

FOUNDATIONS OF INSTRUCTIONAL DESIGN

CHAPTER

2

CHAPTER OBJECTIVES

At the conclusion of this chapter, you should be able to do the following:

- Discuss how some philosophical perspectives, particularly *constructivism*, *empiricism*, and *pragmatism*, have influenced the assumptions, beliefs, and values of instructional designers.
- Describe at least four major assumptions of the authors of this text regarding instructional design and discuss how these assumptions relate to your own philosophy of education.
- Discuss why it is important that instructional designers know the philosophical perspectives and theory bases associated with their field.
- Recognize whether a description of learning or instruction constitutes a *theory* and discuss the purpose of *theory*.
- Describe each of the major theory bases and the ways in which they have contributed to instructional design practices.
- Given a description of a learning situation, describe how learning occurs according to information processing theory.

WHY DISCUSS PHILOSOPHY AND THEORY IN AN INSTRUCTIONAL DESIGN TEXT?

Instructional design is an applied, decision-oriented field. So why include information on philosophy and theory, particularly so early in the text? We have three major reasons for including this material. First, theories are the source of principles from which many of the prescriptions for design arise, and your understanding of the bases will help both your learning from this text and your ability to engage in excellent application in the field. We will be referring to these theory bases throughout the book, particularly in the chapters on instructional strategies. We suggest prescriptions and techniques for doing design work that are based upon conditions (learners and context) and learning goals (tasks). In the field, you will face situations that have particular conditions or goals not covered by this (or any) text. Or you may try our suggestions and find that they don't work. In such situations, you must reflect on what you know to develop your own prescriptions for instruction. If you know relevant theory bases, you can make intelligent and reasoned decisions in such situations.

The second reason for treating philosophy and theory involves the relationships of specialists and scholars to their field of study and practice along with *your* relationship to that field. We feel that it is imperative that writers in our field acknowledge the bases of their conclusions and recommendations. Some of our bases are the beliefs and values that represent our own educational philosophy. In other cases, the statements are not just our studied opinions, nor are they just based upon experiences with "what works." They are based upon theories that have been substantiated and modified upon the basis of empirical research. Of course, to a degree, the theories and research that we deem most valuable are colored by our philosophy. However, the theories that we present in this chapter are also the theories that have definitely shaped the directions of instructional design. Your awareness of these theories may give you the historical insight to understand why certain areas have been emphasized in this field. Theory bases are the common ground that we share with other professionals in the field. The third reason for studying philosophy and theory is because these theories allow designers to explain *why* they make the decisions they do. Sometimes designers must justify or even defend their decisions to clients or students. Theory, as well as educational philosophy, can provide a rationale for many of our decisions.

This chapter briefly describes philosophies and theories that have formed the basis of instructional design. It is an introductory treatment and is not intended to represent a sufficient background of theory or philoso-

phy for professional instructional designers. We recommend that the education of instructional designers include as much preparation in learning theory and instructional theory as possible. In addition, it should also include as much reading as possible about philosophy as it relates to learning and instruction. In particular, references by Anderson (2000); Driscoll (1994); E. Gagné, C. Yekovich, and F. Yekovich (1993); R. Gagné (1985); and Jonassen (2004) will supply critical learning theory background for instructional designers. These and other references at the end of the chapter should provide a good starting point.

THE PHILOSOPHICAL PERSPECTIVES OF INSTRUCTIONAL DESIGNERS

In the first edition of this text, we did not include a section on philosophy related to instructional design. We did, however, include a few assumptions that we held. These assumptions did not formally represent any traditional classification of philosophies, but they *did* represent potential differences in beliefs from some individuals in the areas of education and training. We wished to make these assumptions public for readers' consideration. We have expanded this section briefly because in recent years one particular philosophical position, "constructivism," has been strongly debated by individuals within the field of education—both those working in training and those working in public education. This philosophy (some describe it as a theory, but we feel it does not have the explanatory power of a learning theory) and its implications for instructional design have been much discussed among practitioners, as well as scholars in the field. The philosophy also has had a strong impact on many educators in our learning communities, so some readers will be aware of its current popularity and may wonder how such a philosophy may relate to this text.*

Fields of study, such as instructional design, do not have educational philosophies; people who study in these fields do. This personal nature of educational philosophy makes it very difficult to make general statements about a particular philosophical perspective.

*Some readers may find the discussion of constructivism irrelevant, uninteresting, or difficult to follow. If you do find it difficult to "connect" with, we urge you to skim it briefly and come back to it at some time in the future, particularly after reading the section on "generative instructional strategies" in Chapter 7 or after reading Chapter 12's discussion of strategies for instruction in problem solving. However, we do hope that you will read and reflect on this section at some point, as it examines some Really Big questions regarding the nature of knowledge and how we come to acquire it (epistemology).

However, we will briefly describe three educational philosophies that seem to have a strong influence on instructional designers. We will begin with constructivism, as it is the most recently popular position within many educational communities. After discussing constructivism, a much shorter treatment of two other commonly held philosophical perspectives, empiricism and pragmatism, will be presented. Space does not permit a full discussion of philosophical systems, but the treatment here of a few particularly relevant philosophies should assist in providing perspective on differing fundamental orientations.

Constructivism

Constructivism is an educational philosophy within a larger category of philosophies that are described as "rationalism." A rationalist philosophy is characterized by the belief that reason is the primary source of knowledge and that reality is constructed rather than discovered. Most rationalists would propose that there is not a single reality to be discovered, but that each individual has constructed a personal reality.

We included a fairly extensive discussion of constructivism because it is a current incarnation of a rationalist philosophy. In the past, other movements have represented similar rationalist orientations, and no doubt in the future these issues will be raised under a different label. Although the labels may change, the tension between rationalism and empiricism appears to be long-standing and therefore worthy of consideration.

Many educators trace the roots of constructivism to Jean Piaget. A foundational tenet of constructivism is the assumption that "Knowledge is not transmitted: it is constructed." We would be surprised to find any educational scholars who do not espouse this fundamental position. Indeed, most educators with whom we have worked and whom we have observed even *behave* as if this is their belief. Aside from this fundamental tenet, educators who describe themselves as constructivists have quite a wide range of beliefs about knowledge and how it can be acquired. Most of the controversy is not in disagreement with the major tenet of personal construction of knowledge, but with what the *implications* of this tenet should be. Another contributor to diversity is the division of constructivists into "individual constructivist" and "social constructivist" groupings. Also, many constructivists include a contemporary world view, "contextualism," as a component of their philosophy. Given such a diversity, we have chosen to represent the major assumptions as they were induced by Merrill (1992) and reproduced by Wilson, Teslow, & Osman-Jouchoux (1995) as a foundation for our brief description of constructivism.

INDIVIDUAL CONSTRUCTIVISM. The key assumptions of individual constructivism are the following:

- Knowledge is constructed from experience.
- Learning results from a personal interpretation of knowledge.
- Learning is an active process in which meaning is developed on the basis of experience.

These assumptions can be derived from a branch of constructivism that can be called "individual constructivism." Background in cognitive psychology and human development suggests that these precepts are credible. Certainly, it appears to us that most knowledge is constructed in an active, effortful way by learners who are engaged in experiences that promote an opportunity for reflection and assimilation/accommodation to existing knowledge (see the section on Development Theories later in this chapter).

Interpretations regarding the nature of this "construction" vary greatly among educators. For example, some constructivist writings suggest that, in constructing knowledge, learners must "recreate" knowledge that may be recorded from noted and enduring experts in a field of study in order for this learning to be properly experienced and interpreted. Others view construction of knowledge to be the unique combination of new knowledge and a learner's individual prior knowledge that includes values, experiences, and beliefs. This more conservative perspective proposes that such construction is inevitable and is the essence of learning. However, individuals from this perspective may feel that, depending upon the nature of the learners, the learning task, and the learning context, this construction may be also supported through abstract and vicarious experiences as well as direct "recreation."

Radical constructivists propose that since learners' particular combination of prior experiences are unique, it is inappropriate to propose goals for these learners because educators do not know what the learners' need or want to learn, and designers should not develop particular sequences of instruction, provide specific aids to learning, or restrict the content presented on the learning topic. More moderate constructivists suggest that the active and personal construction of meaning does not necessarily require that all of the responsibility for developing a learning environment be demanded of the learner. Some constructivist designers would propose that the amount of responsibility for arranging the situation for learning should be variable depending upon a number of learner, task, and context factors. (For more on this position, see our discussion of generative and supplantive learning strategies in Chapter 7.) Indeed, some designers who ascribe to the general tenets of individual constructivism would point

out that to assume that individuals who neither possess an expert's knowledge in either a subject matter or in instructional design would have great difficulty in determining what they need to know in order to devise a satisfactory approach to acquire this knowledge. Delegating all of the load of information processing associated with instruction onto learners may place an unrealistic burden on most learners for the vast majority of learning goals. Of course, many contexts, both public education and training environments, have long-term goals that learners become competent as self-regulated, lifelong learners. However, many educators suggest that this capability is acquired over time and is not an inherent ability of learners.

SOCIAL CONSTRUCTIVISM. One key assumption follows:

- Learning is collaborative with meaning negotiated from multiple perspectives.

Some constructivists do not ascribe to this more social interpretation of constructivism. Others find it absolutely central to their philosophy. Some radical constructivists suggest that on all subjects all perspectives are equally viable and should take equal weight in the negotiation of meaning. More moderate constructivists would propose that the universality of the nature of "truth" varies by topic and subject matter. They would suggest that for some topics there is a general "truth for now" that has been negotiated and agreed upon by experts in the field (e.g., the earth revolves around the sun, not the sun around the earth). Although this "truth" may be amended or replaced when more knowledge is acquired, it is not legitimately "multiperspectived" now. Such constructivists would agree that there are topics (e.g., Was the engagement of the North Vietnamese in war an appropriate response by the United States?) in which "rules of evidence" (that is, how can we judge what is "true") (DeVaney, 1990) are quite varied depending upon the perspective, culture, or context and that it would be inappropriate to suggest that one "truth" is more viable than another.

Some educators interpret this assumption to mean that all learning should occur in collaborative work groups. An alternate perspective of the social constructivism tenet might be that whether learning occurs in work groups, in a group discussion, or in an individual interaction with a text, there is some sense of collaboration in that the individuals involved are working toward agreement, or at least understanding. Such constructivists might suggest that there is collaboration in negotiating meaning as learners interact individually with the text of a book or video because the learner is wholeheartedly engaged in trying to interpret the author's perspective and compare it to his own. As well, the author's efforts, although displaced in time, are equally a struggle to find a common ground with readers.

