning devices, language laboratories, educational television, computer-assisted instruction and, more recently, interactive videodisc technology have been adopted and integrated into the curriculum with varying degrees of success. Each technology was widely perceived as meeting a need, and each gained a measure of initial commitment of resources from a high level administrative or legislative entity. Their adoption and diffusion process generally followed what has been termed the "traditional model," a "top-down" process in which administrative "mandate" introduced the technology and administrative perceptions, decisions and strategies drove adoption and diffusion. Successful adoption was highly dependent on the degree, stability and wisdom of administrative sponsorship.

None of these technologies, however, has been generally available for individual or private use due to cost, scope or application. This deterred a "grass roots" technology adoption cycle as it was nearly impossible to generate movement from the bottom up by influencing faculty peers and administrators with demonstrations of successful applications.

Today's educational generation, however, sees personal computers, the Internet and the World Wide Web as technology's new wave. Proponents of distributed learning environments and distance learning on the World Wide Web forecast dramatic innovation at all levels and in all areas of education. And although this enthusiasm is reminiscent of that of past innovators, there are significant differences in the nature of this technology revolution in education and that of earlier ones with corresponding implications for adoption and diffusion.

Unlike most earlier technologies which were thrust upon the education community, Internet technology is individually available to faculty and students who can use their own systems to serve their own purposes. The impetus for the innovation frequently grows from individual users of the technology, and as their communication and influence moves laterally through their contacts, a body of support can grow and exert "pressure" on the institutional administration to commit to adoption of the technology. There is, therefore, a high potential for a "bottom-up" or "grass roots" adoption process to succeed.

Indeed, Everett Rogers (1986), considered by many the "guru" of adoption/diffusion research since publishing Diffusion of Innovations (now in its fourth edition) in 1960, reveals three important ways in which the adoption of interactive communications differs from that of previous innovations. 1) A critical mass of adopters is needed to convince the "mainstream" teachers of the technology's efficacy. 2) Regular and frequent use is necessary to ensure success of the diffusion effort. 3) Internet technology is a tool that can be applied in different ways and for different purposes and is part of a dynamic process that may involve change, modification and reinvention by individual adopters.

Internet technology actually embodies a number of technologies--e-mail, databases, chat rooms, information and education resources, among others. Additionally, the Internet exhibits many elements that constitute a culture or community--language, symbols, rituals, interaction, and other elements of communication. It thus essentially becomes an environment into which users enter (December, 1993; North, 1995). "Visionary" innovation and "pragmatic" application can begin with grass-roots enthusiasts who enter this environment. Viewed as a culture or community, however, the Internet can be perceived as a threatening competitor to the established norms of an existing culture or community, such as an academic department or some other institutional entity.

Adoption/Diffusion Theories

The "top-down" and "bottom-up" models of adoption/diffusion provide a directional perspective to the process. Another theory dichotomy relates to the scale of innovation efforts by distinguishing between **macro-level theories** and **micro-level theories.** Macro-level theories focus on the institution and systemic change initiatives. Innovation typically involves broad aspects of curriculum and instruction and might encompass a wide range of technologies and practices. Micro-level theories, on the other hand, focus on the individual adopters and a specific innovation or product rather than on large-scale change.

Rogers (1995) recently presented four additional adoption/diffusion theories.

Innovation Decision Process theory. Potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation **(knowledge);** second, they must be persuaded of the value of the innovation **(persuasion);** they then must decide to adopt it **(decision);** the innovation must then be implemented **(implementation);** and finally, the decision must be reaffirmed or rejected **(confirmation).** The focus is on the user or adopter.

Individual Innovativeness theory. Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.

Rate of Adoption theory. Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilization and finally a decline.

Perceived Attributes theory. There are five attributes upon which an innovation is judged: that it can be tried out **(trialability),** that results can be observed **(observability),** that it has an advantage over other innovations or the present circumstance **(relative advantage),** that it is not overly complex to learn or use **(complexity),** that it fits in or is compatible with the circumstances into which it will be adopted **(compatibility).**

Each of the above can be considered in the context of either a top-down or a bottom-up adoption/diffusion process and in either macro-level or micro-level reforms. But there is one other adoption/diffusion theory dichotomy that is relevant to the discussion of Internet innovation. The distinction is between a **determinist (developer-based)** focus and an **instrumentalist (adopter-based)** one.

Determinists regard technology as the primary cause of social change. The process is seen as a series of revolutionary advances that are thought to be out of direct human control. Consequently, focus is on an innovation's technical characteristics. Successful adoption/diffusion is the assumed result of an innovation's technological superiority. The innovation's developer is viewed as the primary change agent.

