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Psychology of Learning for Instruction

THIRD EDITION

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Part I: Introduction

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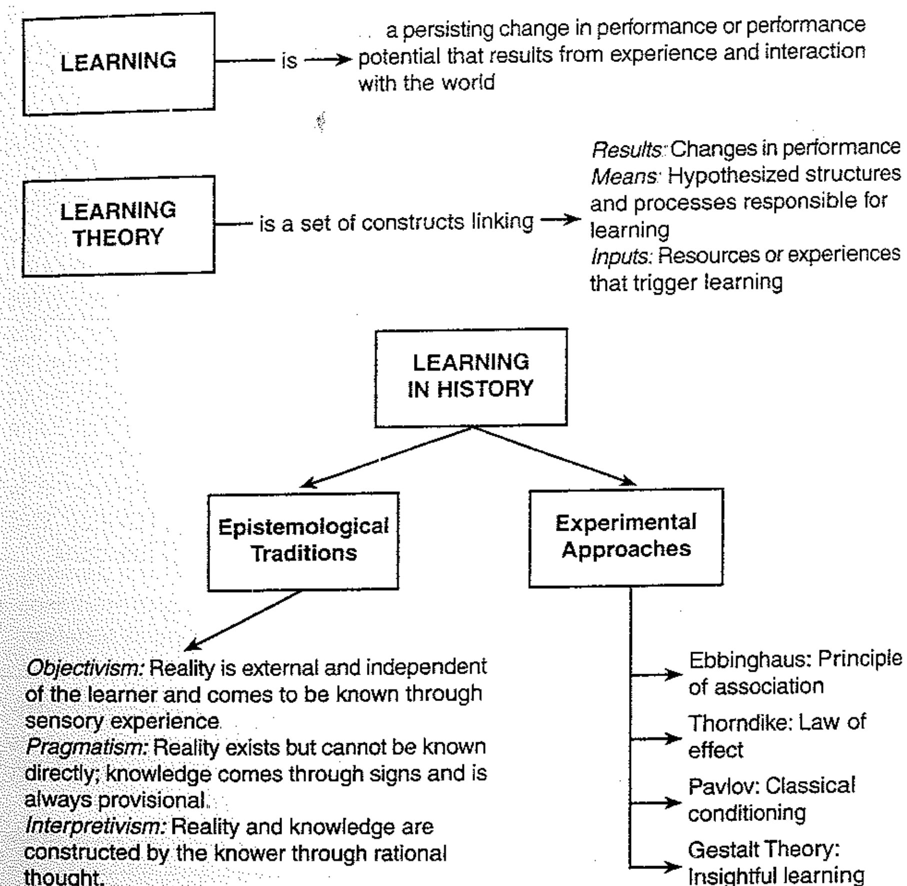
Introduction to Theories of Learning and Instruction



Children learn language in a remarkably brief period of time, but an athlete may take years to develop a powerhouse serve in tennis. Students in school learn how to solve complex problems in mathematics, and sales trainees learn how to mollify irate customers. Chess and bridge players learn tactical strategies; preloaders learn efficient strategies for packing milk crates. These are all examples of what we call learning. But what is learning and how does it occur?

Learning is a lifelong activity. Learning occurs intentionally in formal instructional settings and incidentally through experience. Learning encompasses a multitude of competencies, from knowledge of simple facts to great skill in complex and difficult procedures. Learning sometimes requires great effort and sometimes proceeds with relative ease. These are a few of the things we know about learning. But learning is a complex affair. The results of learning are often observable in human performance, but the process of learning is much less obvious. As a consequence, different theories have been developed to explain learning. These theories represent different perspectives, different assumptions, and different beliefs about learning. It is therefore worthwhile to consider both how learning theories develop and what historical roots underlie the specific theories discussed in this book.

What Is a Theory of Learning?

Most people have an intuitive answer to this question. A theory about learning is a set of laws or principles about learning. But what do these principles involve? What is their purpose? Where do they come from? Let's start with the last question first.

Theories about anything typically originate with questions. Why does the beach remain sunny when afternoon summer thunderstorms are wide-

spread just 5 miles inland? What makes a person successful in reading? How much do adults know about world geography? How do effective teachers organize their instruction? Some of these questions are prompted by curiosity and a desire to understand the world around us. With the expansion of computers and other high-tech equipment in all educational settings, for example, what role will textbooks play? What role do they play now? Are they particularly useful for facilitating learning in certain subject matters? What, in fact, do people learn from reading textbooks?

Other questions may be motivated by problems that require the generation of new knowledge to effect their solutions. For example, should a school or company invest in the latest computer or internet technology? Is the cost of this equipment worth the learning gains that might be expected from its use in instruction? To make an informed decision about such a purchase, school or company officials might wish to know what impacts there are likely to be on learning, social processes, and the like.

Finally, many questions are provoked by events which somehow contradict our beliefs about the way things are. For example, consider the following story that I heard over National Public Radio. A teacher was describing what happened during a science experiment that his students were conducting, which involved putting empty or partially filled cans of soda into a tub of water and observing the degree to which they floated. To complete their experiment, the students added a couple of unopened cans, one of which happened to be diet soda. Lo and behold, the diet soda floated while the regular soda sank! Both were unopened 12-ounce cans. What could possibly account for the difference in their flotation capability? [The answer appears at the end of the chapter.]

Regardless of how questions arise, they generally lead researchers to conduct systematic observations on the basis of which plausible answers can be constructed. In some kinds of investigations, these observations are conducted without many advance, or a priori, expectations about what will be seen. Certainly, "inquiry demands the selection of a particular set of observations or facts from among the nearly infinite universe of conceivable observations" (Shulman, 1988, p. 5). But this selection may be quite broad and general. In a study examining textbook use and learning, for instance, the researchers might decide to look at grade level, subject matter, and teacher experience as possible variables in textbook use. Although these variables then help in the selection of classes to observe, they would not limit what the researchers observed in those classes.

By contrast, other kinds of investigations require the researchers to generate and test potential answers to the research question. The soda can story is illustrative. In this case, the students proposed a working hypothesis about one can containing slightly more liquid than the other (therefore, having more volume). A hypothesis, or one's suggested answer to a research question, determines what variables (in this example, amount of liquid) are thought to be important in understanding the event (sinking/floating) The hypothesis also specifies the presumed relationship between the variables and the observed event. That is, the can that sank should contain more liquid than the can that floated.

In order to examine the viability of hypotheses, a set of particular observations must now be conducted, which in this case consisted of the students pouring the contents of each can into a measuring cup and then comparing the amounts in the two cups. The results of these observations would then be compared with the prediction that was hypothesized. The extent to which results and prediction agree determines whether the hypothesis has been verified or refuted. If refuted, then other, alternative explanations must be considered.

The observations made in any investigation enable researchers to construct or verify propositions about what is going on These propositions form the basis of theories In the soda can example, the students can be said to have a theory of flotation in which the amount of liquid contained in the can determines whether it sinks or floats. Their subsequent observations, however, revealed that both the regular and diet soda cans contained the same volume of liquid Therefore, the students were forced to abandon this variable as part of their theory and to consider alternative ones.

