Learning Theory and Computer Environments

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This entry is a brief survey of the learning-theory field as it relates to educational technology, primarily focused on behavioral and constructivist educational theorists. According to some scholars, both have praised technology and perhaps exaggerated its promise (Berg, 2002; Duffy & Jonassen, 1994). Some point out that computers may finally provide the means by which the very labor-intensive education philosophy of Dewey may be put into practice. On the other side, behaviorists have long held a dominant position in the field of computer-based training (CBT) with the tireless repetition and utilization of clear behavioral learning objectives, key elements of these training programs. In more recent times, those interested in concept mapping, the value of learning computer programming, and simulations have all to some degree based their approaches on behaviorism or constructivism.

In *The Technology of Teaching*, Skinner (1964) argues that the use of technology in teaching can increase learned behavior by organizing learning objectives, increasing the frequency of positive reinforcement, customizing the learning experience, and freeing teachers from repetitive teaching. He focuses on teaching as the structuring of opportunities for reinforcement. Skinner further defines this learning opportunity as the environment in which learning takes place, the occasion upon which behavior occurs, the behavior itself, and the consequences of behavior. The teaching machine is essentially a reinforcer. Skinner also points out the importance of the effective scheduling of reinforcement in educational design in terms of frequency and type. Overall, Skinner sees the key advantage of teaching machines in that the user has immediate feedback from the machine. Constant interchange between program and student, much like a tutor, is the goal. Skinner promotes the notion of the teaching machine as tutor in pacing students through appropriate-level material, and through prompting, hinting, and suggesting ways students can arrive at correct answers. In addition, Skinner points to the advantages of teaching machines beyond issues of behavior modification, which allow improvements in class management, asynchronistic learning, and customization.

Although instructional design has been traditionally dominated by behaviorist approaches to skill development, in recent years constructivism has begun to make inroads. Overall, the constructivist framework puts an emphasis on assisting students in constructing their own knowledge through the use of computers. An active learner elaborates upon and interprets the information presented in an instructional program. A constructivist approach need not only be of the discovery learning type, but can also focus on more direct instruction as long as the emphasis is on going beyond the information given. For constructivists, context is an integral part of meaning. Consequently, constructivists propose working with concepts in complex computer environments that lead to seeing complex interrelationships. Constructivists believe that when learning occurs in isolation as separate topics, the learning remains inert. The goal is to create a computer environment in which tasks take on meaning in a larger context.

Critics of Skinner's position on technology point to his overemphasis on changed behavior as learning. His methods are useful in utilizing repetitive learning methods, they claim, but do not begin to get at the real potential of a teaching machine. Skinner misses the real value of educational technology because he focused on reinforcement of behavior rather than on the potential of a new learning tool that can assist deeper and more creative thinking. Critics of the application of constructivism to educational technology raise problems such as the effectiveness of constructivist instruction when it tries to cover too much material, the lack of concern with the skill level of students, and the reliability of evaluation methods. Furthermore, contrary to the constructivists, some argue that there are different organizations of knowledge required to promote different learning outcomes, and that the learner need not always be in control.

PRACTICAL APPLICATIONS

While the scope of this entry is too limited to go into detail on any one technique, one can sketch out some basic trends in the application of major learning theories.

Probably one of the most high-profile figures in the computer-enabled learning field is Seymour Papert from MIT. Papert (1993) sees value in not only having students use computer applications, but in learning how to use programming languages. Seymour Papert's computer language Logo is designed to give children an opportunity to create simple computer programs by moving a turtle in different directions on the computer screen. He emphasizes a constructivist approach and puts forward the notion of "mathetics," by which he means the art of learning. Papert sees a revolutionary idea in mathetics in which learners take control of their own learning. He believes that the use of simple programming languages allows students to learn by a process he terms "bricolage." Bricolage is a style of organizing thinking that is negotiatory rather than planned in advance. By placing themselves inside the symbolic universe of computer programming and trying to move about, the students are put in close proximal relationship to their problem.

Related to Papert's work is the research on concept mapping with computers. Concepts maps are spatial or graphic representations of concepts and their interrelationships that are intended to represent human knowledge structures. First, concept maps put learners in control of the learning experience in a very direct way. In addition, the concept-mapping metaphor has the potential to become the primary form of desktop interface and consequently change the way humans work and learn with the computer. In fact, interfaces based on concept mapping have been developed, and programs such as Microsoft Frontpage already use concept mapping for Web-page design. Also, concept mapping fits the cognitive research that likens the activity in the human brain to networks, or interrelated clusters of thought. The basic premise behind the use of concept mapping in computers is that by making graphically explicit the structure of thinking, students can better understanding the learning process. Furthermore, these concept maps can be used to assess student learning. Rather than just relying on quantifiable outcomes, teachers can look at student concept maps and really get a good understanding of the student's thought process. Additionally, teachers evaluating concepts maps can more easily understand at what point in the thought process students are having trouble making linkages. Concept mapping can be used to orient students, articulate prior and final knowledge, exchange ideas among students, convert knowledge from seeming unrelated fields, and diagnose errors. While concept mapping can be done without technology, computers give students a powerful tool to manipulate concepts in a quick and graphically vivid manner.

Probably one of the most exciting tools for learning is in the development of intelligent tutors. As many have noted, the application of Dewey's educational philosophy puts an enormous load on the teacher, one that is impractical for a broad-based application. Computers have the potential of meeting this need for labor through the development of intelligent tutors. Many of the programs thus far developed as tutors in training applications have been behaviorist in orientation. Partly, this is because of the limitations of the software itself. However, as research in computer agents and artificial intelligence advances, this will change. One way in which this is already changing is in the area of intelligent agents for research. Applied to the Internet, intelligent agents can track the tendencies of the user and then collect information that fits the user's interests. What is missing in the intelligent tutor applications of present are the more advanced functions of a human teacher that can lead a student in new conceptual directions and make connections that are not readily apparent. While it may be true that artificial intelligence will never reach the point where it can serve as a tutor on the level of a human teacher, techniques such as the incorporation of randomness and intelligent agents customized to the fit the user's interests may serve as useful tools approximating the function of a tutor.

Much has been written about hypertext and hypermedia and their usefulness in education. Hypertext and hypermedia in some ways mimic how the brain works in making quick and easy associa-

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