Most theories of learning recognize that different learners go about learning in different ways. This raises an important issue: “Shall we design our instruction so as to adapt to the various learning styles of our learners?” This point of view has gained increasing popularity in recent years, but Chapter 7 presents the idea that other considerations as to how to best promote learning are of greater importance.

One of the most important types of learning is problem solving. Currently, there is great interest in examining how instructional designers and technologists can help individuals become good problem solvers. As a step in this direction, Chapter 8 describes a new typology of problem-solving tasks in which eleven different types of problems are described. This framework is intended to serve as a stimulus for professionals in our field to design and evaluate instructional strategies that will improve the problem-solving skills of learners.

CHAPTER 4

PSYCHOLOGICAL FOUNDATIONS OF INSTRUCTIONAL DESIGN

Marcy P. Driscoll
The Florida State University

Editors’ Introduction

Instructional design practices have been greatly influenced by a variety of different theories of learning and instruction. Over many years, three of these theories—behavioral learning theory, cognitive information processing theory, and Gagné’s theory of instruction—have had a major influence on instructional design. In recent years, situated learning theory and constructivism have offered a different view of learning and instruction and have influenced the practices of many of those involved in the design of instruction. In this chapter, Marcy Driscoll describes the key ideas associated with each of these theories and discusses the ways in which these theories have influenced instructional design practices.
Knowledge and Comprehension Questions

1. What is meant by the term learning?
2. According to most psychological theories, how does learning occur?
3. Identify the key belief underlying Skinner's behavioral learning theory
4. Describe how antecedents and consequences affect learning.
5. Describe four ways in which behavioral learning theory has influenced instructional design practices.
6. What is the key difference between behavioral learning theory and information processing theory?
7. What roles do attending, encoding, retrieval, and feedback play in the learning process?
8. How does prior knowledge influence learning?
9. Describe two ways in which information-processing theory has influenced instructional design practices.
10. Describe one way in which situated learning theory differs from behavioral learning theory and information-processing theory.
11. Describe, from a situated learning theory perspective, how learning occurs.
12. Describe what is meant by the term community of learners and anchored instruction.
13. What is the primary reason for defining different categories of learning?
14. What is meant by the term conditions of learning?
15. In general, what is the purpose of Gagne's events of instruction?
16. Describe a key difference between the constructivist view of learning and the information-processing theory view.
17. Describe two ways in which constructivism has influenced instructional design practices.

This chapter provides an overview of the major psychological concepts and principles of learning that are foundational to the field of instructional design (ID). The behavioral learning theory of B. F. Skinner, for example, contributed concepts such as reinforcement, feedback, behavioral objectives, and practice to the design of instruction. Cognitive theories such as information processing shifted the focus of the ID field to attributes of learners and the role of prior knowledge in learning new knowledge and skills. Situated learning theory is also shifting the ID field toward consideration of sociocultural factors in learning. Finally, instructional theories such as Gagne's and recent constructivist approaches provide guidance for designing learning environments that facilitate the acquisition of desired skills, knowledge, and attitudes.

Regardless of the differences among psychological perspectives on learning, an underlying assumption of most is that instruction will bring about learning. This assumption is what is important to those in the ID field. As Gagne (1995/96) put it, "There are, after all, some useful human activities that are acquired without instruction, and others that result from self-instruction. But most practical and purposeful activities, such as the pursuits involved in vocational and technical training, are learned in settings that employ instruction" (p. 17).

Learning Defined

Most people have an intuitive notion of what it means to learn: They can do something that they could not do before or they know something that they did not know before. But learning must be distinguished from physical growth, or maturation, which also leads to abilities that were not present before. For example, young children are soon able to grasp objects in both hands simultaneously as they develop muscular control and coordination. However, this change in ability is not considered learning. Changes in ability that are only temporary are not considered learning either, because learning implies a kind of permanence. Thus, the increased abilities of an athlete taking a performance-enhancing drug would not be thought of as learning.