Likewise, consider how theory building might occur in an examination of textbook use and learning Although the investigation would not proceed from specific hypotheses, it is likely that researchers would begin with a question such as, how do textbooks influence learning? In answering this question, they might first examine the degree to which students actually read or studied their textbooks, with the assumption that those who did so would learn more than those who never opened their books. Suppose that observations revealed a general tendency of this sort but that, even among the textbook users, there was considerable variability in performance. This would suggest that the relationship between textbook use and learning involves more than just time spent reading or studying the text. The original assumption must now be amended and might, for example, include the additional variable of what students do when they read or study their textbooks Eventually, a complex picture, or theory, of textbook use would be drawn

As can be seen in these two examples, the process of theory building is recursive The results of each phase of inquiry influence subsequent phases, which eventually feed back to modify original assumptions or hypotheses. In this way, a theory constantly undergoes modifications as new results are accommodated. Figure 1.1 illustrates this process. In the figure we also see the essential purposes of a theory: to explain the occurrence of some phenomenon and to predict its occurrence in the future A learning theory, then, should explain the results associated with learning and predict the conditions under which learning will occur again It is obviously the goal of in-

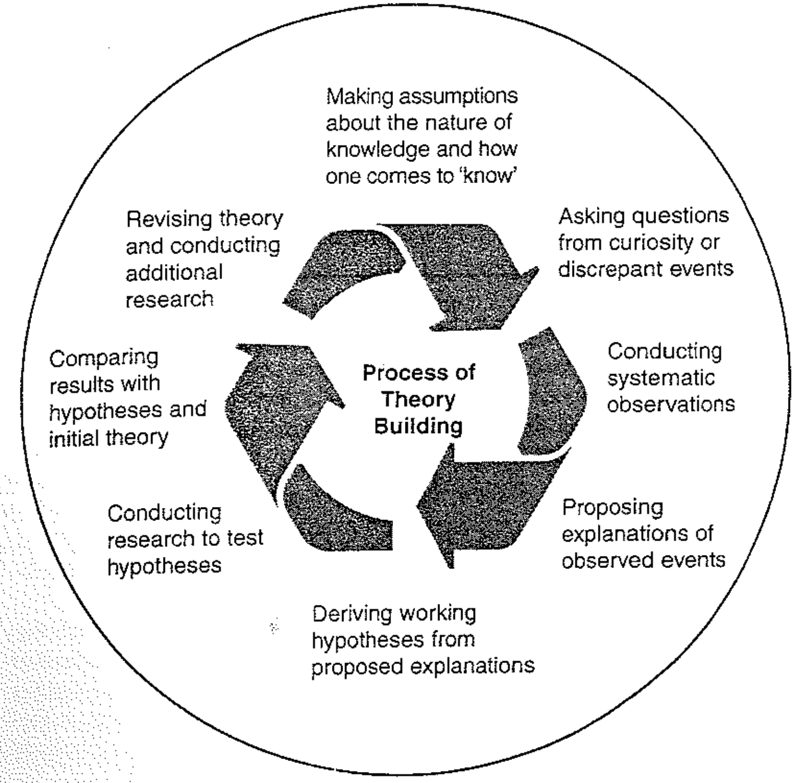


FIGURE 1.1 *A Systematic and Recursive Process for Building a Theory*

struction to apply this knowledge in the provision of appropriate conditions for facilitating effective learning.

Although theory building, as I have described it so far, seems orderly and objective, it is not necessarily either. Take, for instance, the problem of choosing what variables are important to investigate. If you assume that learning is a function of student characteristics, such as their motivation or preferred learning style, you could explain the effects of textbook use on performance in terms of how motivated students were to study the information or whether they possessed a verbal learning style. In other words, more motivated students would be expected to learn more than less motivated students, and those with a verbal learning style would be expected to learn more than their counterparts with a visual learning style. Adopting this perspective emphasizes the student and how he or she approaches the learning task. Finding support for this explanation would probably involve interviewing students, asking them to think aloud as they read through a text chapter, or administering an instrument to measure motivation and/or learning style. These results would then be correlated with performance.

Alternatively, you could assume that properties of the text itself are responsible for student learning. This might suggest that some textbooks (in the same subject matter) should facilitate learning more effectively than others because they contain objectives, chapter summaries, practice questions and feedback, or other features that influence how students read and study texts. Adopting this perspective emphasizes the textbook, and to find evidence of this explanation would require textbook analyses, with subsequent correlation of text features and student performance. How does one decide which perspective to adopt? Is one more true than the other? Or is there a third alternative that recognizes the importance of both perspectives in providing a more complete understanding of the phenomenon?

Research decisions such as these fundamentally stem from disciplinary assumptions, or beliefs, that investigators have about the phenomena they study. An anthropologist, for example, goes about the study of primitive cultures quite differently from how a psychologist would approach the same investigation.

> What distinguishes disciplines from one another is the manner in which they formulate their questions, how they define the content of their domains and organize that content conceptually, and the principles of discovery and verification that constitute the ground rules for creating and testing knowledge in their fields. These principles are different in the different disciplines. (Shulman, 1988, p. 5)

Because the study of learning is not itself a discipline, it has been approached by researchers representing a variety of disciplinary perspectives. You will see this in the resulting theories of learning that have been proposed. Behavioral psychologists, for example, argue that learning can be fully understood in terms of observable events, both environmental and behavioral. Cognitive psychologists, by contrast, believe that learning is mediated by thought processes inside the learner. A third perspective is offered by social psychologists, who contend that learning is a social enterprise, dependent upon interactions between the learner and his or her sociocultural environment. The point is, these beliefs dictate what questions about learning will be investigated and what theoretical constructs will be invented to provide explanations. This also means that two apparently competing theories may not be directed at even the same phenomena. What aspects of learning are obscured by one theory may be illuminated by another.

In the development of a particular theory, research tends to be cumulative, or what Kuhn (1970) called normal science. Investigators ask questions that are logical next steps based on previous findings. They aim to articulate theoretical principles that have already been devised, modifying those principles as necessary to account for unexpected or contradictory findings.

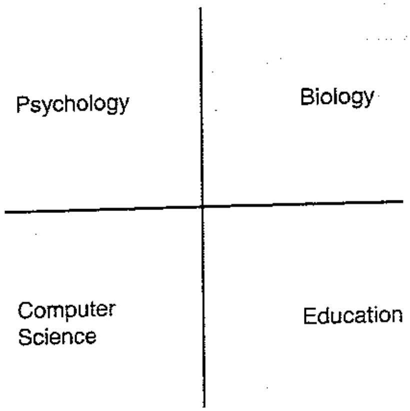
Sometimes, however, the predictions that follow from a theory continue to fail, despite whatever modifications are made to the theory. The result is that anomalies are amassed that cannot be explained very easily. When this happens, one or more researchers will propose an alternative, truly competing theory. This is known as extraordinary science, and represents a real breakthrough in scientific progress and knowledge development.

To be a worthy competitor, any new theory must reinterpret all the previous findings as well as account for the anomalous ones that prompted its invention in the first place. This can occur on a limited scale within a particular theoretical orientation, as when cognitive psychologists propose new theories of long-term memory to accommodate research results not easily handled by the existing theory. It can also occur on a grand scale when researchers shift theoretical orientations altogether, adopting disciplinary assumptions that are incommensurate with the previous orientation. One cannot, for instance, simultaneously believe that learning is entirely understandable in terms of external, observable events and believe that learning depends on internal thought processes.

The ongoing fragmentation of knowledge caused by adherence to different disciplinary assumptions is, Wilson (1998) argues, more an artifact of scholarship than it is a reflection of the real world, and he makes a case for consilience. By consilience, he means "a 'jumping together' of knowledge by the linking of facts and fact-based theory across disciplines to create a common groundwork of explanation" (p. 8). Consider, for example, the four quadrants shown in the top half of Figure 1.2. Represented are four domains in which scholars conduct research on learning. Each domain has its own practitioners, assumptions, language, and standards of validation, and the problems in learning they choose to study vary markedly from one another.

