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FACILITATING LEARNING

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Introduction

> Educational technology is the study and ethical practice of *facilitating learning* and improving performance by creating, using, and managing appropriate technological processes and resources.

Focus on Learning

The definition begins with the proposition that "educational technology is the study and ethical practice of *facilitating learning* . . ." indicating that helping people to learn is the primary and essential purpose of educational technology. All of the AECT definitions since 1963 have referred to learning as the end product of educational technology. However, the definitions have differed regarding the strength of the connection between technological interventions and changes in learner capability.

Prior focus on messages and control. The 1963 definition centered the field on the "design and use of messages which *control* the learning process" (Ely, 1963, p. 18). In this version, the focus is on messages, specifically, messages that *control* learning. The 1963 definition makes the strongest connection between learning and educational technology interventions. Januszewski (2001) proposed that the word *control* had two connotations, which were derived from the dominant theories at that time: the behaviorist learning-theory notion that consequences of behaviors determined whether or not they were learned and the communication-theory notion that processes were regulated by feedback (pp. 42–43).

Prior claim of management of learning. Aside from the official definitions, the notion of control or management has long had strong support within the field. For example, Hoban (1965) observed that "the central problem of education is not learning but the management of learning, and that the teaching-learning relationship is subsumed under the management of learning" (p. 124). Later, in outlining the parameters for research in educational technology, Schwen (1977) proposed that inquiry should center on "the management-of-learning problem." Heinich (1984) also emphasized technology's commanding role: "The basic premise of instructional technology is that all instructional contingencies can be managed through space and time" (p. 68).

Prior focus on processes. Various definitions proposed in the 1970s focused on instruction, problem solving, and systematic design, with little mention of learning processes or outcomes. The Commission on Instructional Technology (1970), for instance, used the expression to "bring about more effective instruction" (p. 19) rather than mentioning learning, using theory from communications and systems as its base. In the Silber (1970) definition, the focus was on solving educational problems. Learners, and their learning improvement, were not mentioned explicitly in the definition. And in another definition of that period, the field was described as a study of the systematic means by which educational ends are achieved (Seels & Richey, 1994, p. 19).

The AECT (1977) and Seels and Richey (1994) definitions focused more on the processes that constitute the work activities of educational technology and then name human learning as the end purpose of those processes without specifying either "controlling" or "facilitating" learning. The 1977 definition returned to the idea of "involving" people and other resources to analyze problems and implement solutions to those problems "involved in all aspects of human learning." While this definition seems to focus on problem solution, which may or may not be learning, the complex nature of this definition (16 pages of it) and the many elements of learning resources and organizational structures, in some ways, may foreshadow the current definition terms. Facilitating learning does involve a complex organization of processes and resources including people, materials, settings, and so on. But facilitating learning puts the emphasis on the learners and their interests and abilities (or disabilities), rather than on an outside entity identifying and defining the "problem" to be solved. In this view, learners have more responsibility for actually defining what the learning problem will be as well as controlling their own internal mental processes.

The 1994 definition again defined the field primarily in terms of its work activities. These work activities yield "processes and resources for learning" but the center of the definition seems to be on the work activities rather than on the learner or learning.

An earlier definition foreshadowing the current one. Given the commonness of the notion of management and control in the 1970s, it is somewhat surprising that the 1972 definition comes close to the current one: "Educational technology is a field involved in the *facilitation* of human learning . . ." (Ely, 1972, p. 36). The authors of the 1972 definition consciously chose the term *facilitation*, as did the current authors, in order to loosen the connotation that either messages or methods *determine* learning outcomes. *Facilitate* is meant to convey the contemporary view that learning is controlled internally, not externally, and that an external agent can, at best, influence the process.

To summarize, all of these definitions in one way or another specify that learning is the purpose toward which educational technology is aimed. The current definition, like the 1972 one, explicitly adopts the term *facilitate* to avoid connotations of management or control. This is meant to reflect current views about how learning occurs. This term suggests synonyms such as promote, assist, and support, which is what external agents—such as teachers—can do, while learners themselves actually manage and control their own learning.

Chapter Purposes

Facilitating learning appears to be a simple, nonthreatening phrase. Its denotation is clear enough. Buts its connotations are associated with years of research, debate, divergent philosophies, and unresolved issues. The goal in this chapter is to present a framework for thinking about the variables involved in facilitating learning through the lenses of divergent scholarly perspectives. Therefore, this chapter presents multiple perspectives on the teaching-learning process, trying to provide a balanced overview of the differences in terminology and consequences of these perspectives for educational technology. It also discusses informal and formal learning activities and instructional methods, and considers the assessment and evaluation of learners whose learning has been facilitated using these activities.

From Learning Theory to Instructional Theory

Learning theories attempt to *describe* how humans learn. They provide an account of what are the key elements in the process of gaining new knowledge and capabilities and how those elements interact. For example, behaviorism focuses on the observable events that precede and follow certain behaviors; cognitivism focuses on inferred mental conditions—the chain of internal activities associated with learning. Learning theories are useful to the extent that they allow us to articulate issues sensibly and to conduct inquiry to test hypotheses that flow from the theory.

It is quite another question to construct *instructional* theories, which attempt to *prescribe* teaching methods, to create the best conditions to help learners to acquire new knowledge and capabilities. The descriptive-prescriptive distinction is discussed at some length in Reigeluth (1983), with Reigeluth, Gropper, and Landa providing logical analysis and examples to illustrate the distinction (pp. 21–23, 50–52, 59–66). They make the point that practical "implications" do not flow directly or easily from descriptive abstractions. As one philosopher of education (Phillips, 1994) points out,

> [A] defect of the 'isms' approach was that it was based on the untenable conception of 'implication.' In order to draw implications from an abstract or theoretical premise, other premises are required which link the first premise to the practical domain of interest. . . . The point is that these matters cannot be decided by deducing them in a simple way from some abstract philosophical position. (p. 3864)

Unfortunately, many learning theorists themselves set a bad example by leaping to conclusions about the instructional implications of their theories. It is no wonder that many other adherents of learning theories, convinced of their descriptive accuracy, quickly rush to spell out practical implications, which they assume to have as much prescriptive as descriptive accuracy. This conflation of learning theory and instructional theory leads to barren arguments about the merits of one theory or the other. Champions of a particular learning theory, which may have a strong grounding in research and is therefore a quite useful *description* of how people learn, sometimes forcefully argue that their *prescriptive* instructional implications must be equally true whether or not they have been tested and upheld empirically.