In most psychological theories, learning is defined as "a persisting change in human performance or performance potential" (Driscoll, 2000, p. 11), with performance potential referring to the fact that what is learned might not always be exhibited immediately. Indeed, you might remember many instances in which you were never asked to demonstrate what you had learned until a unit or final test was administered. It is important to note, however, that such demonstrations of learning are important for instructional designers to establish the effectiveness of instruction. How else can they determine the impact of instruction if they do not, in some way, ask the learners to perform what was to be learned in the first place?

Learning is defined further by how it is thought to occur. In most psychological theories, learning comes about as a consequence of "the learner’s experience and interaction with the world" (Driscoll, 2000, p. 11), and this interaction is understood as an individual process. That is, the individual interacts with the world surrounding him or her, and this experience leads to an increased ability to perform in a particular way. A focus on the individual learner is why there has been such historical interest in differences among individuals and why the performance of individual learners is assessed after instruction. What differs among particular learning theories is how they describe the observed outcomes of learning and how they explain the learning process. Some of these differences are described in later sections of the chapter.

Recently, however, a perspective is emerging that calls into question the individuality of learning. Adherents of this view believe that "[psychological] individuality can only be properly identified and analyzed after the levels of community have been factored out" (Lemke, 1997, p. 49). In other words, learning is to be understood in terms of the activities of people living within a particular sociocultural setting. In this view, learning is more than a change in performance of a single individual; it can encompass the performance of a group of individuals sharing a common purpose or intent or engaged in a common practice. Furthermore, learning is characterized not just by the processes within an individual learner but also by the processes shared by and affecting the members of a defined group.
In the sections that follow, major psychological concepts and principles of learning are explored and their implications for ID discussed. In some cases, such implications have already been observed as influences on the field. In others, implications are being imagined and proposed as potential and future influences on the field.

### Behavioral Learning Theory

Throughout his life and career, B.F. Skinner advocated an approach to the study of psychology and learning that is focused on behavior (see, for example, Skinner, 1938, 1969, 1987). At the core of his radical behaviorism is Skinner's belief that learning can be understood, explained, and predicted entirely on the basis of observable events, namely, the behavior of the learner along with its environmental antecedents and consequences. Antecedents refer to the cues occurring in the environment that signal the appropriateness of a given behavior. A stop sign, for example, signals to the driver that the appropriate behavior is to apply the brakes. Likewise, a teacher's admonition to "listen up!" signals to students that they should stop talking and pay attention. According to Skinner, the consequences of a behavior then determine whether it is repeated and thus considered to be learned. For instance, a student who is rewarded with a teacher's smile for paying attention in class will be more likely to follow the teacher's directions at a later time than will a student whose behavior goes unnoticed. Similarly, a learner who tries a new strategy for finding information on the World Wide Web is more likely to keep using it if the strategy proves to be successful (and is thus reinforced) than if it does not yield the sought-for information.

The principles of behavior modification that Skinner and his disciples investigated in their research and tried out in instructional applications have had significant impact on the ID field. To begin with, behavioral learning theory is empirically based, which means that behavior is observed both before and after an intervention such as instruction has been implemented, and the observed changes in performance are related to what occurred during the intervention. If there is no change in behavior, then the intervention cannot be considered effective. In the ID field, these observations are part of formative evaluation, which is conducted to collect information about whether instruction resulted in learning and how it might be improved to result in better learner performance.

The emphasis in this theory on the behavior of the learner also contributed to concepts such as behavioral objectives and the importance of practice in instruction. For example, prior to instruction, teachers and instructional designers can determine whether learners have already acquired a desired behavior by observing them. Desired behaviors that are not exhibited can be specified as objectives, or learning outcomes, and must be addressed in the instruction that is being designed and developed. In this way, specifying desired behaviors as objectives points out the need to ensure that learners have sufficient opportunities to practice these behaviors as they learn.