Consider now a series of concentric circles superimposed on the four quadrants, as shown in the bottom half of Figure 1.2. According to Wilson (1998), the closer one gets to the innermost circle, the more likely one is to encounter important real-world problems. Yet it is in that innermost circle where the most confusion exists and where the perspectives of all four domains are essential for understanding the problem and constructing a potential solution. For example, think about the controversy over attention-deficit disorder. Is it caused by the delayed maturation of some part of the brain? What about evidence of adults who display attention-deficit symptoms? How can the disorder be treated effectively? What should teachers do who have students in their classes that are diagnosed with the disorder? Depending on the approach taken—whether biological, psychological, or educational—different answers are proffered to each of these questions. Yet none of the answers is truly satisfactory from someone's point of view.

As you study the theories presented and discussed in this book, keep in mind that, if we accept Figure 1.1 as a model of the theory building process,



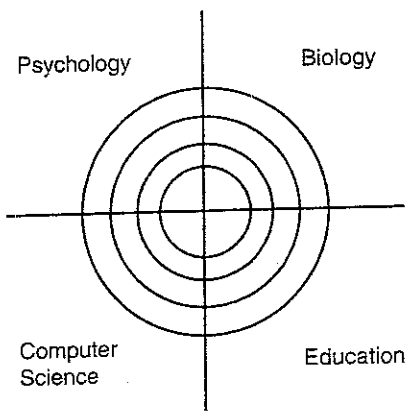


FIGURE 1.2 *An Appeal to Consilience in Developing Theories about Learning and Instruction*

Source: Adapted from Wilson, 1998

then we must also accept the provisional character of theories As much as we might like to think otherwise, theories do not give us the truth of the matter. They simply provide a conceptual framework for making sense of the data that have been collected so far. It is probably wise to adopt the attitude of a "disciplined eclectic" (Shulman, 1988) and view each theory critically for what it can contribute to solving important instructional problems. It is also useful, however, to contemplate how these theories might be synthesized to offer new insights on learning. According to Wilson (1998), "we are approaching a new age of synthesis, when the testing of consilience is the greatest of all intellectual challenges" (pp 11–12). This is an exciting time for theory building about learning, with great potential for illuminating some of the difficult and challenging educational problems of our era

A Definition of Learning

Despite the differences among the learning theories discussed in this book, they do share some basic, definitional assumptions about learning. First, they refer to learning as a persisting change in human performance or performance potential. This means that learners are capable of actions they could not perform before learning occurred and this is true whether or not they actually have an opportunity to exhibit the newly acquired performance Typically, however, the only way a teacher, instructor, or researcher knows that learning has occurred is to ask the learners to demonstrate in some fashion what they have learned. Finding good indicators of learning is as important for designing instruction as it is for building theory.

Second, to be considered learning, a change in performance or performance potential must come about as a result of the learner's experience and interaction with the world This statement has several implications Some behavior changes, such as the acquisition of fine motor control, can be attributed to maturation and are therefore not considered learned. Other behavior changes, such as searching for food when hungry or becoming garrulous when drunk, are obviously explained on the basis of temporary states. These also do not imply learning. Learning requires experience, but just what experiences are essential and how these experiences are presumed to bring about learning constitute the focus of every learning theory.

A Definition of Learning Theory

A **learning theory**, therefore, comprises a set of constructs linking observed changes in performance with what is thought to bring about those changes. Constructs refer to the concepts theorists invent to identify psychological variables. Memory, for example, is a construct implicated in cognitive perspectives on learning In other words, we look at the fact that people can demonstrate the same performance time after time and reason that they do so because they have remembered it. We have invented the concept of memory to explain this result.

To build a learning theory requires defining three basic components:

- The results: What are these changes in performance to be explained by the theory?
- The means: What are the processes by which the results are brought about (including any hypothesized structures that these processes are assumed to operate on)?
- The inputs: What triggers the processes to occur? What are the resources or experiences that form the basis for learning?

The answers given to these questions, as well as how the answers themselves are determined, characterize the various perspectives taken on learning and the specific theories that have emerged. To help you keep these components in mind and to compare across theories, each chapter of this book will end with a "theory matrix" that displays the inputs, means, and results of learning explained by each theory. As theories are added to the matrix, their similarities and differences should become more evident, as should those aspects of learning that are not yet easily explained by existing theories.

Learning in History

How people learn is not a new question in psychology, having been established as a legitimate research pursuit in the late 1800s. But learning is also not the sole territory of psychologists; it has been a matter of deep concern to philosophers for many centuries. What is mind? How does the mind develop? What is knowledge, and how does the mind acquire knowledge? How does the mind come to know other minds? These are just a few of the questions that provide the intellectual and philosophical underpinnings to modern learning theory. It is not my intention to review comprehensively the history of learning theory, but it is useful to trace the major antecedents to today's theories in order to provide a framework for comprehending and evaluating them.

The study of learning derives from essentially two sources. Because learning involves the acquisition of knowledge, the first concerns the nature of knowledge and how we come to know things. What is knowledge? How is knowledge distinguished from opinion or falsehoods? What are legitimate ways of knowing? These are questions of epistemology. How they are answered reflects one's initial assumptions about how the mind acquires knowledge of the world, and these assumptions influence what research methodology is used to conduct investigations on learning.

For example, what does it mean to "know" that density affects an object's weight and therefore its ability to float? (This is a clue to the soda can problem described earlier.) Is it enough to state with conviction that very dense objects will sink while less dense objects will float? Or, does the knowledge lay in one's choice of a stryofoam block to be used for a buoy rather than a rock? Similarly, what counts as legitimate ways of coming to know the relationship between object density and flotation? Must one experience this relationship through actual manipulation of different objects in water, or can one simply be told about it with visual or verbal examples?

As you will soon see, theorists take opposing positions on these questions. Some believe that knowledge is a matter of internally representing the external world and is primarily acquired through experience, whereas others argue that knowledge is a matter of interpretations that learners actively construct by imposing organization on the world about them.

The second source in which modern learning theory is rooted concerns the nature and representation of mental life. When knowledge is acquired, how is it represented in the mind? What are the operations or rules that govern mental phenomena? Although these questions are not considered by behaviorists to be worth asking, their answers are part of any cognitive, developmental, or biological theory about learning. Mental phenomena have been conceptualized as associations among ideas, complex schemas of organized knowledge, and neurochemical changes in synapses, to name only a few. As you progress through this book, you will see that each of these levels of analysis provides a unique view of learning.

Let us now take a brief look at how these two sources have played out through history in the development of modern learning theory. In later chapters, these foundations will be recalled to help you trace arguments of particular theories.

The Epistemology of Learning

Any number of excellent texts present the history of psychology and provide accounts of how philosophers' views about knowledge and learning have changed over the centuries (e.g., Herrnstein & Boring, 1965; Leahey & Harris, 1997; Bower & Hilgard, 1981). It is not my purpose to repeat those accounts but instead to give you a sense of three epistemological traditions that can be said to underlie the theories presented in this book. In fact, criticisms leveled at one theory or another sometimes take an epistemological bent. That is, the critic appeals to epistemological assumptions of the theory under attack and argues that these assumptions are wrong. If the assumptions are wrong, then aspects of the theory must be open to question and implications drawn from it misleading at best and misguided at worst. Accepting alternative epistemological assumptions leads one to champion a competing theory that is assumed to provide a better explanation of learning and thus more valid guidelines for instruction.