At this time, it is conventional to group the various theories of learning into three broad categories: behaviorism, cognitivism, and constructivism (e.g., see Ertmer & Newby, 1993). Each of these bodies of theory, as well as others, has its adherents. Each, some would claim, has suffered from overly enthusiastic advocacy of particular instructional solutions prematurely derived from a descriptive learning theory. The most recent victim of this confusion is constructivism. As Kirschner, Sweller, and Clark (2006) point out, "The constructivist description of learning is accurate, but the instructional consequences suggested by constructivists do not necessarily follow" (p. 78). Or, as the criticism was framed by Bransford, A. L. Brown, and Cocking (2000),

> A common misconception regarding "constructivist" theories of knowing (that existing knowledge is used to build new knowledge) is that teachers should never tell students anything directly but, instead, should always allow them to construct knowledge for themselves. This perspective confuses a theory of pedagogy (teaching) with a theory of knowing. (p. 11)

To avoid a lengthy, hair-splitting descriptive-prescriptive analysis, we will simply refer to each body of thought as a "perspective," not distinguishing rigorously between the descriptive learning theories and the prescriptive instructional theories within each body of thought. The goal is to represent each perspective roughly as it appears in the literature of educational technology.

Perspectives Have Consequences

How one creates, uses, and manages learning resources depends greatly on one's beliefs about how people learn. For example, a teacher inspired by the behaviorist perspective would be expected to determine what the learner already knows, select an appropriate goal for that learner, provide prompts to guide them toward desired behaviors, and arrange reinforcers for those desired behaviors. On the other hand, a teacher inspired by Montessori's (2004) developmental perspective would be expected to determine a child's developmental status, select an appropriate work activity, model that activity, and step back to observe and support the child's efforts to master the new task.

One's view of how learning takes place can also affect decision making about educational policies. If one considers learning to be under the control of teachers—believing that teaching equals learning—it is entirely reasonable to support policies that make teachers directly accountable for student test results. The teacher is the worker and student learning is the product produced. The assumption is that if teachers "work harder" students will learn better. A variation of this viewpoint is that of the student as customer, a metaphor that has become quite popular in higher education and corporate training, often called "learner-centered teaching." The student is seen as the recipient of services provided by the teacher, akin to getting a haircut. In this view, teaching is something done *to* learners, so, obviously, the service provider is the one accountable for the results.

However, if one views learning as being primarily under the control of learners (a constructivist view), teachers and students are seen more as collaborators in a common enterprise. They are coproducers of students' learning accomplishments. Nothing happens until the students do their part of the coproduction. In this view, a more appropriate model is psychotherapy rather than hair cutting. The student is not a customer but a worker doing the hardest part of constructing new knowledge, skills, and attitudes. This view would imply educational policies focused on student motivation to achieve. Teachers would be accountable for doing *their part* of the job professionally but would not be expected to take full responsibility for what students do and do not learn. The issue of motivation and who has control of it is discussed near the end of this chapter and in chapter 3.

Learning Defined and Viewed From Different Perspectives

Learning can be defined as "a persisting change in human performance or performance potential . . . . as a result of the learner's experience and interaction with the world" (Driscoll, 2005, p. 9). Different theories of learning regard different elements of the process as being of paramount importance, and they use a different vocabulary to describe the underlying processes that they believe are occurring within the learner. In the remainder of this chapter, the behaviorist, cognitivist, and constructivist perspectives are each discussed briefly regarding their main elements, emphases, and relationship to educational technology concerns. To these three categories is added the category of "eclectic," reflecting the widely accepted view that theory and practice can be enlightened by viewing problems through different lenses or even combining lenses.

Behaviorism

The name "behaviorism" refers collectively to several quite diverse bodies of thought in psychology and philosophy. This discussion will focus on radical behaviorism because its operationalization, operant conditioning, has had the greatest practical impact on theory and practice in educational technology (Burton, Moore, & Magliaro, 2004). Operant conditioning involves the contingent relationships among the stimuli that precede a response, the response itself, and the stimuli that follow a response, that is, the consequences of the behavior (p. 10). B. F. Skinner (Ferster & Skinner, 1957) discovered that by manipulating these three variables, he could elicit quite complex new behaviors from laboratory animals. Other researchers found that humans, too, responded in similar ways to certain types of consequences or reinforcers.

Behaviorism in Educational Technology. Prompted by his own experiences with schools as a parent, Skinner (1954) became interested in the possibility of applying operant conditioning to academic learning. His analysis of the problems of group-based traditional instruction and his invention of a mechanical device for interactive learning, referred to as a "teaching machine," gained national attention. The pedagogical organization of stimuli, responses, and reinforcers in teaching machines became known as programmed instruction, and programmed instruction lessons in book format were published in great profusion in the 1960s. By the mid-1960s, Skinner (1965; 1968) viewed programmed instruction as a practical application of scientific knowledge to the practical tasks of education and so he referred to his instructional strategies as a "technology of teaching." Other authors converted this term to *educational technology*; an early example is *Educational technology: Readings in programmed instruction* (DeCecco, 1964).

Teaching machines and programmed instruction. Between 1960 and 1970, the research focus of what had been the audiovisual education field shifted sharply toward work on teaching machines and programmed instruction, prompting the change of the name of the field to educational technology. Torkelson (1977) examined the contents of articles published in *AV Communication Review* between 1953 and 1977 and found that the topics of teaching machines and programmed instruction dominated the journal in the 1960s. In fact, between 1963 and 1967, these topics represented a plurality of all articles published.

Programmed tutoring. Programmed tutoring was developed to overcome some of the weaknesses of programmed self-instructional materials, specifically, their being limited to "knowledge of correct response" as a reinforcer and their totally expository strategy. In Ellson's (Ellson, Barner, Engle, & Kempwerth, 1965) programmed tutoring, a live person, usually a peer learner, followed instructions in leading the tutee through practice exercises, giving social reinforcers (a nod, a smile, an affirming phrase) when correct and hints toward a solution ("brightening") when incorrect. The brightening technique was meant to make the experience more of a discovery activity, in which learners figured out the answers rather than being told them. A meta-analysis of programmed and structured tutoring programs showed tutees scoring around the 75th percentile compared to the 50th percentile for conventional instruction (Cohen, Kulik, J. A., & Kulik, C. C., 1982); this difference is one of the largest ever recorded in research comparing methods.

Direct Instruction. Direct instruction (DI) is an empirically based, scripted method for small group instruction; it provides fast paced, constant interaction between students and the teacher (Englemann, 1980). Although it is not consciously derived from behaviorism, its procedure visibly applies behaviorist prescriptions, particularly continuous learner responses to teacher prompts followed by reinforcement or remediation, as appropriate. A large-scale comparison of 20 different instructional models used with at-risk children showed DI to be the most effective in terms of basic skills, cognitive skills, and self-concept (Watkins, 1988). After more than a quarter century of implementation, DI established a solid record of demonstrated success (Adams & Engelmann, 1996). Further, it was found to be one of three comprehensive school reform models "to have clearly established, across varying contexts and varying study designs, that their effects are relatively robust and . . . can be expected to improve students' test scores" (Borman, Hewes, Overman, & Brown, S., 2002, p. 37).