Finally, behavioral theory influenced early conceptions of instructional feedback. That is, feedback was assumed to be essentially equivalent to reinforcement. When learners responded correctly during instruction, immediate feedback that the answer was correct was expected to reinforce the response. Likewise, feedback that an answer was wrong was expected to reduce the incidence of incorrect responding. Because of the anticipated reinforcing benefits of feedback, instructional designs such as programmed instruction resulted that broke instruction into small steps and required learners to respond frequently (see, for example, Holland & Skinner, 1961), thus virtually ensuring errorless performance. Unfortunately, these designs were boring to learners, who could also peek ahead at answers before they responded, which meant that the presumed benefits of feedback were rarely realized (Kulhavy, 1977).

### Cognitive Information-Processing Theory

The informational value of feedback became apparent when researchers and practitioners began to adopt the perspective of information processing theory. This view rose to prominence among psychologists in the 1970s, and variations of it continue to be investigated and articulated today. Like behavioral theory, information processing theory regards the environment as playing an important role in learning. Where information processing theory differs from behavioral theory, however, is in its assumption of internal processes within the learner that explain learning. "The birth of computers after World War II provided a concrete way of thinking about learning and a consistent framework for interpreting early work on memory, perception, and learning. Stimuli became inputs; behavior became outputs. And what happened in between was conceived of as information processing" (Driscol, 2000, pp. 75-76).

Atkinson and Shiffrin (1968) proposed a multistage, multistore theory of memory that is generally regarded as the basis for information-processing theory. Three memory systems in the learner (sensory, short-term, and long-term memory) are assumed to receive information from the environment and transform it for storage and use in memory and performance. With sensory memory, learners perceive organized patterns in the environment and begin the process of recognizing and coding these patterns. Short-term memory permits the learner to hold information briefly in mind to make further sense of it and to connect it with other information that is already in long-term memory. Finally, long-term memory enables the learner to remember and apply information long after it was originally learned.

In addition to stages through which information passes, processes such as attention, encoding, and retrieval are hypothesized to act on information as it is received, transformed, and stored for later recall and use. For instance, learners who fail to pay attention will never receive the information to be learned in the first place. To be most influential on learning, attention must often be directed so that learners heed specific aspects of the information they are being asked to learn. Similarly, the process of encoding provides a means for learners to make personally meaningful connections between new information and their prior knowledge. Finally, retrieval enables learners to recall information from memory so that it can be applied in an appropriate context.

Feedback from an information-processing perspective, then, serves two functions during learning. First, it provides the learner with knowledge about the correctness of his or her response or the adequacy of his or her performance. Although this knowledge
is certainly important during learning, it is not sufficient for correcting misconceptions or other errors in performance. The second function of feedback therefore is to provide corrective information to the learner that can be used to modify performance. In essence, feedback completes a learning cycle in which the feedback can be used to continually modify what is stored in memory and used to guide performance.

In addition to changing our conception of feedback, information-processing theory shifted our focus to various attributes of instruction and how they can facilitate or impede information processing and thereby learning. It also put increased emphasis on the role of prior knowledge in learning new knowledge and skills. For instance, a learner who already knows a good deal about the topic of instruction can call to mind many cues that will be helpful in processing whatever information is new. A learner with little prior knowledge, however, can make few connections between what is already known and what he or she is being asked to learn.

To assist learners in processing information, practitioners have incorporated strategies into their instructional designs that direct attention, facilitate encoding and retrieval, and provide practice in a variety of contexts. The use of boldface and italic print in text materials, for example, can draw learners' attention to important information just as the use of color in diagrams or slides can help learners to distinguish important features of visual information. Graphical diagrams and imagery strategies can help learners to make meaningful connections between their prior knowledge and the new information they are learning. Finally, providing many different kinds of examples or problems in different contexts can help learners to apply the knowledge they are acquiring to situations in which it is relevant.