Any discussion of these traditions, however, must be preceded by a vocabulary lesson on epistemological "isms," or as Wilson (1998) so irreverently called it, an introduction to the "hissing suffix." Table 1.1 presents a list of concepts representing various epistemological beliefs, each pertaining to either the nature of knowledge or how knowledge is acquired.

Empiricism, nativism, and *rationalism* (the concepts shown in the top block) concern what is permitted as a valid source of knowledge. Does knowledge come from experience (all learning theorists generally make this claim), or can it come from thinking and reasoning about things? Is some knowledge already present at birth and therefore inherited? There is interesting speculation, for example, that we are genetically predisposed for some fears because of our evolutionary history. Snakes and spiders were dangerous to the survival of prehistoric humans and still cause trepidations for many people today.

The concepts shown in the middle block—*skepticism, realism, idealism,* and *pragmatism*—refer to the content of knowledge, or what is presumed to

TABLE 1.1 *Concepts in Epistemology*

Concept	Definition
Source of Knowledge	
Empiricism	The belief that sensory experience is the only valid source of knowledge
Nativism	The belief that at least some knowledge is innate (i.e., present in some form at birth)
Rationalism	The belief that reason is the source of knowledge (i.e., the mind actively constructs knowledge)
Content of Knowledge	
Skepticism	The belief that the world may not be "knowable" at all (i.e., that our "knowledge" may never correspond to reality)
Realism	The belief that all things in the world can be known
Idealism	The belief that knowledge consists of only ideas or representations about reality
Pragmatism	1. The belief that reality exists but cannot be known directly. Knowledge is provisional, not absolute—sometimes it corresponds with reality and sometimes it doesn't—and it can be obtained through empirical or rational processes
Knowledge Traditions	
Pragmatism	2. The epistomological orientation that corresponds to the beliefs described above
Objectivism	The epistomological orientation in which reality is assumed to be external to and separate from the knower; empiricism and realism characterize this orientation
Interpretivism	The epistomological orientation in which reality is assumed to be constructed by the knower; rationalism and idealism characterize this orientation

be knowable. Skeptics question whether it is possible to know the world at all, whereas realists believe that all phenomena can be known, even that which is not directly perceptible to human senses. With the right instrument, they say, anything that is real can be detected. Opposite realists on the continuum are idealists who believe that knowledge consists only of ideas constructed about reality. In this view, all sensory data are unstructured and

undifferentiated, to be interpreted by the mind with resulting knowledge constructed and organized. Finally, pragmatism occupies a middle ground where reality is acknowledged but not presumed to be known directly. Rather, it is assumed that knowledge can be ascertained by means of reason or experience, but it is always provisional. That is, sometimes our interpretations will reflect reality, but we must be prepared for when they do not.

The bottom block of Table 1.1 refers to three major epistemological orientations or traditions—*objectivism, pragmatism,* and *interpretivism*—that are still being debated in educational and psychological literature. Objectivists view reality as independent from and outside the knower, so that learning for them becomes a matter of transferring what exists in reality to what is known by the learner. Knowledge tends to be seen as absolute and becomes equated with truth. That is, we claim to know something when we can certify, or verify objectively, that it's true (Shank, 1992, 2002).

Interpretivists, by contrast, worry little about whether knowledge is true in an absolute sense, arguing instead that truth (and therefore, knowledge) depends on the knower's frame of reference. For example, I (who happens to be afraid of spiders) see a speck on the white wall of my bedroom and go in search of my husband to kill the spider. He discovers, however, that what looked like a spider to me was just a bit of dirt caught up in a cobweb. It didn't matter to me, then, whether the spider existed in reality or not; I behaved as if it did. Likewise, scientists behaved as though the sun revolved around the earth before it became an accepted fact that the sun is the center of our solar system. Changing one's frame of reference changes the nature of "facts" interpreted within it.

Objectivism and interpretivism are often discussed as polar opposites, with pragmatism somewhere between them on the continuum. However, pragmatism can also be viewed as a position that supercedes objectivism and interpretivism (cf. Shank, 1990), more like the diagram in Figure 1.3. For the most part, pragmatists hold absolute knowledge as a worthy, but probably unreachable, goal. Thus, they emphasize theories of meaning—of what works—with the understanding that what works may not reflect reality, but to the extent that it can, it should. Their theories are more like hypotheses, accepted and used for as long as evidence supports them.

As an example of the pragmatic epistemological orientation, consider the often inaccurate mental models we hold about the nature of the world and the things around us that nonetheless enable us to function quite effectively from day to day. How many times have you done something and heard, "That's not the way you're supposed to do it!" Your retort, of course, is "Well, it worked!" Examples of this come to mind every time I work on the computer. My knowledge of software programs such as Excel is adequate but not especially sophisticated. I have learned to use certain commands that work pretty faithfully. Only when they fail do I discover that I could be using a more accurate sequence of commands to do what I want to accomplish. My

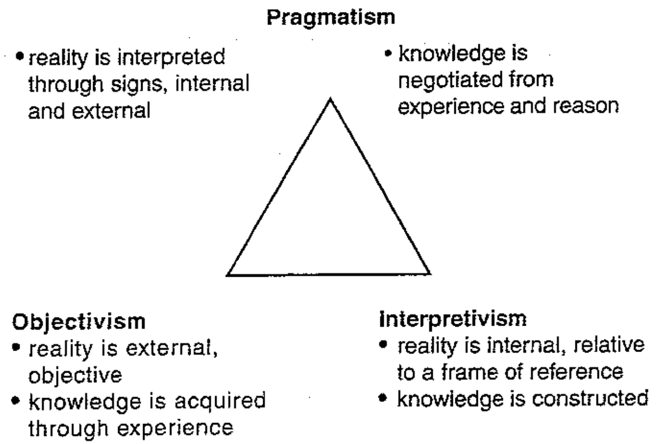


FIGURE 1.3 *A Conception of the Relations Among Three Epistemological Traditions*

mental model of Excel, therefore, is neither accurate nor complete, but it generally works It is meaningful to me

These three major epistemological traditions—objectivism, interpretivism, and pragmatism—are all evident in the learning theories discussed in this book. Although Leahey and Harris (1997) stated that pragmatism is the working philosophy of most psychologists, others (including myself) have argued that objectivism has been the dominant epistemology in psychology and education (cf. Phillips, 1983; Driscoll, 1984; Cunningham, 1992) Certainly, radical behaviorism (see Chapter 2) and cognitive information processing theory (see Chapter 3) rest on objectivist assumptions

By contrast, the constructivist view of cognition (Chapters 5 and 11) is much more consistent with the interpretist perspective, as is Piaget's genetic epistemology (Chapter 6) Similarly related are the ideas of Bruner and Vygotsky (Chapter 7) Finally, biological theorists (Chapter 8) have raised the nature/nurture question again by proposing that learning is limited and influenced by the evolutionary history of humans. Summarized in Table 1.2 are assumptions and theoretical implications of the epistemological traditions described above, along with the learning theories most closely associated with them.