Personalized System of Instruction (PSI). F. S. Keller's (1968) Personalized System of Instruction (PSI), or "Keller Plan," is a method for organizing all the material of a whole course or curriculum. The subject matter is divided into sequential units (could be chapters of a textbook or specially created modules) that are studied independently by learners, progressing at their own pace. At the end of a unit, learners have to pass a competency test before being allowed to go forward to the next unit. Immediately after the test, they receive coaching from a proctor to correct any mistakes. This procedure protects students from accumulating ignorance and falling further and further behind if they miss a key point (Keller, F. S., 1968). The self-pacing and immediate remediation are the elements that lend a degree of personalization. During the period it was being tested at many colleges and universities, the 1960s and 1970s, it was the most instructionally powerful innovation evaluated up to that time (Kulik, J. A., Kulik, C. C., & Cohen, 1979; Keller, F. S., 1977).

Behaviorism's major impact on educational technology has been on the soft technology side, contributing several templates or frameworks for instruction—such as programmed instruction, programmed tutoring, Direct Instruction, and PSI (Lockee, Moore, & Burton, 2004). As hard technology advanced, these frameworks were incorporated in mechanical, electro-mechanical, and ultimately, digital formats, such as computer-assisted instruction (CAI) and online distance education.

Computer-assisted instruction (CAI). Experiments in CAI began just at the time that programmed instruction was at its peak, so many of the early CAI programs followed a drill and practice or tutorial format resembling programmed instruction: small units of information followed by a question and the student's response. A correct response was confirmed, while an incorrect response might branch the learner to a remedial sequence or an easier question. Beginning in the mid-1960s, the CAI research and development program at Stanford University, later the Computer Curriculum Corporation, created successful drill and practice materials in mathematics and reading, later adding foreign languages (Saettler, 1990, p. 308).

More innovative and more learner-centered programs were developed in the TICCIT project at Brigham Young University in the 1970s. These sophisticated programs yielded successful programs in mathematics and English composition. However, both the Stanford and TICCIT programs failed to gain major adoption in their intended sectors, K–12 and community college education (Saettler, 1990, p. 310).

The PLATO project at University of Illinois began in 1961, aiming to produce cost-efficient instruction using networked inexpensive terminals and a simplified programming language for instruction, TUTOR. Most of the early programs were basically drill and practice with some degree of branching, but a wide variety of subject matter was developed at the college level. Over time, terminals at outlying universities were connected to the central mainframe in a timesharing system, growing to hundreds of sites and thousands of hours of material available across the college curriculum. As software development continued, many innovative display systems evolved, including a graphical Web browser. With experience and with more capable hardware, more varied sorts of instructional strategies became possible, including laboratory and discovery oriented methods.

The PLATO system pioneered online forums and message boards, e-mail, chat rooms, instant messaging, remote screen sharing, and multiplayer games, leading to the emergence of what was perhaps the world's first online community (Woolley, 1994). It continued to grow and evolve right through the early 2000s, sparking the expansion of local CAI development and finding a niche in military and vocational education.

Behaviorism and Facilitating Learning How has behaviorism contributed to facilitating learning? For one thing, the behaviorism-based technologies demonstrated that it is possible to achieve dramatic achievement test gains through careful control of the contingencies among stimuli, responses, and consequences, as claimed. Thorough analysis of learning tasks, precise specification of objectives, subdivision of the content into small steps, eliciting active responses, and giving feedback to those responses constitute a successful formula, at least for certain types of learning goals. In addition, the planning process required to produce lessons of this sort gave birth to the larger planning methodology now known as instructional systems design (Magliaro, Lockee, & Burton, 2005).

Programmed instruction demonstrated that individual learners could work effectively at their own pace without the guidance of a live teacher, freeing instruction from the teacher-centered, group-based paradigm. In doing so, it also made the learner an active participant in the learning process, not active in the sense that learners had control of the process, but in the sense that they needed to respond overtly and thoughtfully at frequent intervals, requiring them to stay engaged with the material.

Last but not least, behaviorism, because it does not focus on internal cognitive processes, is not limited to use in the cognitive domain. The behaviors that are taught and learned may combine cognitive, affective, and motor dimensions. Behaviorist approaches have been applied effectively to athletic skills and attitudes as well as to intellectual skills.

However, despite the impressive track record of behaviorally based technologies of instruction in experiments and field trials, their reception in public education has been lukewarm at best. Adoption, where it has taken place, has been slow and piecemeal. This might be attributed both to the nature of academic learning and the nature of educational organizations. First, the learning outcomes in most of these projects are measured in terms of test scores. What some people understood in the 1960s and what more people understood 40 years later is that what students regurgitate on tests tends to be forgotten or ignored as they walk out the classroom door. Early skeptics were concerned whether the new knowledge gained through programmed instruction would be transferred to real-world problems or to future lessons. If students are gaining "inert knowledge," what is the advantage if it is learned 25% faster or better? Educators also questioned whether students in these treatments were gaining the skills, such as metacognitive ability, and attitudes, such as ownership of their learning, needed to help them become self-initiating lifelong learners.

Second, the organizational structures of schools and colleges are not conducive to innovations that require radical change in those structures, such as those proposed in programmed instruction, direct instruction, and PSI. To make sense economically, the costs of any technology must be self-liquidating, as they are in business and other sectors of the market economy. In order to become self-liquidating, technological interventions must replace costly human labor to some extent. This conflicts with the interests of those now doing the labor.

As Heinich (1984) pointed out a generation ago, technologies threaten power relationships within the organization and "as technology becomes more sophisticated and more pervasive in effect, consideration of its use must be raised to higher and higher levels of decision making" (p. 73). As Shrock (1990) put it,

> We can anticipate that teachers comfortable with their traditional role in the classroom will suppress any technology that threatens that role. Unfortunately, the traditional role preferred by most teachers—teacher centered, large group, expository, text supported teaching—is largely incompatible with the recommendations of instructional technologists (and the results of educational research). (p. 25)

Of course, it is not just resistance by teachers that impedes the acceptance of methods that would require rather major restructuring. Schools are complex enterprises, with many different power centers and constituencies, each having expectations and interests at stake. So it is not surprising that the behaviorism-based innovations—as well as other technology-based innovations—have been considered unaffordable or have tended to be resisted in terms of large-scale adoption, at least in most school systems in the United States.