Certainly, many instructional designers would propose that collaborative learning groups are part of a powerful instructional strategy. Many designers would also concur that learning to apply the standards of viability for ideas, how these standards have changed over time, and what issues can and cannot be subjected to these standards within a particular field are excellent learning goals in many contexts.

CONTEXTUALISM. The key assumptions of contextualism are the following:

- Learning should occur (or be "situated") in realistic settings.
- Testing should be integrated into the task, not a separate activity.

Not all constructivists would include contextualism as part of their basic philosophy. However, many constructivists do endorse the above tenets. Contextualists propose that thinking is inextricably tied to the real-life contexts to which it is applied. Educators frequently refer to the learning that is related to a context as "situated cognition" (Brown, Collins, & Duguid, 1989; Henning, 2004). Contextualists recommend presenting problems in situations that are realistic to learners and common to everyday applications of knowledge. This type of learning is termed "authentic learning," and the instruction related to the learning situation as "anchored instruction" (that is, instruction "anchored" in a realistic problem situation) (Cognition and Technology Group, 1990; Streibel, 1995). Some contextualists suggest that certain types of problems should not be simplified for novice learners but should be presented in their full complexity early in the learning process so as to not give learners the false impression that such problems are simple and easily solved (Spiro, Feltovich, Jacobson, & Coulson, 1992). Numerous scholars in the field of instructional design have suggested how the concepts of situated cognition may apply to the design of mediated instruction, resulting in applications such as learning environment, microworlds, phenomenaria, and construction sets (e.g., Choi & Hannafin, 1995; Rieber, 1992, 2004; Wilson, 1996).

The second constructivist assumption that can be attributed to contextualism is that assessment should be "authentic." Swanson, Norman, and Linn (1995) proposed that authentic assessment is synonymous with "performance assessment," defining performance assessment as "testing complex, 'higher order' knowledge and skills in the real-world context in which they are actually used, generally with open-ended tasks that require substantial examinee time to complete" (p. 5). Authentic assessment is generally integrated in a seamless manner with learning activities, not as a separate event. Some constructivists would caution that al-

though it is important that learners perceive assessment to be part of the process of learning, initial activities, or initial tries at solving a type of problem, should be considered "practice," which along with feedback would take place during the initial phases of learning. They would propose that all assessments are indicators of learning at some point in the learning process, but a more accurate reflection of what learners have learned can be obtained *after* some initial opportunities to process both practice and feedback. A sample of additional resources on these and other aspects of contextualism and ecological psychology may be found in Allen, Otto, and Hoffman (2004); Barab, Evans, and Baek (2004); and Young, (2004).

CONTRIBUTIONS AND LIMITATIONS OF CONSTRUCTIVISM

Constructivists both within and outside of the field of instructional design have made what we consider to be substantial contributions to instructional psychology and instructional design. Tenets of constructivism encourage instructional designers to increase the care of their consideration of the intentionality of the learners. Constructivists also point out the perspectives that learners bring to the learning situation that may extend beyond what designers typically consider to be "specific prior knowledge." Constructivism suggests to educators new goals to consider: recognition of the tentative nature of knowledge, understanding the importance of considering multiple perspectives on issues, and the rules within a subject matter for determining what represents a viable interpretation in a field and what does not. In addition, designers in the spirit of constructivism have developed creative strategies that utilize technology in significant ways, expanding the instructional strategy options that designers might consider. We tend to agree with Cobb's (1996) conclusions regarding three major instructional implications of constructivism:

- (a) Priority should be given to the development of meaning and understanding rather than the training of behavior, (b) researchers and teachers should assume that students' actions are rational given the way that they currently make sense of things, and (c) students' errors and unanticipated responses should be viewed as occasions to learn about students' understanding. (p. 56)

Constructivism as it is currently and generally conceptualized is far from providing an adequate single basis from which instructional designers can operate. Indeed, there are educational scholars who suggest that constructivism has no implications at all for instruction (e.g., Gruender, 1996). Constructivism is frequently presented as a theory, but we concur with a number of scholars that it is an educational philosophy that particularly addresses epistemology. Indeed, constructivism has very little to offer as a theory that explains the processes that occur in the cognition that accompanies

learning. Many constructivists reject the explanations of learning cognitions offered by information processing theory, but as yet, they have not proposed a substitute theory. Some constructivists' concentration on the relationship of perception, action, and the environment might put them closer to behaviorism than would make them comfortable (Anderson, 2000).

One potential danger of the misinterpretation of constructivism is a reinforcement of a perennial problem in education: slipping into the "activity for activity's sake" mode. This problem is represented by the belief that if learners are engaged and enthusiastic, then they must be learning. There are, of course, occasions when engagement and enthusiasm are accompanied by only trivial learning. For example, we observed a class in which the learners in a high school Latin class had been enthusiastically engaged for two weeks in building a salt sculpture of Pompeii. Unmistakably, the teacher expected that learners would learn about the Pompeii culture. When I queried a learner about what he had learned during the two weeks, he replied that he had learned that the salt will crack if you don't put enough water in it. (This anecdote is reminiscent of the research findings regarding some "instructional" computer games in which all the learners learned were the rules of the game.)

Research suggests that too often teachers think first of designing activities during instructional planning (Bullough, 1987; Clark & Peterson, 1986; McCutcheon, 1980). Although many teachers simultaneously consider goals, it is also not uncommon for the goal to become lost from the activity (Brophy & Alleman, 1991). Dewey, who can be considered a forefather of constructivism, recognized this potential for interpretation of his own philosophy (Prawat & Floden, 1994). With radical constructivists' reluctance to identify goals and the activity-oriented perspective of constructivism, there is clearly the potential for educators to erroneously claim constructivism as providing theoretical support for activities that have questionable value.

By far the greatest danger that we perceive regarding constructivism is that practitioners in our own field will be persuaded by extreme positions to eliminate from their practice some of the most singular and beneficial tools of instructional design. For example, some constructivists would recommend the elimination of statements of goals and objectives. Of course, untold harm has been done by educators writing goals and objectives to describe relatively trivial learning and failing to express the difficult-to-portray goals and objectives that reflect higher-order thinking, such as problem solving. However, goals and objectives do not lead to trivial and low-level learning; low-level goals do. With effort, learning goals can represent the high-level goals that constructivists advocate. Some constructivists advocate the elimination of task analysis and the identifi-

cation of prerequisite learning, suggesting that they lead to piecemeal and inert knowledge. Of course, it is how these task and prerequisite analyses are used that can lead to disconnected learning, not the tools themselves. Certainly there are occasions that the degree of precision with which these tools are used may be less or more (Wedman & Tessmer, 1990); however, this does not suggest that the tools should not be in an instructional designer's repertoire. Dunn (1994) suggested that the tools of objectives, learning analysis, and evaluation are instructional design tools that would allow constructivist designers to meet their goals of higher-order learning more effectively.

Empiricism

A second philosophical tradition is empiricism, sometimes termed *objectivism*, and it postulates that knowledge is acquired through experience. Most empiricists would propose that this experience allows an individual to come to know a reality that is objective and singular. That is, most experience is defined as sensory experience, as opposed to any "experience" that one might obtain through a "mental life" of reconceptualization and interpretation. Empiricism is also often typified by "reductionism," efforts to reduce complex entities to their more simple components, and "associationism," a tendency to relate ideas if they are experienced contiguously in either space or time. John Locke (1690) is often identified as a major empiricist philosopher. Locke is well-known for his belief that little, if any, knowledge or ability comes "wired" in an individual. Not all empiricists would agree with this perspective.

Some scholars would label any educational approach that employs experimentation and seeks to draw generalizations based upon data as empiricist. However, empiricists may also subscribe to other tenets, such as a belief in a singular and objective reality, the devaluing of mental experience, and the *tabula rasa* (blank slate) perspective of Locke (e.g., Driscoll, 1994). We would agree that a valuing of experimentation and generalization are clearly qualities of empiricists, but various scholars in the empiricist tradition reflect a wide range of beliefs about reality, the mind, and inherent qualities.

Pragmatism

Pragmatism might be considered a "middle ground" between rationalism (constructivism) and empiricism (Driscoll, 1994). Although pragmatists, like empiricists, believe that knowledge is acquired through experience, they believe that this knowledge is interpreted through reason and is temporary and tentative. Most pragmatists are not too concerned with whether there is a common reality, such as general principles of learning

that are "out there" to be discovered. Pragmatists propose that the question of whether there is a "real" reality is an unproductive question, since, if there is a reality, it can never be totally known. When faced with the issue of reality, pragmatists "would simply like to change the subject" (Rorty, 1982, p. xiv). Pragmatists suggest that knowledge in a particular field is negotiated based upon an agreement of experts as to a common interpretation of experience. They would describe knowledge in terms of "truth for now." Pragmatists propose that knowledge is built up by testing this "truth for now" hypothesis and revising or discarding this "truth" as common experience and interpretation implies it should be modified.

The noted educational philosopher John Dewey (1924) was a pragmatist. Leahey and Harris (1989) state that the majority of psychologists are pragmatists. It is our belief that most instructional designers are pragmatists. We would categorize ourselves, personally, as pragmatists, with beliefs that are also consistent with moderate constructivism. We also share with empiricists a valuing of testing knowledge through the accumulation of data and a belief that there are some generalizable principles of learning that can be "discovered."

Assumptions Underlying Instructional Design

A number of assumptions underlie the process of instructional design. Novice designers should encounter these assumptions in an explicitly stated form. Although they may not totally agree with the assumptions (and often design excellent instruction without this agreement), novice designers can find the design process more meaningful when these assumptions are made explicit. Following are some of the most critical assumptions:

1. To design instruction, the designer must have a clear idea of what the learner should learn as a result of the instruction.
2. The "best" instruction is that which is effective (facilitates learners' acquisition of the identified knowledge and skills), efficient (requires the least possible amount of time necessary for learners to achieve the goals), and appealing (motivates and interests learners, encouraging them to persevere in the learning task).
3. Students may learn from many different media; a "live teacher" is not always essential for instruction.
4. There are principles of instruction that apply across all age groups and all content areas. For example, students must participate actively, interacting mentally as well as physically with material to be learned.