For instrumentalists the process is evolutionary, and the causes of change are in social conditions and in human aspirations for change and improvement. Thus their focus is on the user (adopter) of a technology and its value as a tool to bring about desired change. Human control over the innovation is a key issue, and it is considered essential to understand the social context in which it will be used and the function that it will serve.

Comparative Approaches To Technology Adoption And Applications Development

Internet and World Wide Web technology offer opportunities for creating new and significantly different educational applications. But technological functionality is not the sole force currently driving its rapid adoption. Rather, the hope held by many in the educational community that new ways of teaching and learning that the technology makes possible appears to be increasing the rate of adoption. Concomitantly, many instructional technologists and educators now reject technical superiority alone as a sufficient basis for the successful diffusion of Internet and Web-based innovations.

David Jaffee (1998), in his analysis of resistance to asynchronous learning networks (ALN)--which would include many Internet/Web based learning applications--reminds us that classroom teaching is an established practice and cultural tradition of the teaching faculty. It centralizes power and influence with the instructor and serves as a focal point of professional identity. Jaffee suggests that institutionalization of the classroom teaching model is a major factor in reluctance to adopt ALN technology. He also observed that faculty exhibit less opposition to the use of televideo for transmission of classroom lectures, perhaps because the classroom setting is maintained between transmission and reception sites. The virtual classrooms afforded by ALNs and Web based learning modes, on the other hand, can be viewed as a threat in this context. He notes, however, that where professional identity is based on classroom presentation and student "reaction" to it, a disinterested and disengaged student audience might adversely affect that identity. Given that circumstance, Jaffee suggests that the ALN (Internet/Web) based virtual classroom concept might be conceived, or at least presented and promoted, as professionally enhancing.

Thus the focus of the process has shifted to the potential adopter and the organization into which the technology will be integrated. An adopter based, instrumentalist approach incorporating both macro-and micro-level perspectives now appears to be the most widely used to promote the adoption and diffusion of Internet technology.

Ernest Burkman's (1987) user-oriented development approach exemplifies those currently favored for the adoption and diffusion of instructional technology generally and Internet technology in particular. It consists of 5 adopter-focused steps: 1) potential adopter identification, 2) measurement of their relevant perceptions, 3) user (adopter)-friendly product design and development, 4) informing the potential user (adopter) of the product, and 5) support after adoption. An alternative model developed at the University of Minnesota's Telecommunication Center recommended a complete analysis of educational need and user characteristics along with the identification of a new educational technology's relevant and appropriate features and factors (Stockdill and Morehouse, 1992).

Tessmer (1991) stresses the need to analyze the environment in which the potential adopter is expected to use the technology. This process includes identifying the relevant physical and use characteristics of both the instructional situation and the support system. The approach is intended to ensure actual, correct and continual product use.

An adoption analysis approach (Farquhar and Surry, 1994) considers the process from the broader perspective of both user-perception and organization attributes, resulting in a plan for carrying out the adoption of technology that is rooted in an organizational context and addresses issues of concern to the intended user. Product and application design and development are also significantly influenced by this approach.

No single approach or process may be sufficient to ensure successful innovation adoption. But clearly, Internet and Web-based technology is individual-user based in application, and the adoption/diffusion process should start at that level. It should focus on the potential adopters and address their characteristics in the context of the environment in which they will be using the technology.

Differentiation Of Technology Adopters

The traditional adoption/diffusion continuum recognizes five categories of participants: 1) innovators who tend to be experimentalists and "techies" interested in technology itself; 2) early adopters who may be technically sophisticated and interested in technology for solving professional and academic problems; 3) early majority who are pragmatists and constitute the first part of the mainstream; 4) late majority who are less comfortable with technology and are the skeptical second half of the mainstream; 5) laggards who may never adopt technology and may be antagonistic and critical of its use by others. The distribution of these groups within an adopter population typically follows the familiar bell-shaped curve.

Moore (1991) sees these groups as significantly different "markets" in the "selling" of an innovation to faculty adopters. He suggests that the transition from the early adopters to the early majority--one that is essential to an innovation's success--offers particular potential for breakdown because the differences between the two groups are so striking (See table 1).

Early Adopters	Early Majority
• Technology focused • Proponents of revolutionary change • Visionary users • Project oriented • Willing to take risks • Willing to experiment • Individually self-sufficient • Tend to communicate horizontally (focused across disciplines)	• Not technically focused • Proponents of evolutionary change • Pragmatic users • Process oriented • Averse to taking risks • Look for proven applications • May require support • Tend to communicate vertically (focused within a discipline)

Table 1 (adapted from Geoghegan, 1994).