Cognitivism

Like behaviorism, *cognitivism* is a label for a variety of diverse theories in psychology that endeavor to explain internal mental functions through scientific methods. From this perspective, learners use their memory and thought processes to generate strategies as well as store and manipulate mental representations and ideas. Theories that would later become very influential were being developed in the 1920s and 1930s by Jean Piaget in Switzerland and Lev Vygotsky in Russia, but these did not have significant impact on American educational psychology until translations were widely circulated in the 1960s. Cognitive theories gained momentum in the United States with the publication of Jerome Bruner's (1960) *The Process of Education*, the dissemination of Piaget's and Vygotsky's works, and the emergence of information-processing theory in the late 1960s. By 1970, when the journal *Cognitive Psychology* was begun, the cognitive perspective had gained not only legitimacy but also dominance.

Piaget's theory. Jean Piaget, a biologist, became deeply interested in the thought processes of doing science, especially in the development of thinking, which he called "genetic epistemology." Through interviews with children, he developed the theory that young children build up classification systems and try to fit the objects and events of their everyday experiences into the existing framework (he called this *assimilation*). When they encountered contradictions—things that just did not fit—they modified their mental structures (he called this *accommodation*). As he continued his investigation of children, he noted that there were periods where assimilation dominated, periods where accommodation dominated, and periods of relative equilibrium, and that these periods were similar across many different children, leading him to conclude that there were fixed stages of cognitive development.

Information processing theory. Another branch of cognitivism, information processing theory, uses the computer as a metaphor and views learning as a series of transformations of information through various (hypothesized) mental processes. It focuses on how information is *stored in memory.* In this theory, information is thought to be processed in a serial, discontinuous manner as it moves from one stage to the next, from sensory memory, where external stimuli are detected and taken into the nervous system, to short-term memory, to long-term memory (Atkinson & Shiffrin, 1968).

Schema theory. An approach that is more congruent with Piaget's theories, schema theory, suggests that material stored in long-term memory is arranged in organized structures that are amenable to change and that store knowledge in a more abstract form than our specific, concrete experiences. Ausubel's (1963) subsumption theory proposes that meaningful verbal learning involves superordinate, representational, and combinatorial processes that occur during the reception of information. A primary process is subsumption, in which new material is integrated with relevant ideas in the existing cognitive structure.

Cognitive load theory combines notions from information processing and schema theories, proposing that novices become experts as they expand and enhance their mental schemata. However, for schema acquisition to occur successfully the cognitive load should be controlled while processing is taking place in working memory because working memory has a finite capacity (Sweller, 1988).

Neuroscience. The neuroscience approach has become feasible only with the development of imaging technologies that allow observation of neurological activities. It attempts to understand mental processes by more or less direct observation of the physical functioning of the brain and nervous system. Leamnson (2000) provides an accessible account of the biological basis of learning, referring to the functioning of neurons, dendrites, and axons. Learning consists essentially of creating and stabilizing synaptic connections among neurons. Within the brain, the frontal lobes are the major site of organizing thoughts, and the frontal lobes communicate with the limbic system, site of emotion. Leamnson sees the challenge of education being to arouse emotions that inspire learners to focus on the learning tasks (p. 39). Winn (2004) suggests that the information-processing view of cognitivism has been losing favor in light of new evidence, particularly evidence from neuroscience.

In summary, cognitivism differs from behaviorism in its belief that the internal mental processes can and must be understood in order to have an adequate theory of human learning. There are differing hypotheses about how those internal processes operate.

Cognitivism in Educational Technology. Cognitivist instructional theories focus more on the presentation side of the learning equation—the organization of content so that it makes sense to the learner and is easy to remember. The goal is to activate the learner's thought processes so that new material can be processed in a way that it expands the learner's mental schemata.

Audiovisual media. Audiovisual technology, which could stimulate multiple senses, provided new tools to surmount the limitations of the textbook and teacher talk. Since the early days of the visual instruction movement, represented by C. F. Hoban, C. F. Hoban, Jr., and Zisman (1937), the field struggled against empty verbalism or rote memorization. Dale (1946), an early advocate of rich learning environments, expanded the notion of visual instruction by proposing in his Cone of Experience that learning experiences could be arrayed in a spectrum from concrete to abstract, each with its proper place in the tool kit. The prescriptions given in this era tended to be drawn from Gestalt psychology, which attempted to describe how humans and other primates perceived stimuli and used cognitive processes to understand and solve problems. The Gestaltists insisted that an understanding of human psychology required tools beyond those of scientific observation; they sought a unified study of psychology, rejecting the mind-body dichotomy and dealing with thoughts and feelings, aimed at understanding the human experiences of insight, creativity, and morality.

The Gestalt perspective, with its original emphasis on sensory perception and how humans construct meaning from bits and pieces of auditory and visual information, had great appeal to those in audiovisual education.

Visual learning. Educational technology's long and deep interest in message design, based on the principles of visual perception, fits into this agenda. A wide variety of theories, some derived from the Gestalt paradigm and some fitting under the conventional cognitivist umbrella, have been proposed to explain how humans construct and interpret visuals, according to Anglin, Vaez, and Cunningham (2004). In addition, a wide variety of classification schemes have been proposed for the various purposes that instructional visuals can serve. For example, Alesandrini (1984) proposes three broad categories: representational (pictures that resemble the thing or idea pictured), analogical (showing known objects and implying a similarity to the unknown concept), and arbitrary (charts or diagrams that attempt to organize thinking about a concept but do not physically resemble it). Others propose categories focusing on more specific mental functions, such as decorative, representational, mnemonic, organizational, relational, transformational, and interpretive (Carney & Levin, 2002; Lohr, 2003; Clark, R., & Lyons, 2004).

Regardless of these disagreements, researchers have identified a body of principles and generalizations about the juxtaposition of visuals and text that have informed the practice of message design—the layout of image and text to help learners to focus on important features and to understand and remember key ideas (Fleming & Levie, 1993; Lohr, 2003). Usability testing on Web pages is reconfirming the message design principles discovered in the predigital era.

Auditory learning. Learning based on hearing, too, has been examined through the lens of cognitive theories regarding the processing, storing, and retrieving of auditory information (Barron, 2004). Barron's review of research on auditory, visual, and verbal processing suggests that these sensory modalities are processed differently in the brain (p. 957). Many variables affect the productive use of audio materials in instruction, including cognitive load. The situation becomes even more complex when considering the combination of audio, visual, and verbal information in multimedia learning. Moore, Burton, and Myers (2004) attempt to summarize the rather disparate findings of research on multiple-channel presentations by observing that

> The human information processing system appears to function as multiple-channel system until the system capacity overloads. When the system capacity is reached, the processing system seems to revert to a single-channel system. (p. 998)

Overall, they do not consider the research on multiple-channel communication to offer reliable guidance for practice for instructional designers (p. 998), nor is it clear that the cognitivist information-processing model is the most fruitful one for continuing research in this area.