As you study the theories presented in this book, consider your own assumptions about the nature of knowledge and how they influence your views about learning Interest in understanding personal epistemology has grown in recent years, because beliefs about knowledge and learning "appear to innervate almost every aspect of individuals' day-to-day lives"

TABLE 1.2 *Three Epistemological Traditions and Their Relation to the Study of Learning*

	Objectivism	*Pragmatism*	*Interpretivism*
Assumptions about reality	Reality is objective, singular, fragmentable	Reality is interpreted, negotiated, consensual	Reality is constructed, multiple, holistic
Nature of truth statements	Generalization, laws, focus on similarities	Working hypotheses, focus on similarities or differences	Working hypotheses, focus on differences
Source(s) of knowledge	Experience	Experience and reason	Reason
Types of research designs	Experimental, a priori	Any design may be useful for illuminating different aspects of reality	Naturalistic, emergent
Associated learning and instructional theories	Behaviorism, cognitive information processing, Gagné's instructional theory	Educational semiotics, Bruner's and Vygotsky's views of learning and development	Piaget's developmental theory, constructivism

(Schommer, 1994, p. 293). For instance, personal epistemological beliefs affect the extent to which students will actively engage in learning tasks, persist when the task becomes difficult, and cope with ill-defined problems or ill-structured subjects. It is likely that personal epistemological beliefs also affect how likely teachers are to use various sorts of instructional strategies. An instructor who believes that knowledge is constructed and relative to individual learners is more likely to select strategies such as discussion and group problem solving than one who believes knowledge is absolute and must be directly taught to learners.

Early Experimental Approaches to Learning

In addition to epistemological traditions, there is a legacy of experimental approaches to learning upon which modern learning investigators have drawn. Ebbinghaus's verbal learning experiments provided a foundation for later investigations in cognition, and the work of Pavlov and Thorndike laid the groundwork for B. F. Skinner's radical behaviorism. Finally, Gestalt theory established the basis for the cognitive process of perception that remains an integral part of cognitive learning theory today. Let us now turn to a brief consideration of these early approaches to the study of learning.

Ebbinghaus (1850–1909). When psychology split off from philosophy to become the "science of mental life" (Bower & Hilgard, 1981), it was largely concerned with sensation and perception. But the research of Hermann Ebbinghaus ushered in a new era of interest in the study of learning. Herrnstein and Boring (1965) attributed the emergence of this interest to a growing faith in scientific research in general and scientific psychology in particular that encouraged researchers to experiment on learning.

By the time of Ebbinghaus, the classical doctrine of association, which was, in essence, a theory of learning, had already been established in psychology. This was the notion that ideas become connected, or associated, through experience. The more frequently a particular association is encountered, the stronger the associative bond is assumed to be. Association seemed to account well for learning. For example, the stimulus bread is likely to elicit the response butter more often and more rapidly than the response brown, because the association between bread and butter has been frequently experienced and thus has become well learned.

Ebbinghaus presumed, then, that if ideas are connected by the frequency of their associations, then learning should be predictable based on the number of times a given association is repeatedly experienced. This gave rise to the experimental paradigm used by Ebbinghaus and learning researchers after him. The independent variable was defined as the number of repetitions of a list of associated ideas. The dependent variable to measure learning was the subject's recall of the list.

Because Ebbinghaus wanted to investigate the learning of new associations, untainted by past experience, he invented nonsense syllables to simplify his investigations. These took the form of consonant-vowel-consonant trigrams (e.g., qap, jor, mol, kuw) and were assumed to be inherently meaningless. Then he arranged to present sequences of 16 syllables to himself (drawn from a pool of 2,300 syllables he had constructed; Ebbinghaus, [1885] 1913). With this method, Ebbinghaus had a quantifiable procedure for investigating various laws of association, as well as overall memory and forgetting. In conducting an experiment using six 16-syllable lists, for example, Ebbinghaus wrote,

> If I learn such a group, each series by itself, so that it can be repeated without error, and 24 hours later repeat it in the same sequence and to the same point of mastery, then the latter repetition is possible in about two thirds of the time necessary for the first. The resulting savings in work of one third clearly measures the strength of association formed during the first learning between one member and its immediate successor. (Ebbinghaus, [1885] 1913, 524)

By systematically varying such factors as the number of syllables in the list, the number of lists studied, and the amount of time spent studying each list, Ebbinghaus provided experimental verification of some obvious facts about memory. For instance, the more material there is to learn, the longer learning takes. The longer it has been since something was learned, the harder it is to remember. Ebbinghaus is also credited with establishing the now-classic forgetting curve (Figure 1.4), which shows that forgetting proceeds very rapidly at first and then more slowly as the time from initial learning increases. It pays us to remember, however, that Ebbinghaus' forgetting curve was derived from verbal learning experiments. The forgetting of other types of learned experiences (especially events that may have been personally traumatic) may reveal a quite different pattern (Bourne et al., 1986).

Finally, there can be little argument that Ebbinghaus' experiments established a verbal learning tradition that has carried through even to the present day. Although nonsense syllables have given way to meaningful concepts in memory experiments, the principle of association remains a driving force within many modern cognitive conceptions of learning.

Thorndike (1874–1949). Like Ebbinghaus, Edward L. Thorndike was interested in the doctrine of association, but association between sensation and impulse rather than association between ideas. In other words, Thorndike investigated learning in terms of the associations related to action. For his studies, Thorndike preferred to use animals (mostly cats and chickens), which seemed reasonable at the time on the basis of Darwin's thesis of the continuity of species, and he formulated the first experimental procedures to

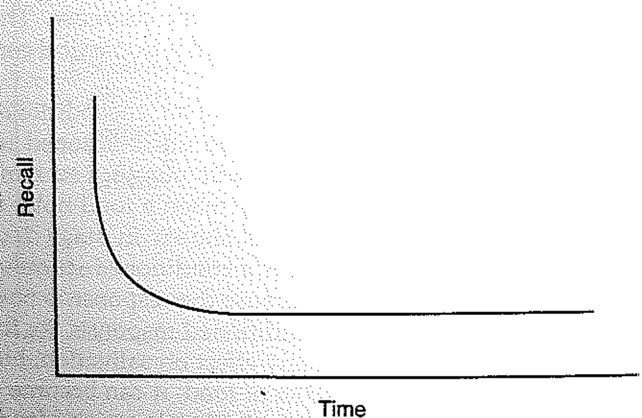


FIGURE 1.4 ***The Classic Forgetting Curve (after Ebbinghaus, [1885] 1913)***

be used in the study of animal learning. These comprised repeatedly placing an animal in a "puzzle box" and recording, as a measure of learning, the decreasing amount of time it took the animal to operate the latch and escape.

The results of his experiments convinced Thorndike that an animal learned to associate a sensation and an impulse when its action had a satisfying consequence. In other words, the animal formed an association between the sense-impression of the interior of the box and the impulse leading to the successful escape action, because the action led to a satisfying result—namely, escape from the box. This principle Thorndike termed the **Law of Effect**, and it represented a modification of the classical principle of association that would have far-reaching implications for behaviorism.

Finally, Thorndike called into question the existence of mental associations in animals. He argued, albeit tentatively, that the associations which explain animal behavior do not necessarily mean animals feel or think while they act. Nor is it necessary to ascribe mental motives to their actions. Perhaps, said Thorndike, animals have no memories, no ideas to associate. This rather revolutionary notion stands as a second legacy to behaviorism, and behaviorists who followed Thorndike extended it quite boldly.

Pavlov (1849–1946). A third experimental approach to the study of associations brought together associationism and reflexology. In his investigations of the digestive reflexes of dogs, Ivan Pavlov noticed that the dogs salivated not only to food, but often to a variety of other inappropriate stimuli (e.g., the sight of the trainer who brought the food). Whereas this phenomenon plagued other researchers, Pavlov saw it as an opportunity to experimentally study learning as well as innate reflexes. He called this salivation to the sight of the trainer a learned reflex that is established because of an association between the appropriate stimulus (food) and the inappropriate one (the trainer). In other words, something neutral is paired with something that causes a response until the neutral thing also causes the response. This proved to be the beginning of an extended research program in classical conditioning (or Pavlovian conditioning).