### Situated Learning Theory

Whereas the context of learning is recognized as important in information processing theory, it takes on a more central and defining role in situated learning theory. As a currently emerging view, situated learning or situated cognition theory is regarded by its proponents as a work in progress (Kirschnerr & Whinston, 1997). Therefore the implications it may hold for the field have yet to be seen.

Unlike behavioral and information processing theory, situated learning theory relies more on social and cultural determinants of learning than it does on individual psychology. Specifically, knowledge is presumed to accrue in "meaningful actions, actions that have relations of meaning to one another in terms of some cultural system" (Lemke, 1997, p. 43). For example, children selling candy on the streets of Brazil develop techniques for manipulating numbers that are related to currency exchanges, whereas their age-mates in school learn standard number orthography (Saxe, 1990). To understand why the candy sellers acquired the particular mathematical knowledge that they did and why it was so different from what their age-mates learned requires reference, at least in part, to the "mathematical and economic problems linked to the practice" of candy selling (Saxe, 1990, p. 99).

Thus learning from a situated perspective occurs through the learner's participation in the practices of a community. Practices that are mutually constituted by the members of the community. Consider, for example, the profession of a community of practice. As a student, you are a newcomer to the community, engaged in learning its models and practices and becoming ever more competent as you gain experience in these practices. With increasing participation, newcomers become old-timers in the community, individuals who control the resources and affect the practices of the community at large. Faculty members in programs, for example, change the practices of the field through their participation in research and development.

According to Wenger (1998), learning as participation can be defined:

- individually, that is, as members engage in the practices of a community;
- community-wide, that is, as members refine the practices of a community and recruit new members; and
- organizationally, that is, as members sustain the interconnected communities of practice through which "an organization knows what it knows and thus becomes effective and valuable as an organization" (p. 8).

Organizations that hire instructional designers, for example, constitute their own communities of practice that embody the ways in which design is conducted in the context of their businesses. Yet their practices are influenced by the academic communities from which they recruit their instructional designers. It should also be obvious that the influence of interconnected communities of practice works in both directions; academic programs modify their practices from time to time on the basis of what they learn from the organizations where they place their graduates.

Proponents of situated learning theory point to its strength as integrating knowing with doing. That is, one learns a subject matter by doing what experts in that subject matter do (Lave, 1990/1997). As an emergent view or work in progress, situated learning theory may not yet have yielded definite implications for the field perhaps, but several are indicated nonetheless.

For over ten years, Scardamalia and Bereiter (1994, 1996a) have researched a community-of-learners approach to instruction called Computer-Supported Intentional Learning Environment (CSILE). CSILE is a computer tool that enables students to engage in the discourse of a subject-matter discipline in a scholarly way. They focus on a problem and build a communal database of information about the problem. With current web technologies, CSILE now has the capability of linking experts in the field with students in the classroom in mutually constituted knowledge-building efforts (Scardamalia & Bereiter, 1996b). Extending the community of learners approach to adults, Wagner and DiSciscio (1999) are exploring technology tools and design strategies for supporting on-line knowledge building among graduate students in a collaborative learning environment. They hope to learn what some of the implications of situated learning theory may be for instructional design models and designing for certain types of learning outcomes, such as the self-regulation and reflection that characterize experts in a discipline.
The influence of situated learning theory is also being felt in designs for anchored instruction. The Cognition and Technology Group at Vanderbilt (1990) proposed anchored instruction as a means of providing a situated context for problem solving. Specifically, they developed video-aided simulation programs containing a series of embedded problems that engaged the viewer in attempting to solve the problems. The video-aided simulation provides a realistic, situated anchor for activities such as identifying problems, making hypotheses, and proposing multiple solutions. The expectation is that students will engage in authentic practices of the discipline in which a given set of problems is anchored, whether mathematics, science, or history, for example. An obvious advantage of anchored instruction is that it requires no additional resources beyond what is provided in the videodisc series and accompanying instructional guides. A disadvantage, perhaps, is that it provides a simulation of a community of practice, casting the learners as observers rather than true participants (Tripp, 1993).