Digital multimedia. In more recent times, the computer captured the attention of cognitivists. First, the digital format can present multimedia displays more easily and more cheaply than was possible with earlier analog equipment. Learner use of multiple sensory modalities as presented in computer multimedia more closely resembles the natural human cognitive system. Second, computers can transform information from one symbol system to another. For example, you can input mathematical data and the computer can transform those data into graphs. In addition, the hypertext capability of computers allows the linking of ideas, both by authors and by learners. Kozma and Johnston (1991), looking at computer capabilities even before the spread of the World Wide Web, speculated about ways in which computers could advance the cognitivists' agenda:

- "From reception to engagement," moving from passive reception of lectures to more active involvement in immersive environments.
- "From the classroom to the real world," suggesting that technology can bring problems and resources from the real world into the classroom, and can allow students' learning to be focused outside of their classroom environment through resources and people they have access to through the Web.
- "From text to multiple representations," enabling the use of mathematical, graphical, auditory, visual, and other systems instead of just verbal symbols.

- "From coverage to mastery," using simulations, games, and drill-and-practice programs that encourage repeated practice of basic skills until they are automatized.
- "From isolation to interconnection," transforming the learner experience from a solitary one to a collaborative one.
- "From products to processes," helping students to engage in the work processes—and the ways of thinking—in their chosen field.
- "From mechanics to understanding in the laboratory," enabling students to use computer simulations that allow them to explore more hypotheses and cover more different processes in less time and at less expense. (pp. 16–18)

Cognitivism and Facilitating Learning. How has cognitivism contributed to facilitating learning? To begin with, we must acknowledge a limitation of cognitivist theory; it is meant to apply to learning in the cognitive domain—knowledge, understanding, application, evaluation, and metacognition. It has much less to say about motor skills or attitudes except as regards the cognitive elements of those skills.

Cognitivism's emphasis on careful arrangement of the content to make it meaningful, comprehensible, memorable, and appealing draws attention to message design issues. Cognitivist prescriptions include showing learners how the new knowledge is structured (e.g., advanced organizers), calling their attention to the salient features by stating objectives, chunking the material into digestible units, laying out text for easy comprehension, and complementing the text with helpful visuals (Silber, K. H., & Foshay, 2006, p. 374).

Both information-processing theory and schema theory suggest that the sequence of mental steps is an important part of facilitating learning, so instructional theorists have proposed a number of lesson frameworks or templates for arranging the steps of a learning event (Molenda & Russell, 2006, pp. 351–360). An example of such a lesson framework is Gagne's (Gagne & Medsker, 1996, p. 140) Events of Instruction, which recommends a specific sequence of events for a successful lesson: (a) Gain the learners' attention by telling them or dramatizing the reason for mastering this skill; (b) tell them clearly what they are expected to be able to do after the learning session; (c) remind them of what they already know and how the current lesson builds on that; (d) demonstrate the new skill or present the new information; (e) guide the learners in mastering the content by suggesting mnemonic devices, asking questions, or giving hints; (f) provide opportunities to practice the new knowledge or skill; (g) during the practice, confirm correct responses or desired performance and give feedback to help learners overcome errors; (h) test the learners' mastery, preferably by having them use the new knowledge, skills, and attitudes in real or simulated problem situations; and (i) help the learners transfer their new skills by giving them on-the-job practice or simulated practice involving varied problems.

Conducting a lesson in this sequence exemplifies an expository or deductive approach: telling the learners "the point"—the concept, rule, or procedure they are supposed to master—and then letting them apply "the point" in some practice setting. Sometimes a discovery or inductive approach may be specified, putting practice and feedback (steps f and g) before stating objectives, review of prior learning, presentation, and learning guidance (steps b, c, d, and e).

Another lesson framework based on cognitivist instructional theories is offered by Foshay, K. H. Silber, and Stelnicki (2003) in the form of "a cognitive training model." They recommend 17 specific tactics organized around five strategic phases: (1) gaining and focusing attention, (2) linking to prior knowledge, (3) organizing the content, (4) assimilating the new knowledge, and (5) strengthening retention and transfer of the new knowledge (p. 29). Examples of the tactics recommended by Foshay et al. are shown in Table 2.1.

Their five stages overlap with Gagne's (Gagne & Medsker, 1996) Events of Instruction, but there are some differences in content and emphasis. The cognitive training model puts special emphasis on the tasks of organizing and linking the new information; it integrates motivational elements from J. M. Keller's (1987) ARCS model; and it provides specific guidance for organizing information, in terms of chunking, layout, and use of illustrations.

Table 2.1. Selected examples of instructional tactics recommended in the Cognitive Training Model.

Learning Stage	Supporting Instructional Tactics
1. Select information to attend to	E.g., tell learners "what's in it for me."
2. Link new information to existing knowledge	E.g., compare and contrast new information and existing knowledge.
3. Organize the information	E.g., employ "chunking"—organize and limit the information according to information processing limits.
4. Assimilate new information with existing knowledge	E.g., demonstrate real-life examples of how the new knowledge is applied.
5. Retain and transfer knowledge	E.g., give practice in real or simulated setting.

Note: Adapted from Figure 2.2 in *Writing training materials that work,* by W. R. Foshay, K. H. Silber, and M. B. Stelnicki. San Francisco: Jossey-Bass/ Pfeiffer, 2003.

Constructivism

The most talked about learning perspective of the past decade is labeled *constructivism*. It is difficult to characterize the claims of *constructivism* because there are a number of claimants embracing a diversity of views. The label itself is most closely identified with the self-educated philosopher, logician, linguist, and cognitive theorist, Ernst von Glasersfeld (1984), beginning with his treatise, *An introduction to radical constructivism*. Von Glasersfeld (1992) attempted to construct an epistemology, a theory of knowing, in which the "experiential world is constituted and structured by the knower's own ways and means of perceiving and conceiving, and in this elementary sense it is always and irrevocably subjective."