According to the **classical conditioning** paradigm, an unconditioned stimulus (UCS) biologically and involuntarily elicits an unconditioned response (UCR). The dog salivates when food is put in its mouth; you blink when a puff of air hits you in the eye; a child startles when a loud noise is made behind her. Theoretically, this is depicted as shown in stage 1 of Figure 1.5. Then, because it is paired with the UCS, a conditioned stimulus acquires the ability to elicit the same response. Because the response is now conditioned to the new stimulus, it becomes a conditioned response. So, for example, ringing a bell does not normally have any effect on salivation, but when it is repeatedly paired with the presentation of food, it can become a conditioned stimulus and will elicit salivation even in the absence of food. This might be depicted as shown in stages 2 and 3 of Figure 1.5.

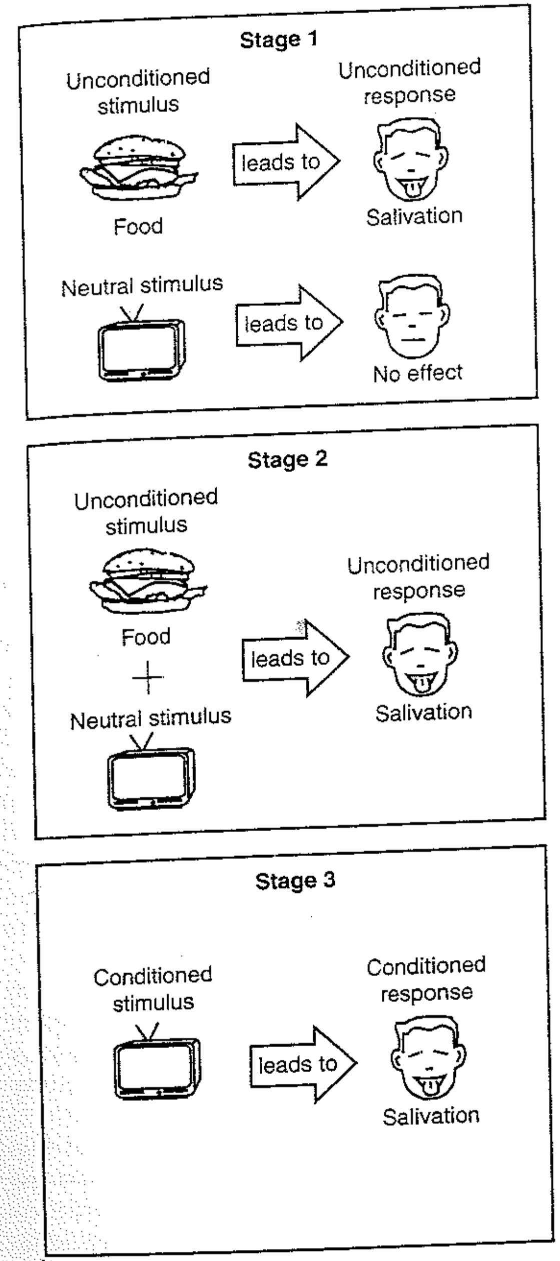


FIGURE 1.5 *The Three Stages of Classical Conditioning*

Examples of classical conditioning probably come readily to mind. My dog salivates at the sight of heartworm pills, because dog bones have customarily been given to him at the same time as the pill. A child cries (CR) at the sight of dogs (CS) after one growled (UCS) menacingly at him. Some years ago, I fell asleep in a church service because the minister turned the lights off. Since darkness had always been associated before with fatigue and going to sleep, it acted as a conditioned stimulus for sleep even though the service was in the morning and I was well rested.

Probably the most widely cited example of classical conditioning in humans is the study conducted by Watson and Rayner (1920) with a 9-month-old baby, Albert B. Interested in the conditioning of emotional responses, Watson and Rayner first sought an unconditioned stimulus that would reliably elicit the unconditioned response of crying in Albert. They eventually discovered that they could trigger the crying reflex with a loud noise, specifically a hammer being struck against a steel bar. Watson and Rayner then presented Albert with a large, tame white rat, and as Albert approached the animal, they hit the hammer against the steel bar. After seven pairings of the noise with the rat, Watson and Rayner presented the rat alone. Immediately, Albert began to cry; the rat was now a conditioned stimulus and crying the conditioned response.

In subsequent tests, Watson and Rayner reported that Albert also cried when exposed to a rabbit and a fur coat. Thus, he exhibited stimulus generalization, a phenomenon that Pavlov had already demonstrated with his dogs. In classical conditioning, stimuli that are highly similar to the CS will also elicit the CR in varying degrees. In addition, Pavlov showed that when a conditioned stimulus is paired with another neutral stimulus, the second stimulus can also become conditioned, resulting in the phenomenon known as higher-order conditioning. Finally, when a conditioned stimulus is presented over a sufficiently long period of time without the UCS, it will eventually lose its ability to elicit the conditioned response. In this way, extinction of the conditioned response to the conditioned stimulus occurs.

So what happened to Baby Albert? Watson and Rayner intended to cure him through extinction and counterconditioning (pairing a pleasant UCS with the rat CS), but they never had the chance, since Albert's mother moved, taking him with her. One can only hope that the conditioned response eventually weakened with time.

The principles of stimulus generalization and discrimination, extinction, and counterconditioning, originally established by Pavlov, became important elements of operant conditioning as well (see Chapter 2). Counterconditioning, now known as systematic desensitization (e.g., Wolpe, 1958, 1969), is also a standard therapeutic technique for treating various types of fears or anxieties. The question of whether humans truly condition in the Pavlovian sense, however, remains a debatable one. Brewer (1974) reviewed over 200 studies that purported to demonstrate conditioning and concluded

that mental processes intervened in most cases. That is, only subjects who were told about UCS-CS pairings tended to acquire the conditioned response. Leahey and Harris (1997) commented that

> it is interesting to observe that the studies Brewer reviews, almost all of which support the cognitive position, go back as far early as 1919 and were produced in all the following decades up into the 1970s, right through the dominance of behavioral theories in the field of learning. This shows the power of tradition. If research programs are going well, then occasional challenging results are either quietly ignored, called interesting phenomena to be shelved for later study, or explained away. Only when an alternative view emerges, as cognitive theory emerged in the 1960s to rival behavior theory, do old problems appear significant. (p. 44)

Cognitive approaches to learning have dominated American psychology since about the 1970s, but they had a much longer-standing tradition in Europe with the Gestalt school.

Gestalt Theory (Early 1900s). While the doctrine of association was being articulated in the experiments of Ebbinghaus, Thorndike, and Pavlov, a countermovement developed among German theorists interested primarily in perception. Called the Gestalt school, it is thought to have started with the publication of Max Wertheimer's article on apparent motion in 1912 (Hergenhahn & Olson, 1997). Wertheimer noticed that two alternately blinking lights on a train appeared to be a single light moving back and forth. This illusion of motion, which he called the phi phenomenon, cannot be explained by analyzing the actual flashing of the lights. Rather, the psychological experience (i.e., perception of motion) appeared to be different from the sensory components (i.e., sensation of flashing lights) that composed it. Thus, consistent with the interpretivist tradition, Gestalt psychologists believed that knowledge comes from more than just experience; it also involves the knower actively imposing organization on sensory data. Indeed, the German word *Gestalt* means "configuration" or "organization."