5. Evaluation should include the evaluation of the instruction as well as the evaluation of the learner's performance. Information from the evaluation of instruction should be used to revise the instruction in order to make it more efficient, effective, and appealing.
6. When the purpose of assessment is to determine whether learners have achieved learning goals, the learners should be evaluated in terms of how nearly they achieve those instructional goals rather than how they "stack up" against their fellow students.
7. There should be a congruence among goals, learning activities, and assessment. Along with learners' characteristics and learning context, learning goals should be the driving force behind decisions about activities and assessment.

These assumptions will be alluded to and further explained throughout this text.

WHAT IS A THEORY?

A theory is an organized set of statements that allow us to explain, predict, or control events. The theories from which instructional design draws are of two kinds: descriptive theory and prescriptive theory. **Descriptive theory** describes phenomena as they are hypothesized to exist. Many learning theories are descriptive: They describe how learning occurs. **Prescriptive theories** prescribe actions to take that will lead to certain results. Instructional theories are basically prescriptive in nature: They suggest that if instruction includes certain features, it will lead to certain types and amounts of learning.

The term "theory" is often misused in popular culture. Characters on television detective thriller programs are quite prone to say that they have a "theory" about who committed the crime when they mean to say that they have a "hypothesis" or "supposition." This frequent misuse of the term, as well as some unfortunate arguments on the theory of evolution from a certain religious perspective, contributes to the wide-

spread impression that theories are made up of casual conjectures, when the very opposite is the case.

MAJOR THEORY BASES CONTRIBUTING TO INSTRUCTIONAL DESIGN

Instructional design has drawn from many theory bases. However, the major contributions have been communication theory, systems theory, theories of learning, and theories of instruction. Although general systems theory and communication theory have had a substantial impact on the development of the procedures of instructional design and development, it is learning and instructional theory that continue to have the most substantial influence on the principles of instructional design. Therefore, we will limit our review of communication and systems theories to a brief discussion and deal in greater detail with learning and instructional theories. We recommend that instructional designers become familiar with their historical roots in systems theory and communication theories, and we recommend Richey's (1986) review of the contribution of these two theory bases on instructional design models.

Communication Theory

Two groundbreaking works by communication theorists have a deep foundational relationship to instructional design, both developed in the 1940s. One was Shannon and Weaver's *A Mathematical Theory of Communication* (1949), which was the first successful approach to the quantification and hence measurement of information, including a model which is so familiar now that it seems part of our cultural heritage (see Figure 2.1); the other was Norbert Weiner's work on feedback control, popularly published in *The Human Use of Human Beings* (1969). Weiner coined the term "cybernetics" (the science of feedback control). These two books were intended for nonspecialist audiences and are English-language translations of primarily mathematical work. Both are mechanistic and transmission-centered, but from these two lines of work

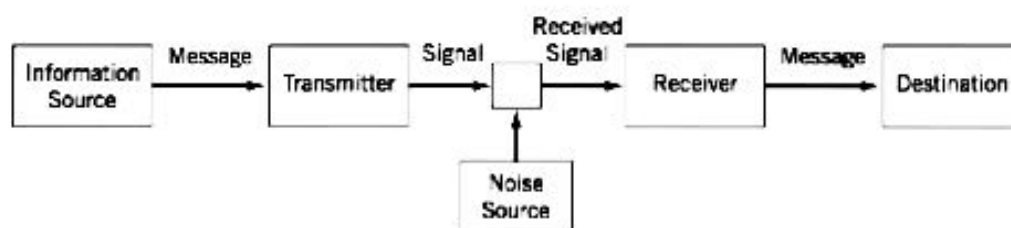


Figure 2.1 Shannon & Weaver General Model of Communication

have come concepts that it would be hard to do without, such as entropy, feedback, and noise.

Approaches to the study of communication from process-centered and meaning-based standpoints can be illustrated by work by Wilbur Schramm and others in interpersonal communication, mass communication, and the orientations of general semantics and semiotics.

The study of interpersonal and mass communication has provided concepts and models that have a foundational influence on instructional design thinking. For example, Schramm's (1956) model of interpersonal communication emphasizes a dialogic process, in which what is feedback and what is the "message" is more or less arbitrary. Looking at the illustration provided in Figure 2.2, hold your book upside-down and notice that the "receiver" and the "sender" are nominal. Either person is a sender, depending on how you view it. In the model, we have added the term "Construct Meaning" to "Interpret" in congruence with current popular views without changing the original meaning of the model substantially.

General semantics is the study of how language impacts our thinking, especially how language habits support irrational, neurotic, or imprecise thinking (Lee, 1941; Hayakawa, 1953). This interdisciplinary body of thought was originated by Alfred Korzybski, the seminal work being *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics* in 1933 (Korzybski, 1973), available online at <http://www.esgs.org/uk/art/sands.htm>.

The fundamental concepts of general semantics rest on a general principle: that even though our language use makes it appear otherwise, no two events over time are the same. Techniques such as dating are recommended to lend precision to thinking as well as language. Tim¹⁹⁷³ helps underscore the idea that Tim²⁰⁰⁴ is not the same as he once was. In addition to the dating technique, common general semantics concepts are: The map is not the same as the territory; words do not contain their definitions but have meaning only by social agreement; habitual use of "etc." as a reminder that what is said is not all there is to something; and mental indexing as a reminder of multiple values and the multidimensional nature of reality (ID₁, ID₂, ID₃, ID₄, etc.).

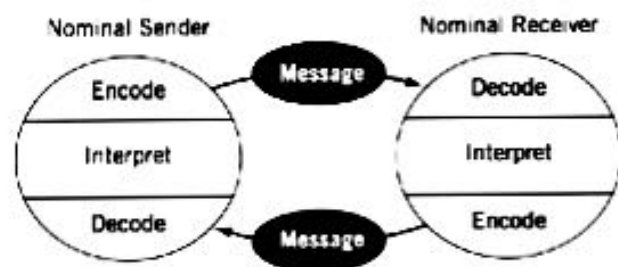


Figure 2.2 An Adaptation of Schramm's Communication Process Model

Although the pursuit of objectivity inherent in general semantics may smack of 1950s modernism in a world of postmodern thought, a great deal of what is currently revered in educational theory has unacknowledged roots in general semantics.

Systems Theory

Systems thinking and general systems theory have had an often misunderstood influence on instructional design. The origins of the interdisciplinary body of thought called "general systems theory" can be traced to Ludwig von Bertalanffy, whose work in the 1930s on unifying separate disciplines in the study of biology led to a general theory of the interrelated and dynamic qualities of open systems. Although the term "systems" is often associated with the idea of being systematic and the use of systems tools such as PERT, Gantt, and flowcharts, the heart of systems thinking is an urge to see the big picture. Chaos theory is often characterized as a polar opposite to the somewhat older systems theory, but the two differ not so much in kind as degree, with chaos theory emphasizing and illustrating the complex depths to which relatedness can go.

A system is often defined as a "set of interrelated and interacting parts that work together toward some common goal." Systems exist naturally, such as the human body, the solar system, and the atom. Systems are also contrived, as in human-made systems, such as a business organization, the heating-cooling unit of a house, and a school system. Systems are thought of as existing within systems. The larger system of which the system under study is a part is called the "supra-system." The elements of the system under study, which themselves are systems, are called "subsystems." Each subsystem serves a purpose and is viewed as interdependent upon each other subsystem. Therefore, a change in one component will cause a change in its interdependent components.

Most instructional design approaches have a "systematic" quality to one degree or another. The care and attention which is associated with instructional design, as well as the general form of most models, suggest a systematic approach. Attention to context and appropriate evaluation (see Chapters 3 and 19) lend a systemic quality as well. In Andrews and Goodson's (1980) article reviewing models of instructional design, 70 percent of the models employed some elements of systems theory. Gustafson and Branch (1997) have performed a wider analysis from an instructional development standpoint. Their survey is extremely helpful in gaining a grasp of the nature of the major approaches to instructional development.

Although any form of instruction may be viewed from a systems perspective, we are convinced that distance education is one which needs a systems view in

order to operate successfully. In that context, we highly recommend Moore and Kearsley's, (1996) discussion of distance education from a systems perspective. Banathy (1992, 2004) and Kaufman (2000) are a sample of additional resources in systems thinking applied to education.

Learning Theories

Promoting cognitive processes that lead to learning is what instructional design is all about. Therefore, instructional designers are very interested in learning theories, those theories that attempt to describe, explain, and predict learning. It is probably helpful at this point to define what is commonly meant by **learning**: R. Gagné defined learning as a "change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth" (1985, p. 2). Mayer (1982) elaborated on this concept in his definition of learning:

"Learning" is the relatively permanent change in a person's knowledge or behavior due to experience. This definition has three components: (1) the duration of the change is long-term rather than short-term; (2) the locus of the change is the content and structure of knowledge in memory or the behavior of the learner; (3) the cause of the change is the learner's experience in the environment rather than fatigue, motivation, drugs, physical condition, or physiological intervention. (p. 1040)

According to this definition, has a person who has successfully followed the directions for assembling a backyard swing set learned something? Not necessarily. The individual may have simply performed each step without trying to remember or understand any aspects of the process. There may be no lasting change in the individual's memory, nor change in ability to assemble objects in the future. In such a case, we would say that learning has *not* occurred. Conversely, the individual may have acquired a new understanding of how certain types of pieces fit together, new knowledge in selecting an appropriate tool for a particular task, or new ability to manipulate a tool. In such a case, we would say that learning *has* occurred. We may see evidence of this learning in the individual's ability to perform future assembly tasks more rapidly or with more aptitude.

As you recall from a previous discussion in this chapter, learning theories are chiefly descriptive. They describe how learning takes place. They are not necessarily prescriptive (i.e., they do not directly suggest what kinds of instructional intervention should support learning). Two major categories of learning theory that have influenced instructional design procedures

and decisions are behavioral learning theories and cognitive learning theories.

BEHAVIORISM. The predominant school of thought in learning theory for the first half of the twentieth century has been labeled *behaviorism*. Behaviorists usually subscribed to an educational philosophy of extreme empiricism. The behaviorist view of psychology had its beginnings in the late nineteenth century and in the first decade of this century with Ivan Pavlov's (1927) "classical conditioning." Other important research includes E. L. Thorndike's (1913) work that culminated in his "laws of learning" and J. B. Watson's (1913) articulation and formation of the behaviorist movement. B. F. Skinner's work on "operant conditioning" in the 1940s and 50s marked the maturation of the movement. Although some research on learning was being pursued from perspectives other than behaviorism during this time, the dominance of the behaviorist view, particularly in the United States, was almost complete during the first half of this century.