The Problem of Defining Constructivism. However, the authors who were probably most influential in introducing *constructivism* to the educational technology audience in North America—Bednar, Cunningham, Duffy, and Perry (1991)—did not refer to von Glasersfeld as a source. Their primary source for a "new epistemology" was Lakoff (1987) and his work in sociolinguistics (although Lakoff used the label *experientialism*, not *constructivism*, for his theory of language acquisition). In discussing instructional applications of constructivism, these authors gave the examples of situated cognition, anchored instruction, cognitive flexibility, problem based learning, cognitive apprenticeship, and everyday cognition (although none of these theories are based on either von Glasersfeld's or Lakoff's epistemology). After the introduction of Bednar et al., the most visible advocates for *constructivism* in educational technology—Duffy, Cunningham, and Jonassen (e.g., Jonassen, 1991; Duffy & Jonassen, 1992; Duffy & Cunningham, 1996) used *constructivism* as an umbrella term for a wide range of ideas drawn primarily from recent developments in cognitive psychology (which were not necessarily dependent on a "new epistemology"). Piaget and Vygotsky are also usually cited as formative influences on the development of this perspective.

Vygotsky observed that mental abilities developed through social interactions of the child with parents, but also other adults. Through these interactions, children learn the habits of mind of their culture—speech patterns, written language, and other symbolic knowledge that influence how they construct knowledge in their own minds. Because of the importance of social and cultural influences in his theory, it is termed a *sociocultural* approach to learning and the branch that follows this theory is often termed *social constructivism*.

Philosopher D. C. Phillips (1995) pointed out the semantic morass that had come to hinder discourse about "constructivism":

> The rampant sectarianism, coupled with the array of other literatures that contain pertinent material, makes it difficult to give even a cursory introductory account of constructivism, for members of the various sects will object that their own views are nothing like this! (p. 5)

Phillips (1995) examined a number of authors or groups of authors, holding widely divergent and sometimes conflicting views, who are most closely associated with the various sects of constructivism: Ernst von Glasersfeld, Immanuel Kant, the feminist epistemologists, Thomas S. Kuhn, Jean Piaget, Lev Vygotsky, and John Dewey (pp. 6–7).

An analysis of "constructivist didactics" by Terhart (2003) attempted to parse out which elements of constructivist didactic theory are dependent on a new paradigm and which are consistent with evolution of thought within cognitivism. He concluded that it is difficult to distinguish *moderate* constructivist principles of instruction, which are the ones most frequently encountered in education literature, from cognitivist principles. On the other hand, *radical* constructivism "would ultimately render didactic thought and activity in specific subjects impossible as well as morally illegitimate" (p. 33). Terhart concludes,

> . . . [moderate] constructivist didactics really does not have any genuine new ideas to offer to the praxis of teaching. Rather, it recommends the well-known teaching methods and arrangement of self-directed learning, discovery learning, practical learning, co-operative learning in groups. I think that the 'new' constructivist didactics in the end is merely *an assembly of long-known teaching methods (albeit not practiced!*). (p. 42)

In view of these many differing and sometimes conflicting streams of thought, Driscoll (2005) concludes, "There is no single constructivist theory of instruction" (p. 386). She cites as constructivism's common denominator the assumption "that knowledge is constructed by learners as they attempt to make sense of their experiences" (p. 387). This overlaps with the assumptions of cognitivists. Where constructivists (some of them) seem to differ from cognitivists, according to Driscoll, is that they argue, that "knowledge constructions do not necessarily bear any correspondence to external reality" (p. 388). This aligns with von Glasersfeld's (1992) "irrevocably subjective" stance.

A possible solution to this labeling problem is to follow the advice of Terhart (2003) and use the label *moderate constructivist* to refer to constructivist theories and strategies that accept the assumptions of cognitivists and the label *radical constructivist* to refer to constructivist theories and strategies that depend on the subjectivist epistemology of von Glasersfeld. In the remainder of this chapter, we are discussing the moderate constructivist perspective unless otherwise indicated.

Setting aside the semantic issues, it is quite clear that the constructivist perspective is the one that holds the "commanding heights" in educational technology research and development at the beginning of the 21st century. The American Psychological Association's (1995) *Learner-centered psychological principles*, the most authoritative recent position paper on learning, features constructivist ideas as its driving force.

Constructivist Prescriptions. Prescriptive principles derived from constructivism include, according to Driscoll (2005): "1. Embed learning in complex, realistic, and relevant environments. 2. Provide for social negotiation as an integral part of learning. 3. Support multiple perspectives and the use of multiple modes of representation. 4. Encourage ownership in learning. 5. Nurture self-awareness of the knowledge construction process" (pp. 394–395). What sorts of instructional strategies are derived from these principles? We will focus on those mentioned in the early article by Bednar et al. (1991)—situated cognition (which is associated with cognitive apprenticeship), anchored instruction, and problem-based learning—plus collaborative learning.

Situated cognition. The theory of situated cognition emphasizes the notion that all human thoughts are conceived within a specific context—a time, a place, and a social setting. J. S. Brown, Collins, and Duguid (1989) point out that academic learning is situated in the classroom environment and therefore tends to become "inert knowledge," not transferred to life outside the classroom. This theory puts the social aspect at the center of the learning process, viewing expertise as developing within a community of practice.

Cognitive apprenticeship, which embodies the first two principles cited by Driscoll (2005), provides a theoretical framework for the process of helping novices become experts through one-to-one guidance. It takes a method traditionally applied in trades and crafts and applies it to learning in the cognitive domain. Dennen (2004) views cognitive apprenticeship as being grounded in "scaffolding, modeling, mentoring, and coaching . . . all methods of teaching and learning that draw on social constructivist learning theory" (p. 813).

Anchored instruction. The Cognition and Technology Group at Vanderbilt (CTGV) introduced anchored instruction as a strategy in the 1990s to incorporate the insights of situated cognition into classroom instruction. CTGV developed interactive videodiscs that allowed students and teachers to plunge into complex, realistic problems requiring the use of mathematics and science principles to solve. The video materials served as anchors or macrocontexts for a series of learning episodes. As explained by CTGV (1993), "The design of these anchors was quite different from the design of videos that were typically used in education . . . our goal was to create interesting, realistic contexts that encouraged the active construction of knowledge by learners. Our anchors were stories rather than lectures and were designed to be explored by students and teachers" (p. 52). These video materials have been often cited as examples for multimedia design and production within constructivist frameworks.

Problem-based learning. Problem-based strategies embody Driscoll's (2005) first principle, complex and realistic environments, and usually all of the other principles as well. They have been used in medical education for several decades. Since the 1990s, computer-based simulations, sometimes being self-contained ecological systems known as microworlds, have been used to immerse learners in problem spaces. These immersive environments overlap considerably with anchored instruction, but claim to emphasize first-hand involvement in, rather than observation of, problem situations. They also often entail collaborative group work, thus also embodying Driscoll's second principle of social negotiation. The group members are encouraged to reflect on their learning, thus embodying the principle of self-awareness of the knowledge construction process.

Moderate constructivists tend to recommend immersing learners in simplified versions of the problem to begin with, moving toward more complex versions as learners master the knowledge and skills needed to cope with growing complexity, as in Reigeluth's (1979) elaboration theory and Merrill's (2002) pebble-in-the-pond strategy. Radical constructivists tend to value the authenticity of the experience, not being as concerned about complexity or cognitive load.