Gestalt theory came to the attention of American psychologists by the publication in English of Wolfgang Kohler's *The Mentality of Apes* (1925) and Kurt Koffka's *The Growth of Mind* (1924) (Bower & Hilgard, 1981). Of particular interest are Kohler's experiments with apes, because it was on the basis of these that he struck a dissenting opinion to the associative view of memory. Instead of allowing that the mind learned simple connections between ideas or associations between stimuli and responses, Kohler argued that his apes learned relations among stimuli and could modify their behavior by perceiving stimuli in new ways.

The typical experiment conducted by Kohler involved placing food just out of reach of an ape in a cage. The food could be obtained, on different trials, by moving an obstructing box out of the way, pulling a cord in a particular direction, or putting two sticks together to make a lever long enough to reach the food Although some of their attempts to reach the food failed, the apes did not behave in a random fashion, asserted Kohler Nor did learning appear to occur in a regular, continuous way from a pattern of trial and error and a gradual buildup of correct associations. Instead, the apes exhibited what Kohler called **insight**. After a failed attempt or two and often a period of complete inactivity, the apes employed the correct solution and obtained the food.

According to Kohler, the behavior he observed could not be easily explained by the principle of association alone. Thus, he proposed a "class of inner processes" which enabled the apes to grasp the structure of a situation. That is, they acquired a relation between two things, an "interconnection based on the properties of the things themselves, not a mere 'frequent following of each other' or an 'occurring together'" (Kohler, 1917, p. 578; emphasis his).

For insightful learning to occur, Gestalt theorists argued that all the parts to a problem had to be exposed to the learner They criticized Thorndike's experiments for keeping important elements of the problem hidden from the chickens, thus preventing insightful learning (Hergenhahn & Olson, 1997) Four features generally characterize insightful learning:

1. After a period of inactivity or trial and error, the learner suddenly and completely grasps the solution.
2. The learner performs the solution in a smooth and errorless fashion.
3. The learner retains the solution for a very long time.
4. The learner can easily apply a principle gained through insight to other, similar problems.

The fourth characteristic has important implications for instruction that differ radically from what might be suggested from the principle of association. Wertheimer (1959), for example, contended that memorizing rules or facts and applying them without thinking can lead to stupid mistakes, as when "a nurse, while making her rounds in the night shift, wakes up patients to give them their sleeping pills" (Michael Wertheimer, 1980, cited in Hergenhahn & Olson, 1997, p 268) What is more important, according to Wertheimer, is coming to see the structure of problems, which leads to understanding how they can be solved. Although teachers can guide students toward understanding, in the end, the students themselves must experience the insight required for problem solution for it to be lasting.

Summary. Most of the major issues for learning and the topics of this book have now been established. Ebbinghaus, Thorndike, and Pavlov shared the view that learning depends on associations and proceeded on the assumption that the complexity of thought and behavior can be reduced to simple connections among events We see the same perspective underlying modern behavioral theory and cognitive information processing theory In the former, the associations are between environmental stimuli and behavioral responses. In the latter, mental associations mediate between stimulus and response. In both, however, theorists fundamentally assume that they can account for complex behavior in terms of elemental associations.

By contrast, Kohler's view that learning is more than a collection of associations established the treatment of learning and perception associated with Gestalt psychology. This perspective is evident in constructivist conceptions of cognition which are finding voice in schema theory, situated cognition, and educational semiotics.

Largely ignored by both behavioral and cognitive information processing theorists have been issues of biology and development in learning. These were of prime concern to Piaget, whose theory has had a tremendous influence on the study of cognitive development, and Vygotsky, whose writings from the 1920s and 1930s are again exerting influence on learning and developmental theories In addition, neuroscientists have now proposed their own theories of how learning and memory operate and suggested, once more, that evolution may impose constraints on learning

Finally, motivation has met with a renewed interest in studies of learning. Originally investigated under the notion of "drive" in early behavioral theories, motivation has been reconceptualized as an affective variable mediating cognition and subsequent performance. Along with biological and developmental determinants of learning, motivation as well deserves our consideration

Learning Theory and Instruction

Theories of learning focus on and describe the process of learning. For many learning theorists, this description is their primary goal and whatever applied knowledge may come from it is serendipitous. Cognitive psychologists, for example, concern themselves largely with the structure and processes of the mind and cognition. Development psychologists seek to understand human development from infancy to old age. Neuroscientists hope to discover the secrets of the brain But some of these researchers, as well as educational and instructional psychologists, think about the implications of learning theories for instruction.

By **instruction** I mean any deliberate arrangement of events to facilitate a learner's acquisition of some goal. The goal can range from knowledge to skills to strategies to attitudes, and so on. The learners can be adults or children of any age, background, or prior experience. The setting in which learning takes place can be formal, school-based, on-the-job, or in the community—wherever programs for learning are being designed and implemented Those in charge of instruction can include public and private school teachers, training instructors, or instructional designers. The basic assumption, no matter what the particulars of an instructional situation, is that effective instruction is informed by theories of learning

Reigeluth (1983, 1999) distinguished between descriptive and prescriptive learning theory, as well as between learning and instructional theory As indicated earlier, the very point of learning theory is descriptive—to describe the processes by which observed changes in performance are brought about On the basis of descriptive theory, however, prescriptive principles can be derived and empirically tested For example, the behaviorist principle of reinforcement, "pleasant consequences of any behavior increase the probability of the behavior's reoccurrence," can be rephrased in terms of a prescription: "To increase the occurrence of some desired behavior, reward it"

This prescription essentially indicates what conditions of instruction should facilitate learning, but it does not prescribe specific instructional methods To do this, we might say, "To increase the occurrence of some desired behavior, begin instruction by modeling the behavior, then reward the learner with colored stickers for each succeeding attempt to perform the behavior. Then, when the behavior seems firmly established, reduce reinforcement to every third correct performance." Thus, according to Reigeluth (1983, 1999), a learning prescription is not exactly the same thing as an instructional prescription, as might be obtained from an instructional or instructional design theory. As a result, he argued, learning prescriptions may not be as easily applied by the classroom teacher or instructional designer as instructional prescriptions

Although Reigeluth is undoubtedly right that learning theories are not as readily applied as instructional theories, there are few instructional theories as well developed as most learning theories. One of the few exceptions is Gagné's (1985) conditions of learning (see Chapter 10) But lest we become disheartened, there are instructional implications that can be drawn from the learning theories in this book, and many of these have been independently investigated and have amassed empirical support. To the extent possible, therefore, each chapter not only describes a given learning theory, but also presents instructional implications that either have been, or can be, derived from it. Moreover, questions are included with each chapter that are designed to help you compare and contrast theories and derive instructional implications of your own

The General Plan and Approach of This Book

In Part II, the behaviorist perspective on learning is presented with the radical behaviorism of B. F Skinner. Although traditional behavioral theorists who preceded Skinner are described briefly, they had relatively little to say about instruction, whereas Skinner had a great deal to say The cognitive perspective on learning is the subject of Part III, which includes chapters on the information processing model of cognition, meaningful learning and schema theory, and situated cognition

Developmental issues related to learning are raised in Part IV, beginning with Piaget's theory of cognitive development and information processing theories that have been proposed to cover areas where Piaget's theory seems to be in error In addition, Bruner's concept formation and inquiry model of instruction and Vygotsky's social formation of mind are discussed.

Part V offers a chapter on learning and biology, in which the sociobiological and physiological bases of learning and memory are explored Although these may seem rather far removed from instruction, researchers from a variety of fields have attempted an interdisciplinary discussion on the brain, cognition, and education

Part VI focuses on motivation as a mediator of learning and performance. Albert Bandura's social learning theory is presented, along with John Keller's model of motivational design Finally, in Part VII, learning and instruction are brought together in the contrasting instructional theories of Robert M. Gagné and modern-day constructivists.