The behaviorist view held that the only things about human learning worth studying are those that can be observed. Although most behaviorists did not deny the existence of mental activity, they did not conjecture about these thinking processes, mental states, and other unobservable phenomena. Rather, they concentrated on the observable *behavior* of organisms. At first, it may appear that a behaviorist view would be so limiting as to make it absurd. However, even though our current interests go beyond the strict limitations of the behaviorists, the behaviorist view has spawned the research and theory of many important phenomena of learning.

Behavioral theory emphasized the influence of the environment on learning. According to behaviorism, learning has occurred when learners evidence the appropriate response to a particular stimulus. How this connection or association between stimulus and response is developed is the major explanation that characterizes behavioral theory. Later behavioral theories, particularly that of Skinner's operant conditioning, explained the development of this association as the result of learners receiving the appropriate reinforcement when the appropriate response is given to a particular stimulus.

The principles of behaviorism in terms of classical and operant conditioning, specifically the influence of reinforcers in building stimulus-response associations, have relatively no influence on instructional design practice today. (This assertion is also supported by Case and Bereliter, 1984.) However, some of the applications of behaviorism, such as programmed instruction, have had a lasting impact. Although programmed instruction did not revolutionize education as many thought it

would, its legacy has been significant. Innovations that were a part of programmed instruction include recognition that effective nonhuman mediated instruction could be developed and that evaluation and revision of the materials through an empirical test of their effects could improve the effectiveness of instruction. As you can see from the key assumptions of instructional design listed earlier in this chapter, these two ideas are major building blocks in the principles of instructional design. They have had an enormous impact on the design of quality instruction for education and training contexts.

Often, instructional designers and other educators point to behaviorism as the source for the practice of writing explicit objectives. This attribution seems to be inaccurate. The origin of instructional objectives appears to be Herbert Spencer, a curriculum developer who lived in the middle of the nineteenth century. Davies (1976) traced the idea of specific objectives to well before the rise of behaviorism. The term "behavioral objectives" has less link to behaviorism than it does to relatively atheoretical curriculum development. Objectives and some goals developed by instructional designers may continue to have forms that are reminiscent of behaviorism. However, the rationale for current instructional designers writing objectives that reflect action is not on the same basis as the behaviorists (disinterest in cognitive activities or processes such as understanding) but is from an attempt to gain "best evidence" of cognitive processes and states that cannot be directly perceived or recorded. (For all of that, we have expunged the term "behavioral objective" from our vocabulary, to the extent possible, and have substituted such terms as "learning objective" wherever possible, and more importantly, recommend in following chapters that you approach the writing of learning goals and objectives from a standpoint that is considerably less rule-bound in format than the behavioral objectives tradition has emphasized.)

COGNITIVE LEARNING THEORIES. Currently, cognitive learning theories are the dominant theoretical influence on instructional design practice. Cognitive learning theory has generally corresponded to a rationalist philosophy and frequently appears compatible with the central tenets of constructivism. Cognitive learning theory places much more emphasis on factors within the learner and less emphasis on factors within the environment than behavioral theories. Schuell (1986) credits five major ways that cognitive psychology has influenced learning theory:

- (a) the view of learning as an active, constructive process;
- (b) the presence of high-level processes in learning; (c) the cumulative nature of learning and the corresponding role

played by prior knowledge; (d) concern for the way knowledge is represented and organized in memory; and (e) concern for analyzing learning tasks and performance in terms of the cognitive processes that are involved. (p. 415)

Clearly, cognitive learning theory focuses on explaining the development of cognitive structures, processes, and representations that mediate between instruction and learning. In attending to these structures and processes, the role of the learner as an active participant in the learning process takes on great importance. The learner is viewed as constructing meaning from instruction, rather than being a recipient of meaning residing alone within instruction (a perspective that is very compatible with a constructivist philosophy). Therefore, cognitive learning theories attempt to explain learning in terms of cognitive processes, structures, and representations that are hypothesized to operate within the learner. Anderson (2000), Greeno, Collins, and Resnick (1996), Haberlandt (1997), and Winn (2004) are samples of additional resources in cognitive psychology, with Winn's work written specifically for instructional design and technology audiences.

INFORMATION-PROCESSING THEORY. One of the most influential contributions from cognitive learning theory to instructional design practice is information-processing theory. Most current cognitive learning theorists advocate a theory (actually a set of theories) called *information processing*. **Information-processing theories**, in strong contrast to behavioral theories, describe learning as a series of transformations of information (i.e., processing) through a series of postulated structures within the brain. These structures currently are merely hypothesized and utilized to explain learning processes. To date, brain research has not identified specific locations of these particular structures, nor have information-processing theorists ever considered them in a physical sense. One of the most influential information processing theories is the conceptualization of "Multi-Store Models." These models explain learning as a series of transformations of information through several types of storage or memory. Atkinson and Shiffrin (1968) were the first to model a Multi-Store Model. R. Gagné's (1974) elaboration of this model illustrates the structures and processes of information processing (see Figure 2.3).

Two other influential information-processing theories, Schema theory (Rummelhart, 1980) and Level of Processing theory (Craik & Lockhart, 1972) were originally posited as alternatives to Multi-Store theory. However, in recent years they have been viewed more as theories that are compatible with Multi-Store theory and capable of explaining subprocesses or structures

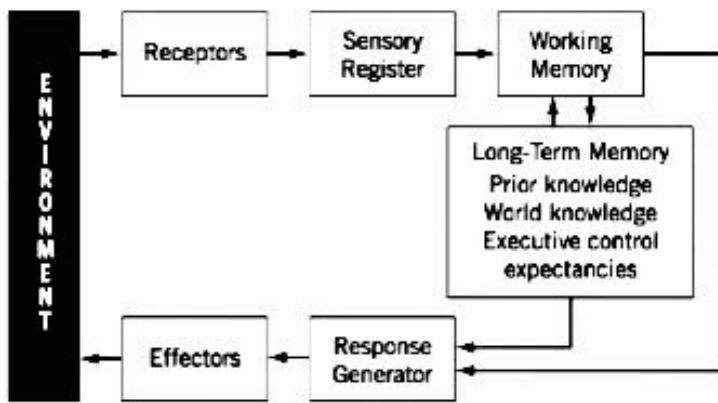


Figure 2.3 An Information Processing Model of Learning and Memory

within it. In the following section, we will briefly summarize these theories, but we encourage you to read more complete descriptions, such as those texts suggested earlier in this chapter.

Sensory Register and Selective Perception. We receive information from our environment through our sensory receptors, our senses. The sensations are converted to electrochemical messages and sent to the brain where these impulses are stored very briefly (approximately one quarter of a second for visual images [Sperling, 1960], slightly longer for auditory information) in a structure, or a cluster of structures, labeled the **sensory register**. Perceptions of many environmental stimuli enter this register, but very few receive the attention, sometimes termed **selective perception**, to be further processed within the brain. The unattended stimuli receive no further consideration. Without such a process, we would be overwhelmed by the multitude of environmental stimuli we encounter in every instant. Our prior experience, including our expectancies, values, and beliefs, influence the stimuli to which we attend. For example, you may have noticed how easily you overhear your own name in a conversation at a party, or how easily you can find your name in an extensive list.

Working Memory. Information to which attention has been paid passes into a structure called **working memory**, sometimes equated with an older concept called *short-term memory*. Working memory has been likened to a desktop or workbench, which is where everything actually happens but which can only hold a finite amount on its surface. Working memory is also similar to the RAM memory of a computer, which is certainly limited in size, but within which everything must at least momentarily reside to be processed.

Working memory and other structures hypothesized by information theory are increasingly seen as dynamic and flexible entities, the qualities of which are seen in interaction with factors such as development and expertise (Case, 1993; Kantowitz, 1987).

Under traditional information-processing theory, working memory is characterized by its limited capacity, in terms of amount of information that it can retain (seven plus or minus two units of information [Miller, 1956]), and its short duration, in terms of the limited amount of time that information can be retained there (10 seconds [Murdock, 1961] to 20 seconds [R. Gagné, 1985]). As you can see from the bidirectional arrows in Figure 2.3, there is continuous transfer of information between long-term and working memory. Information is brought out of long-term memory into working memory (retrieval) in order to make sense out of new, incoming information. This activity is controlled by executive control processes. Not all information that enters working memory is transferred to long-term memory. We have all experienced such a dropout of information when we have retained a phone number only long enough to be able to redial it. We can keep that information in working memory longer than 10 to 20 seconds by rehearsing or repeating it. However, such a process would be an impossible method to retain all the information we need. Therefore, information that we remember for more than a short period of time is transferred, or encoded, into long-term memory.

Encoding and Long-Term Memory. Transfer of information into **long-term memory**, memory that provides long-term storage of information transferred from working memory, is the most critical process of all the information processing to those who are interested in learning. A critical characteristic of information that is stored in long-term memory is that it must be meaningful. It is very difficult to store nonmeaningful information in long-term memory. In order for information to be meaningful, it must be integrated with related prior knowledge (i.e., information that is already stored in long-term memory). We can store fairly nonsensical information in long-term memory if we artificially make it meaningful. For example, we can remember a phone number by making it meaningful. A number like 799-2779 can be remembered by noticing the relationship of the numbers 7, 2, and 9, with the repetition of the nines in the first set of numbers and the sevens in the second set. Likewise, we may try to “learn” (store in long-term memory, or LTM) someone’s name by connecting it with the interests or physical appearance of the person.

The more effortful this meaning-making is (that is, the more “elaboration” we make of the contents of LTM), the more likely it is that this information will be remem-

bered. Craik and Lockhart (1972) suggested that the more “deeply” information is processed, the more likely it is to be remembered. Deep processing involves considering information at the meaningful or “semantic” level, whereas shallow processing involves considering only the surface features or stimulus features of the information. They suggested that deep processing strengthens the memory trace in long-term memory (much as exercise strengthens a muscle). The effects of semantic elaboration are often explained in a different manner by theorists who suggest that it leads to more connections to more information in long-term memory, thus creating more possible paths to the stored information.

Organization is also a critical characteristic of long-term memory. Most theorists suggest that information is stored in nonrandom patterns. They generally conjecture that information is represented within memory in networks of propositions, ideas, or concepts that are connected with relationships (Anderson & Bower, 1973; Kintsch, 1974). The richness of these relationships and the adequacy of the organization will influence how available the stored information is for retrieval and use. In addition, some theorists believe that images may be stored as images in long-term memory (Paivio, 1971). There are many other theories that propose how knowledge is represented in long-term memory.