Collaborative learning. Driscoll's (2005) second principle, social negotiation (derived from Vygotsky's theories of the sociocultural nature of knowledge), is represented in collaborative learning, which is incorporated in most of the constructivist instructional strategies discussed earlier. Computer-supported collaborative learning (CSCL) is currently the most prominent format. Roschelle and Pea (2002) speculate that wireless handheld devices will allow CSCL to evolve in new directions from those possible in traditional computer labs.

Collaborative learning is not achieved only through CSCL, of course. Educators and teachers at all levels have been using and continue to use collaboration as a strategy for learners. Classroom teachers especially have been urged to employ engaged learning activities, based upon constructivist principles, within small-group authentically based inquiries, in order to improve communication skills, problem solving and creative thinking skills, and cooperation and team learning abilities in students. These activities can be computer mediated or computer supported, or can involve the use of computer software for recording and reporting results of inquiry by students.

Constructivism in Educational Technology. The engaged learning principles as promoted by the North Central Regional Educational Laboratory (NCREL) (Tinzmann, Rasmussen, & Foertsch, 1999) include many of the components of constructivism and the use of educational technology as a tool for achieving learning. The description of engaged learning includes:

> Students are explorers, teachers, cognitive apprentices, producers of knowledge, and directors and managers of their own learning. Teachers are facilitators, guides, and colearners; they seek professional growth, design curriculum, and conduct research. Learning tasks are authentic, challenging, and multidisciplinary. Assessment is authentic, based on performance, seamless and ongoing, and generates new learning. (p. 1)

Engaged learning, as developed by teachers through the use of technology, is worthwhile when it helps students reach important district, state, or national standards. Many teachers have learned through their initial education, staff development, or inservice education to plan for student activities that represent engaged learning, are authentic, are worthwhile, and involve constructivist principles while employing educational technologies as tools for learning. Advocates of constructivism have repeatedly encouraged such development through texts and articles for educators, based upon constructivist ideals.

These advocates also frequently point out the needed changes in the methods by which learning is assessed. Assessment in these classrooms must also be authentic and focused on performance, use complex and meaningful activities, be based upon construction of knowledge rather than repetition of facts, and be conducted through observation, presentation, and other realistic, real-world-based activities (Jonassen, Howland, Moore, & Marra, 2003).

Constructivism and Facilitating Learning. How has constructivism contributed to facilitating learning? First, the strong advocacy advanced by its adherents has captured the attention of educational technologists. Since the late 1980s, the conversation within educational technology has revolved around the claims of constructivism, debating their merits and imagining their implications.

At the very least, a host of earlier innovations, such as anchored instruction, problem-based learning (PBL), and collaborative learning, have been explored as instantiations of constructivist theory. Constructivism has infused these explorations with a sense of mission.

Cautions emerging from research. The profusion of research and development has provided results that allow some conclusions to be drawn regarding the efficacy of these methods for different audiences and learning goals. One of the clearest syntheses of this research is offered by Kirschner, Sweller, and R. E. Clark (2006), who examine "minimal guidance." Problem-based or inquiry-based programs are often set up so that learners explore a problem space freely, with minimal guidance. Kirschner et al. find that, for learners who are at the novice or intermediate stage, such programs are less effective as well as less efficient than programs with strong instructional guidance. Further, minimally guided programs "may have negative results when students acquire misconceptions or incomplete or disorganized knowledge" (p. 84). They hypothesize that minimally guided learning environments subject learners to a heavy cognitive load that interferes with use of their cognitive processing abilities.

In medicine and science courses, the inquiry-based approach is often justified on the basis that it forces learners to "think like scientists." Kirschner et al. (2006) point out, "The way an expert works in his/her domain (epistemology) is not equivalent to the way one learns in that area (pedagogy)" (p. 78). So, the consistently poor results of these methods when applied to learners who are at the novice or intermediate stages should not be surprising. Going back to the original proposition of von Glasersfeld, a "new epistemology" does not necessarily equate with new or unique instructional prescriptions.

In summary, it is difficult to identify any particular learning theory or instructional strategy as unequivocally constructivist. But the instructional methods most often advocated under the guise of constructivism seem to be most suited to facilitating learning for advanced or complex learning goals being pursued by learners who already have a high level of skill in that domain.

An Eclectic Perspective

As discussed in chapter 5, an eclectic perspective, combining principles from different theories, may provide a synthesis that serves well in practice. In philosophy, blithely tacking together conflicting doctrines can produce incoherent theoretical structures, but in practical matters, eclecticism often makes sense. Educators can easily see that different theories of learning lead to instructional theories that offer guidance for different sorts of learning goals. The theories do not necessarily contradict each other; rather, they explain certain phenomena better than others. Ertmer and Newby (1993) suggest one such fairly simple formula for combining the theoretical perspectives discussed here: Employ the behaviorist perspective in situations in which learners have lower levels of task knowledge and for learning goals requiring lower cognitive processing; use the cognitivist perspective for middle levels of task knowledge and cognitive processing; and consider the constructivist perspective for situations in which learners have a higher level of prior knowledge and are working on higher level tasks, such as complex problem solving in ill-structured domains (pp. 68–69). While not all may agree with this as a recommendation, it illustrates the sort of synthesis that can flow from an eclectic approach.

Since the late 1990s, an umbrella under which different perspectives, especially cognitivist and constructivist, converge is *learner-centered* education. This concept gained wide credibility when it was endorsed by the APA Board of Educational Affairs (1995) in the form of 14 principles, shown in Table 2.2.

These principles addressed cognitive and metacognitive, affective and motivational, developmental, social, and individual differences factors. They were "learner-centered" in the sense that they attempt to derive instructional implications from research on the learning process and in the sense that they encourage adapting instruction to individual learners. The list is somewhat enigmatic in that it is a list of observations (descriptions) about the learning process, but the items are referred to as "principles," implying prescriptive advice. In any event, the APA's learner-centered principles have played a major role in shaping the discussion about how to facilitate learning early in the 21st century.

Formal and Informal Learning

Thus far we have assumed learning to be a formal, planned process such as is usually associated with schooling. It is interesting to note, however, that the definition of educational technology and its goal to facilitate learning is not necessarily limited to a formal process. The old AECT (1977) definition text included a definition of *learner* as an individual "engaged in acquiring new

Table 2.2. APA's learner-centered psychological principles.