Each chapter begins with a concept map and outline that provide both graphic and verbal organizers for the material discussed within. One or more scenarios follow that illustrate with concrete examples some of the theoretical concepts of the chapter; these are elaborated within the chapter so that you can get a sense of what each theory looks like in context. To help you make connections across chapters and discern similarities and differences among the different theories, a single story, "Kermit and the Keyboard," is presented at the end of this chapter that is discussed again in each succeeding chapter from a different theoretical perspective. This is essentially a true story, although some details have been altered or elaborated to make a particular point about one theory or another. By viewing the same situation from differing theoretical vantage points, you should begin to appreciate where theories converge on their explanations of learning and where they diverge.

As you read the story for the first time, try to identify what you think are the inputs, processes, and results of learning, as these concepts have been defined in this chapter Try to do the same thing from the perspective of each new chapter that you study, before you read my interpretation of that theory as it relates to the story. If your interpretation differs from mine, what are the points of disagreement and why do you think they occurred? Consider as well your reaction to the explanation or view of learning that each theory appears to provide with respect to the story What aspects of the explanation do you find compelling? Of what aspects are you skeptical, and why?

The book ends with a brief chapter entitled, "Toward a Personal Theory of Learning and Instruction." Any book on learning necessarily reflects its author's unique perspective and individual beliefs about the nature of knowledge and how we come to know things. My selection of theories to discuss, the sequence in which I have placed them, the examples I have used to illustrate them, and the conclusions I have drawn from them are all clues to my view of learning.

By the time you finish this book, however, you should have developed or fine-tuned your own informed view of learning. You should be ready to take a stand on the merits or faults of a particular theory as it might be applied to various instructional problems. You should be in a position to identify gaps in theory and to suggest where future research might profitably be conducted. In essence, if this book is effective, you will have become a "reflective practitioner," whether your practice is in the classroom, the training center, or the laboratory.

Kermit and the Keyboard

Three years ago, Kermit decided that he wanted to learn to play the keyboard. Many years ago, he studied music formally, and he enrolled as a music performance major at a local university. He became proficient at clarinet and saxophone and played in both the community symphony and a five-piece dance band. However, the repetitive nature of concerts— playing the same pieces time and again—eventually bored Kermit, and he dropped out of school before earning a degree.

Kermit became attracted to the keyboard because he liked the idea of a one-man band. The electronic capabilities of these instruments are truly amazing. One person at the controls can indeed sound like many instruments playing in harmony. The instrument Kermit bought had many built-in features (e.g., prerecorded backgrounds and accompaniments, different voices and rhythms, the ability to play and record multiple tracks, the ability to slow down or speed up the accompaniments). As one might imagine, the instrument also came with a lengthy manual illustrating and describing all its various features and how to use them.

Although Kermit learned to read a musical score when he was taking formal lessons, he has never played a keyboard before, so he spends time hunting and pecking on the keys to familiarize himself with the layout. He hauls out some old music instruction books with simple exercises in them, and he buys a couple of fake books that contain familiar popular songs. Fake books show what chords are to be played during each measure of a song. These chords correspond with shortcut keys on the keyboard, so the player has to play only one key instead of the entire chord. Kermit selects some exercises to practice and makes a list of a dozen or so songs that he would like to learn to play.

Every day, Kermit plays for about an hour. On some days, he plays for longer; on others, he might quit after 20 minutes. Some days, he plays more

than once, perhaps 30 minutes in the morning and 20 minutes in the evening. The more mistakes he makes while playing, the more likely he is to quit after a short time. He plays a few songs frequently, but he makes so many mistakes on some songs that he stops playing them at all.

One of the songs that Kermit plays often is "House of the Rising Sun," and he tries many different voices and accompaniments to hear how different the song sounds using each one. He seems to enjoy coming up with unique arrangements by mixing voices and backgrounds. One day, toward the end of the song, Kermit makes a mistake and holds one note longer than the music score indicates, but it sounds fine with the rhythm of that particular accompaniment, so he doesn't seem aware that he has made a mistake. Every time he plays the song using that accompaniment again, he makes the same mistake. Playing the song with other backgrounds, though, he performs flawlessly. When he first started practicing this song, Kermit had to play it quite slowly to avoid making mistakes, but now he plays it at the recommended tempo.

About once a week, Kermit reads a section of the keyboard manual, usually pertaining to some feature with which he has been experimenting during his practice sessions. Occasionally, he seeks help understanding the text, asking questions of his wife or going on-line to participate in a chat session. He is considering joining a group that meets every other Sunday to play together. He has attended the jam session a couple of times, and it is mostly a social event. The group is very fluid; people attend as their schedules permit, and they play whatever pieces strike their fancy on a given evening. Some members of the group play by ear, but many share pieces of music that they practice individually before getting together. Kermit can't decide whether he would learn more by playing with others or whether the same boredom would set in that he remembers from his dance band and symphony days.

Initial Focus Questions about "Kermit and the Keyboard"

1. What is Kermit learning in this story?
2. What appear to be the inputs or preconditions to learning in this story?
3. What appear to be the processes of learning in this story?
4. What is Kermit's role during the learning process?
5. What instruction appears to be present in this story, and what is its role?
6. What are the implications of Ebbinghaus's forgetting curve for Kermit's practicing?
7. Do you see any examples of Thorndike's Law of Effect in this story?

Answer to the Soda Can Problem: Regular soda is much denser than diet soda because of the sugar it contains compared with the very small amount of artificial sweetener contained in diet soda.

Suggested Readings

Bower, G. H., & Hilgard, E. R. (1981). *Theories of learning* (5th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Dills, C. R. & Romiszowski, A. J. (1997). *Instructional development paradigms.* Englewood Cliffs, NJ: Educational Technology Publications.

Leahey, T. H., & Harris, R. J. (1997). *Learning and cognition* (4th ed.). Upper Saddle River, NJ: Prentice-Hall.

Wilson, E. O. (1998). *Consilience: The unity of knowledge.* NY: Knopf.

Reflective Questions and Activities

1. Unger, Draper, and Pendergrass (1986) reported that students may have difficulty understanding epistemologies that clash with their own, tacit beliefs. They suggested, therefore, that students should examine their personal beliefs about knowledge and ways of knowing. Look up Unger et al.'s study, and complete the survey they provide (directions for self-scoring are included). How might your score be interpreted?

   REFERENCE: Unger, R. K., Draper, R. D., & Pendergrass, M. L. (1986). Personal epistemology and personal experience. *Journal of Social Issues, 42*(2), 67–79.

2. Unger et al. (1986) discuss a variety of reasons accounting for different epistemological beliefs among groups of individuals, including gender, for example. Ask your classmates to complete the survey, and then discuss the results. What are possible reasons for the differences in your scores?

   REFERENCE: same as above

3. According to Schommer (1990), the epistemological beliefs learners hold may influence the manner in which they approach a learning task and what they subsequently learn. Specifically, she examined such beliefs as "Knowledge is discrete and unambiguous," "Ability to learn is innate," "Learning is quick or not at all," and "Knowledge is certain." She found that students who believed in learning as a quick, all-or-none phenomenon generated simple, overly general conclusions from what they read and were overconfident in their own learning. What do Schommer's findings imply for instruction? Should teachers or instructional designers be concerned with their students' epistemological beliefs? How should instruction be modified based on these beliefs?

   REFERENCE: Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology, 82*(3), 498–504.

Part II: Learning and Behavior

2

Radical Behaviorism