In addition to network-based representations, some scholars suggest a specific type of propositional networks termed *schemata* (the singular is *schema*). **Schemata** are data structures that represent the generic concepts, such as “face,” “restaurant,” and “burglary,” that are stored in memory and have “slots” that are filled with information related to a specific situation (Rummelhart, 1980). Other scholars propose another type of memory representation termed *mental model*. **Mental models** are similar to schemata but in addition to the concepts and their relationships that are stored in schema, mental models contain information about task demands and task performances that are used for problem solving. Theorists suggest that learners use a mental model representation to store information regarding how machines work or how situations are organized. Cognitive theorists, such as Anderson (2000), suggest that a different type of knowledge (i.e., procedural knowledge) is stored and represented in a form quite different from propositions. They theorize that procedural knowledge is stored in a *production*, an IF-THEN statement that connects conditions (in the IF part of the production) with actions (in the THEN part of the production). (We will provide a lot of examples of these productions in Chapter 5 and later chapters that discuss intellectual skills.)

In recent years, **connectionism** has attempted to describe how thinking might occur at the neuron level without permanent memory representations. According

to Parallel Distributed Processing theory (McClelland & Rumelhart, 1988), information is represented in patterns of activation among neural elements. These basic elements are nodes that are subsymbolic; that is, they alone do not constitute a concept or rule. It is the pattern of activation among neurons that creates meaningful constructs, such as concepts and principles. Input from the environment activates the connections among nodes, making some links stronger and others weaker. So some links have stronger weights than others. (This concept of “weight of memory link” is reminiscent of the “strength of a memory trace” described earlier in the discussion of Levels of Processing.) Bereiter (1991) pointed out that according to theory, all knowledge resides in weights themselves.

A third characteristic of long-term memory is its relatively unlimited capacity and permanency. Unlike working memory, long-term memory’s capacity is theoretically open-ended, and its duration may last a lifetime. While in learning we may experience a feeling of being “overloaded,” this is caused by the overloading of working memory or a difficulty in retrieving relevant prior knowledge with which to integrate it, rather than a saturation of long-term memory. While we may be unable to retrieve information stored in long-term memory, it may not be lost from memory, but rather the cues or strategies we are using are inappropriate. We have all experienced the inability to retrieve a person’s name on one occasion, only to find that we could retrieve it on a later occasion.

Information related to particular subject matter or experiences is stored in long-term memory. In addition, executive control strategies, which are cognitive or learning strategies that influence how we manipulate information, are stored in long-term memory. Also, affective memories, including expectancies regarding learning experiences, are stored there. All of these memories influence the stages of information processing. For example, our prior knowledge of a particular content, our expectancies regarding the goal and relevance of a lesson, and the strategies that we have learned to use in approaching a particular content all influence that which we choose to “selectively attend to” in a lesson on that particular content.

Retrieval and Response Generator. As we described earlier, memories of relevant information are retrieved from long-term memory into working memory to allow us to understand incoming information and in order to integrate the new information with the old. In some cases, this information is simply re-coded in its enriched form and restored in long-term memory. In other cases, in addition to this re-coding and storage, people may act upon the information by speaking or writing an answer, manipulating objects, or any of a

number of other physical responses. The form, organization, and sequence of the response is determined by the response generator. This information is sent to the effectors, muscles, nerves, and glands, which in turn act and affect the environment.

A number of theorists have elaborated and expanded upon the processes and structures in information processing, particularly as they apply to learning. In contrast to the gestalt psychologists who primarily concerned themselves with the initial stages of information processing, recent cognitive learning theorists have concentrated primarily upon the later stages of information processing. Specifically, they have conjectured upon the structures and processes surrounding encoding information into long-term memory from working memory and retrieval of information from long-term memory into working memory.

INFLUENCE OF COGNITIVE PSYCHOLOGY ON INSTRUCTIONAL DESIGN. We will now briefly review how each of the phases of design (analysis, strategy development, and evaluation) is affected by cognitive psychology.

The analysis phase involves analysis of the learner, the task, and the context. What is included in the analysis of the learner and the task has been influenced by cognitive psychology. The analysis of the context is much more strongly influenced by systems theory and by sociological theories, such as principles regarding the dissemination and diffusion of innovations.

As you might expect, with the shift from behavioral to cognitive theory bases, the attention given to the analysis of the learner has grown. The learner plays a constructive role according to cognitive theory. Therefore, in order to provide learners with instruction from which they can build, designers must acquire knowledge about the learners' prior knowledge and the organization of that knowledge. In addition, knowledge of the learners' general aptitudes in terms of processing skills is becoming increasingly sought by designers. As you will see in Chapter 4, designers also draw from cognitive and social development theories for other learner characteristics, such as attitudes, motivations, attributions, and interests that should be analyzed because of their strong influence on learning.

One of the points at which cognitive psychology has had its strongest influence is in the way that a learning task is analyzed. In the past, a task was analyzed by noting the observable behaviors that had to be completed to do a particular task. This procedure has been greatly enriched and supplemented by attention to the mental tasks required in order to perform the observable tasks. This type of analysis is called an *information-processing analysis* or a *cognitive task analysis*. Some designers may even analyze the difference between the

ways novices and various levels of experts complete mental and physical tasks in order to understand the levels of expertise that can be learned. This emphasis on the cognitive, as well as the performance aspects of the task, is reflected in the types of goals and objectives that are developed. Attention is given within objectives to tapping the "understanding" underlying a performance.* For example, it is not uncommon to find objectives that ask learners to explain the reasoning processes behind their performance.

Development of instructional strategy is the area in which cognitive psychology, including gestalt psychology and cognitive load theory, has its greatest influence. Instructional designers draw upon the conclusions of cognitive psychologists' research to infer principles for design. Cognitive load theory has provided a research basis for the identification of "bottlenecks" which can interfere with the effectiveness of learning environments along with ways of reducing cognitive load when needed (e.g., Mayer & Moreno, 2003; Renkl & Atkinson, 2003). In addition, designers draw upon theories themselves to infer instructional treatments that may support particular learning outcomes. Gestalt psychology influences in this fashion the techniques used in instructional message display (the way information is arranged on a page or screen). The chapters on strategy development in this text contain many references to these influential bodies of research and theory.

The two aspects of evaluation—evaluation of the learners' performance and evaluation of the instruction—are both influenced by cognitive psychology. For example, evaluation may include test forms that solicit information on the learners' reasoning, in congruence with objectives that reflect an interest in the learners' acquiring understanding. Evaluation of instruction, particularly of instruction that includes materials, may include the use of techniques such as "read-think-aloud" protocols (Smith & Wedman, 1988) in formative evaluation. This procedure allows the designer to obtain information about the internal processing of learners as they interact with the instruction.

We have merely described a few of the influences that cognitive psychology has had and continues to have on instructional design practice. For a more comprehensive review, we suggest that you review articles by Bonner (1988), Di Vesta and Rieber (1987), Low (1981), Richey (2000), and Wildman (1981).

*A forceful argument on the importance of "understanding" is provided by Bereiter (2002). His discussion of declarative knowledge (pp. 133–138) and of concepts (pp. 306–318) provides examples of learning goals that are typically misapprehended by failure to appreciate and describe the understanding which underlies significant learning that is too frequently trivialized in educational practice.

Developmental Theories

Until recent years, many instructional designers have made little use of theories of cognitive development. With the popularization of such theories by constructivists, instructional designers may reconsider whether principles within these theories have application to our field.

PIAGET. One of the most influential development theories is Piaget's theory (Piaget & Inhelder, 1969) of cognitive development. Many educators are familiar with his stage theory of development, which proposes four distinct stages through which all humans proceed in a fixed order. Each stage is identified with the emergence of new cognitive abilities. These cognitive abilities require a reorganization of a learner's cognitive structure. (These stages of cognitive development are described in Chapter 4, *Analyzing the Learner*.)

Piaget proposed that (a) the sequence of stages is invariant and nonreversible; (b) learners cannot be taught key cognitive tasks until they reach a particular stage of development; (c) stages represent qualitative changes in cognition; (d) children exhibit the characteristics of each stage; and (e) global restructuring characterizes the shift from stage to stage, cutting across all domains of learning. Research (reported in Berk, 1994; Driscoll, 1994; Slavin, 1994) suggests that these stages are not invariant, that instruction can assist learners to achieve cognitive tasks beyond their current stage, that learners do revert to earlier stages of cognition, and that stages are not global across domains (i.e., learners may operate at different stages, perhaps because of the varying prior knowledge that learners have in different domains of knowledge).

Although Piaget's stage theory is the most familiar aspect of his theory, perhaps his more long-lasting and relevant contribution is his description of the processes that lead to shifts from one cognitive stage to another. Educators today generally view these processes as an explanation of cognitive learning processes, not just those that lead to major shifts in cognitive ability. Many of these terms are common to schema theory that we discussed earlier in this chapter. The major processes suggested by Piaget are:

- *Assimilation.* Cognitive processes that can fit new learning into existing cognitive structures.
- *Accommodation.* Cognitive processes that modify existing cognitive structures based upon new information that will not "fit" into existing structures.
- *Disequilibrium.* A cognitive state of confusion, dissonance, or discomfort when new information cannot be integrated within existing structures.
- *Equilibration.* Cognitive processes that create major restructuring of knowledge to accommodate or assimilate information that caused disequilibrium.

Piaget clearly perceived that development preceded learning. In other words, learners must be cognitively "ready" before they can achieve certain kinds of tasks.

VYGOTSKY. In contrast to Piaget, Vygotsky (1978) proposed that learning precedes development. He coined the term "zone of proximal development" to describe the type of problem-solving cognitions that are not possible for a learner independently but can be generated with the assistance ("scaffolding") of a teacher or more knowledgeable peer. Such a representation of learning and development are consistent with Vygotsky's belief in the social origins of cognitive processes.

Vygotsky's theory of development is termed a *sociocultural theory*, as he proposed that learners and their sociocultural contexts interact, assisting learners to develop cognitions that will enable them to adapt to their environments. Vygotsky also proposed that language, which is a social action, is critical to the development of higher cognitive processes. Not surprisingly, social constructivists and contextualists find Vygotsky's theory to be very compatible with their beliefs.