1. **Nature of the learning process.** The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.
2. **Goals of the learning process.** The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.
3. **Construction of knowledge.** The successful learner can link new information with existing knowledge in meaningful ways.
4. **Strategic thinking.** The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.
5. **Thinking about thinking.** Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.
6. **Context of learning.** Learning is influenced by environmental factors, including culture, technology, and instructional practices.
7. **Motivational and emotional influences on learning.** What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking.
8. **Intrinsic motivation to learn.** The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty, relevant to personal interests, and providing for personal choice and control.
9. **Effects of motivation on effort.** Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without learners' motivation to learn, the willingness to exert this effort is unlikely without coercion.
10. **Developmental influences on learning.** As individuals develop, there are different opportunities and constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.
11. **Social influences on learning.** Learning is influenced by social interactions, interpersonal relations, and communication with others.
12. **Individual differences in learning.** Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.
13. **Learning and diversity.** Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.
14. **Standards and assessment.** Setting appropriately high and challenging standards and assessing the learner as well as learning progress—including diagnostic, process, and outcome assessment—are integral parts of the learning process.

Note: Adapted from Learner-Centered Psychological Principles: A Framework for School Redesign and Reform. The full list of principles is available online at: http://www.apa.org/ed/lcp2/lcp14.html.

skills, attitudes or knowledge whether with a specified sequence of instruction or a random assortment of stimuli" (p. 209). So learning, it might follow, can be formal or informal, and a learning environment can include structured and unstructured settings.

It may be important to consider informal learning as a salient aspect for educational technologists as technologies and media continue to provide and expand learning opportunities for learners of all ages. It cannot be said that most learning occurs in schooling or training situations. Individuals are motivated to learn through the Web, through print materials, and through informal encounters with "experts" in the community. This informal learning is neither designed nor assessed by educators, but must be considered when we discuss the role of facilitating learning for learners of all ages and stations of life. The field may need to increase its awareness of these public resources and continue to consider their instructional potential for both motivating and providing learning opportunities.

In fact, even in formal learning settings, planned instruction is not the only, or even the most important, determinant of success or failure in learning. To simplify a complex situation somewhat, we can say that learning is most directly dependent on three factors: aptitude, effort, and instruction (Walberg, 1984). Those who come into the setting with a high level of native ability—aptitude—may succeed without even trying very hard or receiving quality instruction. Or those who exert tremendous effort may succeed even if they have limited aptitude and uninspired teaching. The investment of effort is assumed to be driven by the individual's motivation, which itself is a product of home and personal background, expectations, and interest in the subject matter.

Therefore, it is important to recognize that instruction, no matter how well designed and executed, is only one part of the learning equation, often overshadowed by learners' developmental abilities, their needs, and their interests. Instructional designers can influence effort through *motivational design*—making the materials as interesting and relevant as possible and arranging the total learning environment so that learners have an expectation of success and achieve satisfying results (Keller, J. M., 1987). However, the motivation that comes from beyond the classroom is largely beyond the instructional designer's span of control. Looking at the instructional setting as a total system and seeing how the various factors interact is discussed in greater depth in chapter 3.

Media Versus Methods

Some enthusiasts for using media to improve learning seem to assume that merely embedding the content into a newer media format will automatically improve its effectiveness. This assumption has been under attack since R. E. Clark (1983) declared that "The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (p. 445). He based this conclusion on a meta-analysis of hundreds of research reports from studies in which instructional presentations in one media format were compared with presentations in a different format. R. E. Clark concludes, "It seems not to be media but variables such as instructional methods that foster learning" (p. 449).

A debate about "media versus methods" raged for a decade. The most effective counterargument was raised by Kozma (1991), who contended that the studies cited by R. E. Clark (1983) were based on a presentation paradigm—learners watching or listening to a presentation. Kozma agreed that, under such conditions, different media formats only made a difference in time and cost, not learning effectiveness. Kozma proposed that different results could be expected from a different instructional paradigm, one in which media are used as tools by learners, not as presentations. In other words, not learning *from* media (Clark's term), but learning *with* media (Kozma's term). In subsequent years, as the use of media more and more comes to mean digital media, educational technology looks forward to a new research agenda, studying the possibilities of this new paradigm.

Summary

The current definition of educational technology explicitly adopts the term *facilitating learning* in order to emphasize the understanding that learning is controlled and owned by learners. Teachers and designers can and do influence learning, but that influence is facilitative rather than causative. The term *facilitating learning* is posited as the purpose of the field, not as the result of processes that are the raison d'etre of the field.

Different theories of learning and instruction emphasize different variables in the learning process, so *facilitating* has different meanings for each theory. Understanding the implications of the different theories is impeded by the practice of conflating instructional theories with learning theories and even epistemologies. For the purposes of this chapter, the bodies of theory are viewed simply as different perspectives on teaching and learning. Behaviorism, cognitivism, and constructivism each have prompted interesting and successful applications of educational technology. Each has added to our overall understanding of how people learn and how instruction might be improved. It is possible to envision an eclectic umbrella under which various creative uses can be combined to provide rich environments for active learning.

Assessment and evaluation methods are an important link in the chain of successful implementation of any behaviorist, cognitivist, or constructivist instructional innovation. If the innovative program is striving toward the goal of deeper, higher level, metacognitive, or applied knowledge, its results will not be adequately captured by conventional paper-and-pencil tests.

Although most of the discussion in the chapter is framed in terms of formal instructional situations, the current definition is also intended to apply to informal learning. In fact, that is one of the reasons that the definition chooses the term *educational technology* rather than *instructional technology*, using the term with the broader connotation in order to capture both planned and spontaneous learning situations.

We conclude with some comments about the *values* underlying this whole chapter. In facilitating the process of learning, regardless of associated theoretical perspectives, the practice of educational technology actually helps or hinders the *people* who are in pursuit of learning. In other words, we do what we do as educational technologists not so much to facilitate learning in and of itself but to facilitate learning by the intended audience. This shift in emphasis from the process to the people indicates an increasing focus and awareness of students as the core of our activities as educational technologists. When the learner is the focus, as opposed to the hardware, the design, or the materials, then the idea of facilitating learning must also focus on the learner and their abilities and responsibilities. Learner-centered thinking reminds us that at its core, learning is still an idiosyncratic or at least not completely controllable activity. As instructors and designers, we take advantage of generalizations about people and the ways they may learn. In our efforts to facilitate learning truly, however, we must acknowledge the diversity of the individual. We may not be capable of always facilitating learning for that particular person, but we must not forget facilitating learning for each individual is the goal. Facilitation suggests that we attend more completely to the learner within the setting, consider the context and the environment, and make an attempt to relate our designs to the cultural and societal aspects of the setting as we design or create learning environments. The diversity of learners would be addressed and learning supported through our use of both hardware and software, and in fact, this becomes the goal of technology integration into learning environments.

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