Need-based Diffusion Strategies

Addressing the needs implied by the early adopter-early majority differences when designing diffusion strategies can greatly enhance the likelihood that a technology will be successfully integrated into the curriculum by groups beyond the innovators and early adopters (Geoghegan, 1994).

Need for recognition and process involvement. The chances of successfully "selling" an innovation to the pragmatic early majority will significantly increase if their differences are addressed in terms of their perceptions and needs. They should be recognized as a distinct group within the community and made a part of the planning and policy making process. Attempts to "convert" them to the point of view of the innovators and early adopters are likely to be futile, not to mention almost certainly disastrous to impose the technology on them otherwise. 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.

Need for vertical support structure to overcome technophobia. When technology adoption begins from the grass roots, innovators and early adopters, with their strong technology orientation, may be able to get by on their own initiative. Narrowly focused technical support staff may not pose a threat or discouragement to them and their needs for initial training and support may be relatively easy to accommodate. Members of the early majority, however, tend to have no interest in the technology per se and some may exhibit a form of technophobia. Their introduction to the technology should be related to their perceived program and process needs. Since they tend to focus vertically within a discipline, training and support provided by staff who enjoy discipline/content credibility will likely be best received. Correspondingly, such training and support will be more transferable to the late majority and laggards.

Need for well-defined purpose or reason. The very existence of a technology may be reason enough for innovators and early adopters to pursue it. Their bent for experimentation and their innate interest in technology may dispose them to adopt it and be content with "finding a problem to fit the solution". Members of the early majority (and the others by extension), however, tend to derive their purposes from problems related to their disciplines. If the innovation can be demonstrated as an effective, efficient and easily applied solution to those focused needs, it is more likely to be adopted and integrated into the program.

Need for ease of use and low risk of failure. The early majority's aversion to risk quite naturally translates into a need for ease of use and early success if they are to adopt and diffuse the technology. The overlap with support and training requirements is obvious.

Need for institutional/administrative advocacy and commitment. In the top-down adoption effort, institutional sponsorship and support is a given. The innovation may be mandated and grant moneys or other funds are committed. Without advocacy and resource commitment by the institution's "policy setters" and "holders of the purse strings", other issues become moot as the process is likely doomed to stalemate, if not to an early demise. But innovation that occurs from the bottom-up also requires institutional attention, and an administration as an entity (except for some possible rare exceptions) tends to emulate the early majority rather than the innovators and early adopters. And even when an institution initiates an innovation from the top, their perspective tends to be a pragmatic one based on a problem or need that a given technology promises to alleviate. It may relate to staffing, financing, scheduling, teaching, distance or communication. In any case, the mindset is similar to that of the early majority and, as always, there is a need for advocacy to occur if the conditions and activities that can promote adoption by the early and late majorities and laggards are to prevail.

Meeting these needs is an essential part of any successful diffusion strategy. From their work at the University of Colorado, Wilson, Ryder, McCahan and Sherry (1996) derived several principles that apply particularly to situations in which students and faculty are introduced to networked learning environments.

First-time success. No one enjoys frustration or failure. An innovation is most likely to be accepted and integrated by the early and late majorities if success is experienced initially and subsequently built upon. E-mail is typically introduced early on because of its ease of use, and its success is almost guaranteed. It also extends the peer network, both within and outside the institution, thereby magnifying its impact on adoption and diffusion.

On-going peer support. Complementing the experience of initial success, there should be ample "hand-holding" along the way of integration as other Internet applications are introduced. Live peer support not only serves as assistance and encouragement; it contributes to the person-to-person communication that promotes diffusion throughout an educational community. In addition to a training cadre of recognized peers, a network of on-line mentors can expand the potential of the support structure to promote the exchange of innovative techniques.

Real task activities The early and late majorities are pragmatists who see technology in terms of real problem and task solutions. Activities designed to introduce and teach the technology should address those needs. As pointed out earlier, institutional administrations tend to emulate this pragmatic perspective. Internet access to information and resources, and its use for intra and inter-institutional communication can address many administrative needs in addition to those of the faculty, as well as establish a well-defined and recognizable need for adopting the technology.

Ownership and identity on the Internet Encouraging and enabling faculty and students to "create an active presence" on the Internet is important. Participating in listservs, creating a personal home page, publishing electronic papers all contribute to the electronic world-community and help ease "cultural assimilation." As with using e-mail to ensure early success with the technology, this "presence" extends the peer network impact on its adoption and diffusion. Beyond that, it also creates a professional identity and a credibility standing similar to that derived from traditional publication.