There is a difference in orientation between learning theory and developmental theory, a difference that is sometimes subtle and potentially confusing when one is trying to understand both perspectives. With some risk at doing injustice to the developmental perspective, it seems to us that developmentalists want to attribute all major changes in cognition to development, whereas a learning theory perspective tends to attribute major cognitive changes to cumulative learning effect, with development relating more to physical and emotional capacity factors. It may be helpful to think of these differences in perspective as illuminating, just as looking at a physical object from different standpoints can help better discern its actual shape. To think of these differences as a contest between right and wrong is less helpful. Various perspectives can be true at once; the difference may lie in which ones are the most helpful.

INFORMATION-PROCESSING DEVELOPMENTAL THEORIES.

Theorists in this tradition have attempted to explain cognitive development in terms of changes to the human information-processing system. For example, Case (1993), explained Piaget's stage theory in information-processing terms. He proposed that "mental space," a concept similar to working memory, increases during development. He suggested that this increase occurs because of three processes: brain maturation and its resulting myelination increases processing speed; cognitive strategies become automatic; and prior knowledge becomes more extensive and better organized. He suggested that Piaget's stages represented increasing demands on working memory and that transition from one Piagetian stage to another results from

increased working memory rather than conceptual reorganization. A contrasting interpretation might be that instead of working memory capacity increasing, less working memory is required as this cognitive development occurs.

In contrast to Case, Siegler (1986) proposed that it is the process of encoding that distinguishes cognitive development. He observed children attempting a Piagetian-like task that involved the consideration of two variables and four principles. During his investigations, he observed that learners at a "lower" stage of development than an assigned task (requiring the manipulation of two variables and four rules that related them) tended to concentrate on only one of the task's variables and the rules related to this variable. He found that with coaching they could be encouraged to consider both variables and all four rules. He concluded that it was the learners' limited prior knowledge that inhibited their ability to use all of the features and rules necessary to solve the problem.

Contrary to Piaget, who perceived development as preceding learning, and Vygotsky, who perceived development as following learning, Case and Siegler appear to perceive learning and development as almost concurrent.

To this point, our discussion of theories of cognitive development has described cognitive development regardless of age, although some educators would view these theories as more relevant to the cognitive development of children than adults. We could locate no theories of cognitive development that were specifically targeted at adults. This may be because the primary development in adults is social and personal, as opposed to cognitive (Rice, 1995). Therefore, the major theories dealing with adult development relate to social and personal maturation, as opposed to cognitive development. These social and personal issues strongly influence adult learners' motivation and should be seriously considered by instructional designers. However, we will not discuss them in depth here.

Of course, designers who are designing for older adults should keep in mind that both sensory receptors and cognitive processes change for this audience. Sight, hearing, and tactile responses tend to show decrements in adults past the age of fifty. These senses, in addition to taste and smell, tend to decrease in acuity even more seriously for many adults in their seventies, eighties, and beyond. Although sensory and working memory do not appear to diminish with increasing age, long-term memory may be affected more seriously. Cognitive tasks that are difficult for all ages, such as remembering meaningless information and information for which one has little related prior knowledge, appear to become even more difficult for older adults (Hess & Flanagan, 1992).

CONTRIBUTIONS OF DEVELOPMENTAL THEORIES TO INSTRUCTIONAL DESIGN. Although theories of development have not had as much impact on instructional design as other cognitive theories, specific implications may affect decisions made during at least two instructional design activities. During the analysis of the learner, considering the learner's level of cognitive development may be beneficial. (We discuss this further in Chapter 4.) Also, during the development of instructional activities, designers might consider both the implications of Piagetian stages of development and the processes of cognitive development in selecting ways of organizing information and designing learning activities. In addition, designers may consider what might be described as the "zone of proximal development" of learners and the role of teachers and peers in supporting learning as they extend their ability to the level of independent performance. Finally, in keeping with Vygotsky's belief in the social nature of learning, many designers may wish to consider strategies that support the formation of a learning community.

We must now acknowledge a fundamental question that often arises in instructional design classes that include both teachers of children and trainers of adults: Are the cognitive processes of children and adults qualitatively different, or are the differences that we often see between how adults learn and how children learn more an artifact of prior learning (strategic, domain-specific, and world knowledge)? This question has not yet been answered definitely, and there are persuasive anecdotes on both sides. Our experiences suggest that a novice adult and a novice child have many similarities in processing and in instructional needs, taking into account other factors considered during learner analysis. To a degree, the research investigating the theories presented in this section tend to support this position. A factor that may play the most distinguishing role between adult and child learners is motivation. (We will discuss this issue further in Chapter 14, *Strategies for Attitude Change, Motivation, and Interest*.)

The next section discusses instructional theories, which have developed primarily from cognitive learning theory.

Instructional Theories

Of all theory bases, instructional theories are those that instructional designers draw from most directly. Bruner (1966) is usually credited with being the first to describe the characteristics of instructional theory. More recently, Gagné and Dick (1983) described instructional theories as follows:

Theories of instruction attempt to relate specified events comprising instruction to learning processes and learning outcomes, drawing upon knowledge generated by learn-

ing research and theory. Often instructional theories are prescriptive in the sense that they attempt to identify conditions of instruction which will optimize learning, retention, and learning transfer. To be classified as theories, these formulations may be expected, at a minimum, to provide a rational description of causal relationships between procedures used to teach and their behavioral consequences in enhanced human performance. (p. 264)

Although none of the theories is complete for all types of learning and all kinds of learners, many of the theories do attempt to prescribe the characteristics of instruction that will support learning. These theories are quite different from learning theories that describe how learning occurs, without attention to what the learner or others might do to foster this learning. In contrast, instructional theories explicitly address which and how features of the learning environment may be developed to intentionally promote learning.

Many instructional theories will be described and used throughout the text, including Conditions Theories of Instruction—notably Gagné's Theory on Conditions of Learning, Reigeluth's Elaboration Model, Collins's Theory of Inquiry Teaching, Keller's ARCs Model of Motivation, Mayers and others Cognitive Load Theory, and a variety of theories and models labeled as the New Paradigms of Instructional Theory. However to provide an example of instructional theory, we will describe one general instruction theory—Bloom's Model of Mastery Learning.

Bloom's (1968) most influential contribution to the field of instructional design is the proposition that the "normal curve" should not be the expected model of outcomes of instruction. According to Bloom, the normal curve, with a few students learning very well, some learning well, many learning medially, some learning less well, some learning poorly, and a few learning very poorly, is what we might expect to occur *without* the intervention of instruction. It is what we would expect if students were to learn totally on their own, with aptitude (and, perhaps, perseverance) being the only factors influencing learning. However, instruction should foster learning. Its very purpose should be to support (or "scaffold") learners at points where their own native aptitudes or attitudes might infringe on learning. Hence, Bloom contends the following: "Most students (perhaps more than 90 percent) can master what we have to teach them, and it is the task of instruction to find the means which will enable them to master the subject under consideration" (p. 51).

Through the years, Bloom has proceeded to investigate variables within learners and instruction that can be altered to promote "mastery learning" for almost all learners. He has identified two learner characteristics—cognitive entry behaviors and affective entry behaviors—and quality of instruction as factors that can be

altered to promote mastery (Bloom, 1976). In his discussion of cognitive entry behaviors, he supported the identification of specific task prerequisites within instruction. If entry skills are missing, he suggested a number of ways to ameliorate the situation. With regard to affective entry behaviors, Bloom asserted that learners "vary in what they are emotionally prepared to learn as expressed in their interests, attitudes, and self-views" (p. 74). While he felt that these affective characteristics may be difficult to change, he asserted that quality instruction that promotes successful learning experiences and ensures that the learner finds reward in successful experiences will aid in promoting a positive affect toward learning.

Finally, Bloom discussed features of quality instruction that can promote mastery among most learners. He described four features of quality instruction: cues, participation, reinforcement, and feedback/correctives. Cues are communications to the learner as to the requirements of the learning task and how to go about meeting these requirements. Participation involves covert or overt active practice with the learning task. Bloom suggested that reinforcement, whether positive or negative, should be given to learners by teachers, peers, or other adults to indicate approval of positive learning performance and disapproval of poor performance. Feedback and corrective procedures follow participation or interaction by the learner. They may include "alternative cues or additional time and practice" (p. 125).

Bloom's model of mastery learning has had a strong impact upon instructional design practice, indeed upon its fundamental philosophy. The goal of instructional design is to develop instruction from which the majority of students can learn very well. For instance, it is very common to have a designer trying to design and revise instruction to an 80/80 criterion (at least 80 percent of the learners achieve at least 80 percent of the objectives). Although mastery learning models generally incorporate instructional design practices, the reverse is not always true. *Not all instructional programs created with instructional design principles and procedures are predicated on a mastery model.* An instructional system that adheres to a mastery model sets a minimum level of competence for all, or most, students. The system is developed to provide the remediation and reevaluation necessary to bring learners to this level of competence and has developed a scheme for grading that accommodates the mastery model. Instructional systems may use instructional design principles and procedures, but because of unfeasibility or alternate philosophies, their designers choose not to employ a mastery model.

The instructional theories included in this text are not exhaustive. A number of other theories might be included. We attempted to select those theories that have had or that we expect to have the greatest impact

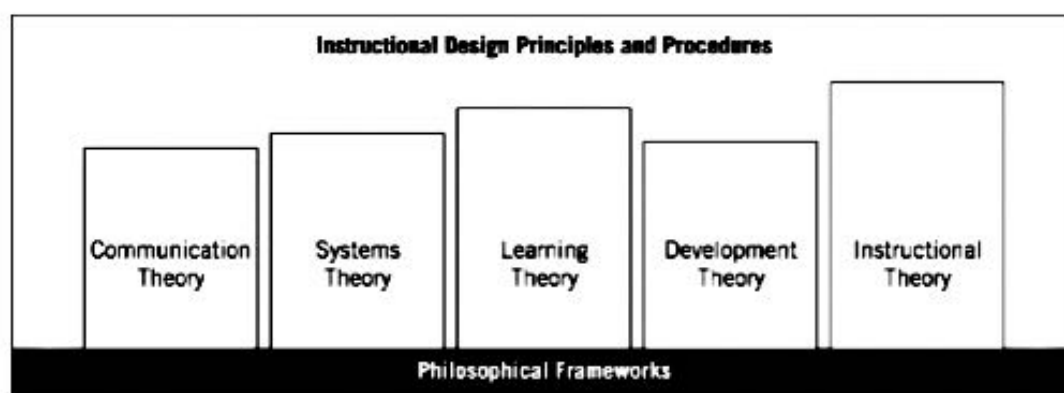


Figure 2.4 Summary Diagram

in the field. Refer to Reigeluth's texts on instructional design theories (1983, 1999) and Jonassen's *Educational Technology Research Handbook* (2004) for additional information in this area.