**Gagné’s Theory of Instruction**

Although many learning theorists are interested in what their work means for instruction, the explanation of learning is their primary concern. Robert M. Gagné, by contrast, was concerned primarily with instruction and how what is known about learning can be systematically related to the design of instruction. He proposed an integrated and comprehensive theory of instruction that is based primarily on two foundations: cognitive information processing theory and Gagné’s own observations of effective teachers in the classroom. A long-term collaborator of Gagné, Briggs (1980) wrote that:

> I never asked Gagné about this, but I believe his early work in designing training programs for the Air Force must have been an important factor in his later derivation of his (a) taxonomy of learning outcomes, (b) concept of learning hierarchies, and (c) related concepts of instructional events and conditions of learning (pp. 45–46).

As it evolved, Gagné’s theory of instruction came to comprise three components:

- a taxonomy of learning outcomes that defined the types of capabilities humans can learn;
- internal and external learning conditions associated with the acquisition of each category of learning outcome; and
- nine events of instruction that each facilitate a specific cognitive process during learning.

Taxonomies of learning existed before and since Gagné’s formulation of his, but none besides his includes all three domains in which individuals are presumed to learn: cognitive, affective, and psychomotor. According to Gagné (1972, 1985; Gagné & Medsker, 1996), there are five major categories of learning:

- verbal information, that is, knowing “that” or “what”;
- intellectual skills, that is, applying knowledge;
- cognitive strategies, that is, employing effective ways of thinking and learning;
- attitudes, that is, feelings and beliefs that govern choices of personal action; and
- motor skills, that is, executing precise, smooth, and accurately timed movements.

The reason for defining different categories of learning outcomes stems from the assumption that they must all require different conditions for learning. For example, learning to ride a bicycle (a motor skill) is different in fundamental ways from learning the multiplication table (verbal information), which is different in fundamental ways from learning to solve scientific problems (intellectual skill).

The differences in conditions of learning among categories of learning outcomes provide guidelines for which conditions must be included in instruction for specifically defined instructional goals. For example, instruction on the goal of “perform CPR” (motor skill) is likely to include a demonstration of the procedure, individual practice on the procedure, and perhaps a job aid depicting each step. By contrast, instruction on an attitudinal goal implicit in job training on an electronic support system (such as “choose to use the help function before seeking human assistance”) is likely to provide a human model and focus on the benefits of making the desired choice.

In addition to conditions of learning that are unique to each learning outcome, there are conditions of learning which facilitate the process of learning in general. Gagné conceived of the nine events of instruction as learning conditions to support internal processes such as attention, encoding, and retrieval. The events of instruction are presented briefly below:

1. Gaining attention: a stimulus change to alert the learner and focus attention on desired features.
2. Informing the learner of the objective: a statement or demonstration to form an expectancy in the learner as to the goals of instruction.
3. Stimulating recall of prior learning: a question or activity to remind the learner of prerequisite knowledge.
4. Presenting the stimulus: an activity or information that presents the content of what is to be learned.
5. Providing learning guidance: a cue or strategy to promote encoding.
6. Eliciting performance: an opportunity to practice or otherwise perform what is being learned.
7. Providing feedback: information of a corrective nature that will help learners to improve their performance.
8. Assessing performance: an opportunity to demonstrate what has been learned.
9. Enhancing retention and transfer: examples or activities that prompt the learner to go beyond the immediate context of instruction.