Variety of incentives. Attempts to impose a technology through explicit mandates and requirements, as in the top-down scenario, are not likely to be effective. This is particularly true with Internet and Web technology because the technology is so generally available to anyone who has a mind to adopt it. Policies and procedures promoting the technology should grow naturally from its application, and incentives for using it likewise should be tied to its practical use. Adoption and diffusion is more likely to occur where incentives and policies encourage a natural acceptance and use of the new technology.

Technology innovation in the educational community has often been hindered by the lack of a reward structure. Written publication has long been held as evidence of scholarly work that is worthy of recognition through promotions or tenure. In contrast, time consuming effort directed to pragmatic problem solving, instructional materials design and development or innovative classroom teaching has rarely received similar recognition. Integrating a technology like the Internet into one's teaching is time consuming and "effort intensive," usurping time and energy that otherwise could be devoted to more traditional--and more rewarded--endeavors. If innovative behavior is to be sustained, there must be a recognized and acknowledged system of rewards parallel to, and equal to, that associated with "traditional" academic pursuits.

Issues, Implications And Questions

From an innovation integration perspective, a collaborative, inter-institutional application of Internet technology for distance learning, or other purposes, raises issues with serious implications. Whereas the adoption/diffusion lines of communication for previous technologies tended to be confined within a single institution and vertical in nature, Internet and World Wide Web technology inherently extend those communication lines externally and broadly in a horizontal fashion. The aggregate of grass root innovators and early adopters at multiple institutions magnifies the impact that these "players" have on the process. What effect does this have on the adoption and integration at any of the individual institutions? How might that body of innovators be organized to best advantage? Is there a NIH (Not-Invented-Here) syndrome that must be overcome? If so, what strategies might be employed to do so?

The multi-institutional mass of innovators and early adopters provides opportunities for sharing trainers and training opportunities, and for expanding the scope and magnifying the impact of adoption efforts. Local, live peer support can be augmented by distributed "hand holding," but how might that be coordinated and integrated? And is distributed peer support effective?

Early success with the innovation, and ownership of and identity with the technology can be promoted through a variety of activities such as e-mail, listservs and chat rooms. Shared development of resources and papers can be collaborative efforts in which individuals at different sites can participate at their own level at any given time. Are some of these activities and tasks more likely to positively affect adoption/diffusion than others? How might they most effectively be introduced? Opportunities abound to develop resources and course material for alternative delivery on the Internet and World Wide Web, not to mention alternative, electronic publication of papers and research. What is the current extent of professional recognition for development and publication of this sort? How might professional recognition be fostered?

Advocacy of innovation and commitment to integration on the part of the institution's administration is essential to success. The inter-institutional nature of Internet and World Wide Web application, however, introduces a need for inter-institutional collaboration at the administrative policy/procedure setting level. Are there models of administrative collaboration that might be adapted to the integration of Internet technology?

Other issues that impact Internet and World Wide Web adoption need to be addressed, including, to mention a few, protection of intellectual property delivered on the Internet, copyright protection of electronically published materials, liability with regard to certain content and resources such as those of a medical nature, and licensure where "license boundaries" are crossed.

Summary

The adoption and diffusion of an innovation within an institution does not guarantee its successful integration into the curriculum or its continued use. A classic example might be the once ubiquitous classroom film, frequently used in public schools as a "Friday afternoon filler" rather than as a planned learning experience. Similarly, the lack of appropriate and adequate teacher training inhibited the full use of language laboratories in public schools decades ago. Now, Internet technology is at risk of being misused. If its glitz, popularity and apparent ease of use are allowed to preempt careful planning, or if teachers and students do not receive proper training in its use, its integration as an information and learning resource, as well as a communication tool will likely be subverted.

In addition to a strong stable advocacy needed to ensure the conditions necessary for technology adoption and diffusion, training in its technical aspects and application to real needs is crucial to its integration beyond the innovators and early adopters. Time for experimentation and development of applications is essential. Successful peer users are needed to lead its integration into the curriculum. If the technology is perceived as difficult to learn and/or too time consuming to prepare and use, or is in some other way perceived as threatening, it probably will not be used. No amount of administrative force would likely be effective reversing a negative trend. A perception of value in terms of needs/problem solving and academic or other rewards through establishment of policies, incentives, recognition and an on-line presence in the Internet culture and environment need to be nurtured by the institution's administration.

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