EXERCISES

1. In your own words, explain why it is important for instructional designers to be able to describe and explain the philosophical foundations and theory bases of their field.
2. Discuss how the major educational philosophies of constructivism/rationalism, empiricism, and pragmatism relate to behaviorism and cognitive learning theories.
3. Describe the major differences between behaviorism and cognitive learning theories.
4. Ted is sitting in class listening to his teacher explain the difference between the concepts "liberal" and "conservative." Using the model of information processing described in this chapter, explain how this information flows through Ted's cognitive processes and structures. Give particular attention to the processes of selective perception, encoding, and retrieval.

SUMMARY

Both philosophy and theory provide foundations for instructional designers. In the first section of this chapter, we attempted to portray how educational philosophies may influence educators' beliefs about what knowledge is and how it is acquired. In the subsequent section, we discussed another way of viewing these same questions via the development and testing of learning theories. While this chapter does not exhaustively cover the philosophies and theories that have contributed to instructional design, it is our goal that as you read subse-

quent chapters, you will be able to relate assertions and principles that are stated to their particular philosophy and theory base. We also hope that we have pointed you toward additional sources of information to which you may refer throughout your career. Figure 2.4 summarizes key points in this chapter.

READINGS AND REFERENCES

- Allen, B. S., Otto, R. G., & Hoffman, B. (2004). Media as lived environments: The ecological psychology of educational technology. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 215–241). Mahwah, NJ: Erlbaum.
- Anderson, J. R. (2000). *Cognitive psychology and its implications* (5th ed.). New York: Worth.
- Anderson, J. R., & Bower, G. H. (1973). *Human associative memory*. Washington, DC: V. H. Winston.
- Andrews, D. H., & Goodson, L. A. (1980). A comparative analysis of models of instructional design. *Journal of Instructional Development*, 11(3), 2–16.
- Arter, J. A., & Spandel, V. (1992, Spring). Using portfolios of student work in instruction and assessment. *Educational Measurement: Issues and Practices*, 36–43.
- Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation*, Vol. 2 (pp. 89–193). New York: Academic Press.
- Banathy, B. H. (1992). *A systems view of education: Concepts and principles for effective practice*. Englewood Cliffs, NJ: Educational Technology.
- Banathy, B. H. (2004). Systems inquiry and its application in education. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 37–57). Mahwah, NJ: Erlbaum.
- Barab, S. A., Evans, M. A., & Baek, E.-O. (2004). Activity theory as a lens for characterizing the participatory unit. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 199–214). Mahwah, NJ: Erlbaum.

- Bednar, A. K., Cunningham, D. J., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link? In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 17–34). Hillsdale, NJ: Erlbaum.
- Berelter, C. (1991). Implications of connectionism for thinking about rules. *Educational Researcher*, 20(3), 10–16.
- Berelter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Erlbaum.
- Berk, L. (1994). *Child development* (3rd ed.). Boston: Allyn and Bacon.
- Bloom, B. S. (1968). Learning for mastery. *Evaluation Comment 1* (2). Los Angeles: University of California.
- Bloom, B. S. (1976). *Human characteristics and school learning*. New York: McGraw-Hill.
- Bonner, J. (1988). Implications of cognitive theory for instructional design: Revisited. *Educational Communication and Technology Journal*, 36, 3–14.
- Boud, D., & Feletti, G. (1991). *The challenge of problem-based learning*. New York: St. Martin's Press.
- Bredo, E. (1994). Reconstructing educational psychology: situated cognition and Deweyan pragmatism. *Educational Psychologist*, 29(1), 23–35.
- Briggs, L. J. (Ed.). (1977). *Instructional design: Principles and applications*. Englewood Cliffs, NJ: Educational Technology Publications.
- Britton, B. K., Westbrook, R. D., & Holdredge, T. S. (1978). Reading and cognitive capacity usage: Effects of text difficulty. *Journal of Experimental Psychology: Human Learning and Memory*, 4, 582–591.
- Brophy, J., & Alleman, J. (1991). Activities as instructional tools: a framework for analysis and evaluation. *Educational Researcher*, 20(4), 9–23.
- Brown, D. (1988). Twelve middle-school teachers' planning. *The Elementary School Journal*, 89, 69–87.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.
- Bruner, J. S. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University Press.
- Bullough, R. (1987). Planning the first year of teaching. *Journal of Education for Teaching*, 13, 231–250.
- Case, R. (1993). Theories of learning and theories of development. *Educational Psychologist*, 23(3), 219–233.
- Case, R., & Bereiter, C. (1984). From behaviourism to cognitive behaviourism to cognitive development: Steps in the evolution of instructional design. *Instructional Science*, 13, 141–158.
- Choi, J., & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational Technology Research and Development*, 43(2), 53–70.
- Clark, R. E. (1982). Antagonism between achievement and enjoyment in ATI studies. *Educational Psychologist*, 17, 92–101.
- Clark, C., & Peterson, P. (1986). Teacher's thought process. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 255–296). New York: Macmillan.
- Cobb, P. (1996). Constructivism and learning. In T. Plomp and D. P. Ely (Eds.), *International encyclopedia of educational technology* (2nd ed.) (pp. 56–59). Tarrytown, NY: Elsevier Science.
- Cognition and Technology Group. (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher*, 19(8), 2–10.
- Cognition and Technology Group. (1992). An anchored instruction approach to cognitive skills acquisition and intelligent tutoring. In J. W. Regian and V. Shute (Eds.), *Cognitive approaches to automated instruction* (pp. 135–170). Hillsdale, NJ: Erlbaum.
- Cognition and Technology Group. (1992). The Jasper experiment: An exploration of issues in learning and instructional design. *Educational Technology Research and Development*, 40(1), 65–80.
- Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11, 671–684.
- Davies, I. K. (1976). *Objectives in curriculum design*. London: McGraw-Hill.
- Davis, R. H., Alexander, L. T., & Yelon, S. L. (1974). *Learning system design*. New York: McGraw-Hill.
- DeVane, A. (1990). Rules of evidence. *Journal of Thought*, 25(1 & 2), 6–18.
- Dewey, J. (1924). *Democracy and education*. New York: Macmillan.
- Di Vesta, F. J., & Rieber, L. P. (1987). Characteristics of cognitive engineering: The next generation of instructional systems. *Educational Communications and Technology Journal*, 35, 213–230.
- Dick, W. (1992). An instructional designer's view of constructivism. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 91–98). Hillsdale, NJ: Erlbaum.
- Dick, W., & Carey, L. (1985). *The systematic design of instruction*. Glenview, IL: Scott, Foresman.
- Driscoll, M. P. (1994). *Psychology of learning for instruction*. Boston: Allyn and Bacon.
- Duffy, T. M., & Jonassen, D. H. (Eds.). (1992). *Constructivism and the technology of instruction*. Hillsdale, NJ: Erlbaum.
- Dunn, T. G. (1994). If we can't contextualize it, should we teach it? *Educational Technology Research and Development*, 42(3), 83–92.
- Dwyer, F. M. (1972). *A guide for improving visualized instruction*. State College, PA: Learning Services.
- Gagné, E. D., Yekovich, C. W., and Yekovich, F. R. (1993). *The cognitive psychology of school learning* (2nd ed.). New York: HarperCollins.
- Gagné, R. M. (1974). *Essentials of learning for instruction*. New York: Dryden Press.
- Gagné, R. M. (1985). *The conditions of learning* (4th ed.). New York: Holt, Rinehart, & Winston.
- Gagné, R. M., & Dick, W. (1983). Instructional psychology. *Annual Review of Psychology*, 34, 261–295.
- Gagné, R. M., & Driscoll, M. P. (1988). *Essentials of Learning for instruction* (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.
- Gergen, K. J. (1995). Social construction and the educational process. In L. P. Steffe & J. Gale (Eds.), *Constructivism in education* (pp. 17–40). Hillsdale, NJ: Erlbaum.
- Goldman, S. R., Pellegrino, J. W., & Bransford, J. (1994). Assessing programs that invite thinking. In E. L. Baker & H. F. O'Neil (Eds.), *Technology assessment in education and training* (pp. 199–230). Hillsdale, NJ: Erlbaum.