The application of Gagné’s theory is often a highly analytical affair, and it is therefore possible to lose sight of the overall context for learning while dealing with all the details of instruction. As a means of helping instructional designers integrate multiple goals into instruction, Gagné and Merrill (1990) proposed the notion of an enterprise schema. The enterprise schema defines the context for learning, the reason for learning a particular set of goals in the first place. For example, the enterprise schema of “managing a lemonade stand” provides a meaningful context for learning how to exchange currency, how to calculate needed supplies on the basis of an anticipated volume of business, and so on.
Constructivism

The final theory to be considered in this chapter is not yet a single theory, but rather a collection of views sharing a fundamental assumption about learning that contrasts sharply with the assumptions underlying theories such as information processing. The contrast can be drawn this way: In information-processing theory, learning is mostly a matter of going from the outside in. The learner receives information from the environment, transforms it in various ways, and acquires knowledge that is subsequently stored in memory. In constructivist approaches, on the other hand, learning is more a matter of going from the inside out. The learner actively imposes organization and meaning on the surrounding environment and constructs knowledge in the process.

From a radical constructivist point of view, knowledge constructions do not have to correspond with reality to be meaningful, but most constructivist researchers agree that not all knowledge constructions are equally viable. To sort out which ideas are viable and which are not, learners must test their personal understandings against those of others, usually peers and teachers.

Constructivism has been keenly felt in the world, partly because it seems to contrast so starkly with the other foundations, such as information processing and Gagne’s theories, that have influenced practices in our field. Some of the philosophical issues related to these views are taken up in Chapter 5 and so will not be repeated here. Rather, I have chosen to describe a few of what I perceive to be the greatest impacts of constructivism on the field.

To begin with, constructivist researchers focused attention on high-level, complex learning goals, such as “the ability to write persuasive essays, engage in informal reasoning, explain how data relate to theory in scientific investigations, and formulate and solve moderately complex problems that require mathematical reasoning” (Cognition and Technology Group at Vanderbilt, 1991, p. 34). While these kinds of goals are certainly definable using taxonomies such as Gagne’s, under such approaches, they do not necessarily assume the prominence that constructivists would assign to them. Addressing broad and complex learning goals is also consistent with constructivist beliefs that individuals do not all learn the same things from instruction.

Constructivism has also had a substantial impact on views pertaining to the learning conditions and instructional strategies believed essential to the support of important learning goals. To engage learners in knowledge construction, facilitate tests of their understanding, and prompt reflection on the knowledge-generation process itself, constructivist researchers have recommended the creation and use of complex learning environments. Such learning environments should:

- engage learners in activities authentic to the discipline in which they are learning;
- provide for collaboration and the opportunity to engage multiple perspectives on what is being learned;
- support learners in setting their own goals and regulating their own learning; and
- encourage learners to reflect on what and how they are learning.

The rapid growth in computer technologies has assisted researchers in creating different kinds of technology-mediated learning environments that implement these strategies. It remains somewhat difficult to judge the effectiveness of these systems, however, because advances in assessment have not kept up well with advances in technology. Furthermore, constructivists argue that assessment of individual student learning should involve authentic practices observed during learning and would not necessarily reveal a uniform level of accomplishment across learners.

Conclusion

This chapter has presented a brief introduction to some of the major psychological principles and avenues of thought that have contributed (and continue to contribute) to professional practices in the field of instructional design. Behavioral and cognitive information-processing theory came out of research programs dominating psychology in the 1960s and 1970s. Gagne’s theory evolved through two decades of research from the 1960s to the 1980s and integrates cognitive with behavioral views. These theories collectively form the bedrock on which the field of instructional design was founded and initially developed. They provided, and continue to provide, useful and reliable guidance for designing effective instruction.

Constructivist and situated learning theory now offer the ID field sharply contrasting ways of thinking about learning. Along with advances in technology, they promise design strategies for producing learning environments more complex, more authentic, and more appealing than ever before. The long-term implications of these theories to the ID field are not yet fully known, but they surely offer an invitation to professionals who are new to the field to help shape that legacy.

References


Gagne R M (1972) Domains of learning. Interchange 3 1–8