- Greeno, J. G., Collins, A. M., & Resnick, L. (1996). Cognition and learning. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 15-46). New York: Macmillan.
- Gruender, C. D. (1996, June). Constructivism and learning: A philosophical appraisal. *Educational Technology*, 36(3), 21-29.
- Gustafson, K. L., & Branch, R. M. (1997). Survey of instructional development models (3rd ed.). Syracuse, NY: ERIC Clearinghouse on Information and Technology. Publication IR-103.
- Haberlandt, K. (1997). *Cognitive psychology*. Needham Heights, MA: Allyn & Bacon.
- Hamm, R. L. (1981). *Philosophy and education: Alternatives in theory and practice* (2nd ed.). Danville, IL: Interstate Publishers.
- Hayakawa, S. I. (1953). *Symbol, status, and personality*. New York: Harcourt, Brace, & World.
- Heinich, R., Molenda, M., Russell, J. D., & Smaldino, S. E. (1996). *Instructional media and the new technologies of instruction*. New York: Macmillan.
- Henning, P. H. (2004). Everyday cognition and situated learning. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 143-168). Mahwah, NJ: Erlbaum.
- Hess, T. M., & Flanagan, D. A. (1992). Schema-based retrieval processes in young and older adults. *The Journals of Gerontology*, 47, 52-58.
- Honebein, P. C. (1996). Seven goals for the design of constructivist learning environments. *Constructivist learning environments* (pp. 11-24). Englewood Cliffs, NJ: Educational Technology Publications.
- Jonassen, D. H. (1992). Evaluating constructivist learning. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 137-148). Hillsdale, NJ: Erlbaum.
- Jonassen, D. H. (Ed.). (2004). *Handbook of research on educational communications and technology* (2nd ed.). Mahwah, NJ: Erlbaum.
- Kantowitz, B. H. (1987). Mental workload. In P. A. Hancock (Ed.), *Human factors of psychology* (pp. 81-121). North-Holland: Elsevier.
- Kaufman, R. (2000). *Mega planning: Practical tools for organizational success*. Thousand Oaks, CA: Sage.
- Kerr, S. T. (1983). Inside the black box: Making design decisions for instruction. *British Journal of Educational Technology*, 14, 45-58.
- Kintsch, W. (1972). Notes on the structure of semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 247-308). New York: Academic Press.
- Kintsch, W. (1974). *The representation of meaning in memory*. Hillsdale, NJ: Erlbaum.
- Kirst, M. W. (1991). Interview on assessment issues with Lorrie Shepard. *Educational Researcher*, 20(2), 21-23.
- Kirst, M. W. (1991). Interview on assessment issues with James Popham. *Educational Researcher*, 20(2), 24-27.
- Korzybski, A. (1973) *Science and sanity: An introduction to non-Aristotelian systems and general semantics* (5th ed.). Englewood, NJ: International Non-Aristotelian Library.
- Language Development and HyperMedia Research Group. (1992). Bubble dialogue: A new tool for instructional and assessment. *Educational Technology Research and Development*, 40(2), 59-68.
- Leahey, T. H., & Harris, R. (1989). *Human learning* (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.
- Lebow, D. (1995). Constructivist values for instructional systems design: Five principles toward a new mindset. In B. B. Seels (Ed.), *Instructional design: A reconsideration* (pp. 175-187). Upper Saddle River, NJ: Educational Technology Publications.
- Lee, I. (1941). *Language habits in human affairs*. New York: Harper.
- Lesgold, A., Eggen, G., Katz, S., & Rao, G. (1992). Possibilities for assessment using computer-based apprenticeship environments. In J. W. Regian & V. J. Shute (Eds.), *Cognitive approaches to automated instruction* (pp. 49-80). Hillsdale, NJ: Erlbaum.
- Linn, R. L. (1994). Performance assessment: Policy promises and technical measurement standards. *Educational Researcher*, 23(9), 4-14.
- Linn, R. L., Baker, E. L., & Dunbar, S. B. (1991). Complex, performance-based assessment: Expectations and validation criteria. *Educational Researcher*, 20(8), 15-21.
- Locke, J. (1690/1995). *Essay concerning human understanding*. Amherst, NY: Prometheus Books.
- Low, W. C. (1981). Changes in instructional development: The aftermath of an information processing takeover in psychology. *Journal of Instructional Development*, 4, 10-18.
- Mager, R. F. (1984). *Preparing instructional objectives* (2nd ed.). Belmont, CA: Fearon-Pitman.
- Mayer, R. E. (1982). Learning. In H. E. Mitzel (Ed.), *Encyclopedia of educational research* (pp. 1040-1058). New York: The Free Press.
- Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, 38, 1, 43-52.
- McClelland, J. L., & Rummelhart, D. E. (1988). *Explorations in parallel distributed processing: A handbook of models, programs, and exercises*. Cambridge, MA: MIT Press/Bradford Books.
- McCutcheon, G. (1980). How do elementary school teachers plan? The nature of planning and influences on it. *The Elementary School Journal*, 81, 4-23.
- Merrill, M. D. (1992). Constructivism and instructional design. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 99-114). Hillsdale, NJ: Erlbaum.
- Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63, 81-97.
- Moore, M. G., & Kearsley, G. (1996). *Distance education: A systems view*. Belmont, CA: Wadsworth.
- Morris, V. C., & Pai, Y. (1976). *Philosophy and the American school* (2nd ed.). Boston: Houghton Mifflin.
- Murdock, B. B. (1961). The retention of individual items. *Journal of Experimental Psychology*, 62, 618-625.
- Paivio, A. U. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, & Winston.
- Pavlov, I. P. (1927). *Conditioned reflexes*. (G. V. Anrep, Trans.) London: Oxford University Press.
- Perkins, D. N. (1992). What constructivism demands of the learner. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 161-166). Hillsdale, NJ: Erlbaum.

- Perkins, D. N., & Salomon, G. (1989). Are cognitive skills context-bound? *Educational Researcher*, 18(1), 16–25.
- Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, 24(7), 5–12.
- Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York: Basic Books.
- Prawat, R. S., & Floden, R. E. (1994). Philosophical perspectives on constructivist views of learning. *Educational Psychology*, 29(1), 37–48.
- Reigeluth, C. M. (Ed.). (1983). *Instructional design theories and models*. Hillsdale, NJ: Erlbaum.
- Reigeluth, C. M. (Ed.). (1987). *Instructional theories in action*. Hillsdale, NJ: Erlbaum.
- Reigeluth, C. M. (1992). Reflections on the implications of constructivism for educational technology. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 149–156). Hillsdale, NJ: Erlbaum.
- Reigeluth, C. M. (Ed.). (1999). *Instructional-design theories and models: New paradigms on instructional theory*. Mahwah, NJ: Erlbaum.
- Renkl, A. & Atkinson, R. K. (2003). Structuring the transition from example study to problem solving in cognitive skill acquisition: A cognitive load perspective. *Educational Psychologist*, 38, 1, 15–22.
- Rice, F. P. (1995). *Human development: A lifespan approach* (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.
- Richey, R. (1986). *The theoretical and conceptual bases of instructional design*. London: Kogan Page.
- Richey, R. (Ed.). (2000) *The legacy of Robert M. Gagné*. Syracuse, NY: ERIC Clearinghouse on Information and Technology. Publication IR-108.
- Rieber, L. P. (1992). Computer-based microworlds: A bridge between constructivism and direct instruction. *Educational Technology Research and Development*, 40(1), 93–106.
- Rieber, L. P. (2004). Microworlds. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology*. Mahwah, NJ: Erlbaum.
- Rorty, R. (1982). *Consequences of pragmatism*. Minneapolis: University of Minnesota.
- Rousseau, J. (1950). *Emile*. (B. Foxley, Trans.) New York: E. P. Dutton.
- Rummelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 33–58). Hillsdale, NJ: Erlbaum.
- Schneider, W., & Braham, D. J. (1992). Introduction to connectionist modeling in education. *Educational Psychologist*, 27(4), 513–542.
- Schott, F. (1992). The contributions of cognitive science and educational technology for the advancement of instructional design theory. *Educational Technology Research and Development*, 40(2), 55–58.
- Schramm, W. (1956). Procedures and effects of mass communication. In N. B. Henry (Ed.), *Mass media and education*. NSSE Yearbook 53 (pp. 113–138). Chicago: The University of Chicago Press.
- Schuell, T. J. (1986). Cognitive conceptions of learning. *Review of Educational Research*, 56, 411–436.
- Seels, B. B. (Ed.). (1995). *Instructional design: a reconsideration*. Englewood Cliffs, NJ: Educational Technology Publications.
- Shannon, C., & Weaver, W. (1949). *The mathematical theory of communication*. Urbana, IL: University of Illinois Press.
- Siegler, R. S. (1986). *Children's thinking*. Upper Saddle River, NJ: Prentice-Hall.
- Slavin, R. E. (1994). *Educational psychology: Theory and practice*. (4th ed.). Needham Heights, MA: Allyn and Bacon.
- Smith, P. L., & Wedman, J. F. (1988). Read-think-aloud protocols: A new data-source for formative evaluation. *Performance Improvement Quarterly*, 1, 13–22.
- Sperling, G. A. (1960). The information available in brief visual presentation. *Psychological Monographs*, 74, Whole No. 498.
- Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1992). Knowledge representation, content specification, and the development of skill in situation specific knowledge assembly: Some constructivist issues as they relate to cognitive flexibility theory and hypertext. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 57–76). Hillsdale, NJ: Erlbaum.
- Steffe, L. P., & Gale, J. (Eds.). (1995). *Constructivism in education*. Hillsdale, NJ: Erlbaum.
- Streibel, M. J. (1995). Instructional plans and situated learning: The challenge of Suchman's theory of situated action for instructional designers and instructional systems. In G. Anglin (Ed.), *Instructional technology: Past present and future* (2nd ed.) (pp. 145–160). Englewood, CO: Libraries Unlimited.
- Swanson, D. B., Norman, G. R., & Linn, R. L. (1995). Performance-based assessment: Lessons from the health professions. *Educational Researcher*, 24(5), 5–11, 35.
- Thorndike, E. L. (1913). *Educational psychology: Vol. II. The psychology of learning*. New York: Teachers College, Columbia University.
- Tripp, S. D. (1993). Theories, traditions, and situated learning. *Educational Technology*, 33(3), 71–77.
- von Glasersfeld, E. (1995). A constructivist approach to teaching. In L. P. Steffe and J. Gale (Eds.), *Constructivism in education* (pp. 3–16). Hillsdale, NJ: Erlbaum.
- Vygotsky, L. S. (1978). *Mind and society: Development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review*, 20, 158–177.
- Wedman, J., and Tessmer, M. (1990). A layers of necessity instructional development model. *Educational Technology Research and Development*, 38 (2), 77–85.
- Weiner, N. (1969). *The human use of human beings: Cybernetics in society*. New York: Avon (original publication date: 1954).
- Wildman, T. M. (1981, July). Cognitive theory and the design of instruction. *Educational Technology*, 23, 14–20.
- Wilson, B., Teslow, J., & Osman-Jouchoux, R. (1995). The impact of constructivism (and postmodernism) on ID fundamentals. In B. B. Seels (Ed.), *Instructional design: A reconsideration* (pp. 137–157). Englewood Cliffs, NJ: Educational Technology Publications.

- Wilson, B. G. (1996). Introduction: What is a constructivist learning environment? In B. G. Wilson (Ed.), *Constructivist learning environments* (pp. 3–10). Englewood Cliffs, NJ: Educational Technology Publications.
- Wilson, B. G. (Ed.). (1996). *Constructivist learning environments*. Englewood Cliffs, NJ: Educational Technology Publications.
- Winn, W. (1995). Instructional design and situated cognition: Paradox or partnership. In B. B. Seels (Ed.), *Instructional design: A reconsideration* (pp. 159–169). Englewood Cliffs, NJ: Educational Technology Publications.
- Winn, W. (2004). Cognitive perspectives in psychology. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology* (pp. 79–112). Mahwah, NJ: Erlbaum.
- Young, M. F. (1993). Instructional design for situated learning. *Educational Technology Research and Development*, 41(1), 1042–1629.
- Young, M. (2004). An ecological psychology of instructional design: Learning and thinking by perceiving-acting systems. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 169–177). Mahwah, NJ: Erlbaum.