Instructional Design

Second Edition

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Introduction to Instructional Design

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Chapter Objectives

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

- Explain what is meant by *instructional design.*
- Define *instruction,* distinguish it from related terms (such as *education, training,* and *teaching*), and when given descriptions of educational activities, determine which of these are instruction.
- Identify and describe the three major activities of the instructional design process, and when given descriptions and instructional design activities, identify which activity is being employed.
- Describe advantages of using instructional design: for school curriculum developers, for teachers, for training designers and trainers.
- Discuss the types of contexts in which instructional designers work and how their activities may differ in these different contexts.

Introduction

Fourth-grade teacher Dora Brady is sitting at her desk after school, looking at the scores that her class made on the long-division quiz she gave today. She is reviewing the students' performance in her mind and recalling how she taught the students. She is working on new ways to teach the kids next week and next year. She is drawing upon her knowledge of something called *instructional design* in her thinking.

Dick Montiville is in conference with three coworkers at Amalgamated Airlines. Mr. Montiville and his team are figuring out the exact nature of the learning that aircrew members need in order to improve the safety of the company's flights. The areas of required learning have already been established, and now the team is breaking those learning tasks down into the components and prerequisites. Montiville and his team are using some techniques from instructional design to guide their work.

Faye Hartman and William Burke are in charge of evaluating a new textbook series in organic chemistry being developed by MacBurdick Publishers. The series is intended to capture the market in its subject area, and principles of instructional design were used in many phases of the project, including the evaluation work of Hartman and Burke.

What Does *Instructional Design* Mean?

The term **instructional design** refers to the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation. An instructional designer is somewhat like an engineer. Both plan their work based upon principles that have been successful in the past—the engineer on the laws of physics, and the designer on basic principles of instruction and learning. Both try to design solutions that are not only functional but also attractive or appealing to the end-user. Both the engineer and instructional designer have established problem-solving procedures that they use to guide them in making decisions about their designs.

Through this systematic process both the engineer and the instructional designer plan what the solution—often a finished product—will be like. Both write specifications (plans) for the solutions, but they do not necessarily translate their specifications into an actual product. They often hand their plans to someone who specializes in production (in the case of an engineer, a building contractor; in the case of the instructional designer, a media production specialist). This holds true for many instructional designers. However, some designers, such as those with production skills (computer programming, video production, or development of print materials), may themselves translate their specifications into the final instructional material. Classroom teachers often implement their own plans. In any event, the designer typically begins the production or implementation once the specifications are completed.

Careful, systematic planning is important no matter what media of instruction are used in implementation. When the medium of instruction is something other than a teacher, and when it is possible that a teacher may not be available or prepared to compensate for poorly planned instructional materials, careful instructional design is critical. When the instructional medium is not immediately adaptable (as with printed materials, videotaped materials, and computer-based instruction), having a design that is based upon principles of instruction is very important. Any oversights that were made in the design of these instructional materials cannot be easily remedied because the instruction is being delivered via instructional media. When the primary medium of instruction is a teacher/trainer or when a teacher/trainer has a major role as coordinator of instruction, then high-quality instructional design is also highly beneficial. The systematic planning needed prior to implementation and the reflection that should occur afterward are well informed, guided, and organized by instructional design principles and processes. Teachers'/Trainers' careful planning allows them to allocate their mental resources during instruction to adaptations that are necessary due to the differing prior experiences of the learners; to motivation, behavior, or administrative problems; or to serendipitous events that require instructional planning on the spot.

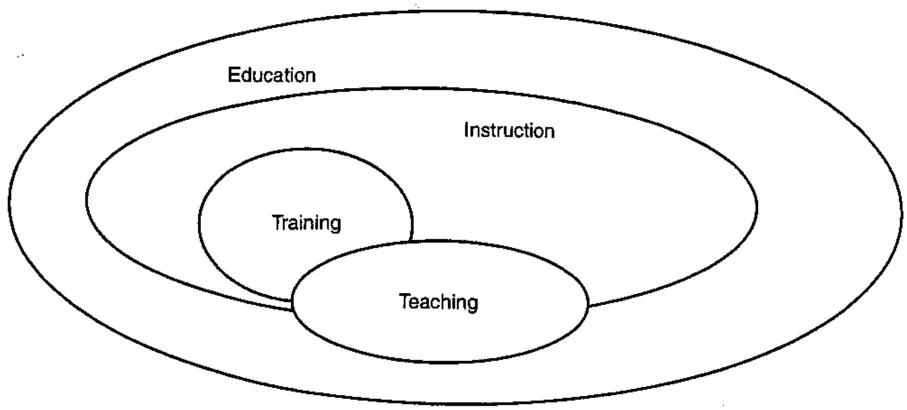
To understand the term *instructional design* more clearly, we will review the meanings of the words *instruction* and *design.*

What Is Instruction?

Instruction is the intentional facilitation of learning toward identified learning goals. Driscoll (1994) defines *instruction* from a similar perspective: "the deliberate arrangement of learning conditions to promote the attainment of some intended goal" (p. 332). In both definitions, instruction is intentional arrangement of experiences, leading to learners acquiring particular capabilities. These capabilities can vary qualitatively in form, from simple recall of knowledge to cognitive strategies that allow a learner to find new problems within a field of study. For example, a teacher or trainer may wish to help learners use a particular kind of computer software to solve a certain set of problems. The instructional designer will develop materials and activities that are intended to prepare the learners to use the software effectively. Every experience that is developed is focused toward one or more goals for learning. In addition to effective instruction, designers also wish to create instruction that is efficient (requiring the least time and cost necessary) and appealing.

Terms such as *education, training,* and *teaching* are often used interchangeably with *instruction*. However, in this text we will make some distinctions among these terms. Certainly, these distinctions may not be made in the same way among all individuals in the field of education, or even in the field of instructional design. However, we have found these

Figure 1.1 Relationships Among Terms Associated with Instruction



definitions helpful in laying the framework for this text. Figure 1.1 illustrates the relationships among these terms.

We will use the term **education** very broadly to describe all experiences in which people learn. Many of these experiences are unplanned, incidental, and informal. For example, many people learn to drive a car in city traffic through a trial-and-error process involving many harried morning trips. The driver learns, so these experiences can be considered part of her general education; however, no one has specifically arranged this learning experience so that she can learn well, quickly, and with a minimum of danger and frustration. It would be possible to create a series of particular experiences (perhaps using videotapes and city maps) that would be specifically focused on preparing one to navigate city traffic easily. We would call the delivery of these focused educational experiences **instruction.**

So, all instruction is part of education because all instruction consists of experiences leading to learning. But not all education is instruction because many experiences that lead to learning are not specifically developed and implemented to ensure effective, efficient, and appealing experiences leading toward particular learning goals. A common misapprehension of instruction relates instruction to particular strategies—such as expository or didactic ones—and avoids the term when referring to learning environments that employ a more student-centered approach. The tools and principles of instructional design that you will see described in this book are applicable to all forms of experience, as long as the experience in question has facilitation of particular goals for learning as its purpose. However, learning environments that are truly "goal free"—if such exist—would not be examples of instruction.

We generally use the term **training** to refer to those instructional experiences that are focused upon individuals acquiring very specific skills that they will normally apply almost immediately. For example, many instructional experiences in vocational education classes can be considered *training*. The students learn skills, specifically focused toward job competencies, that they will use almost immediately. Much instruction in business, military, and government settings can be termed *training* because the experiences are directed toward preparing learners with specific on-the-job skills. In addition, the instruction in certain special education classes is "training" because the learning experiences have been developed to provide students with life skills, such as counting change, which we anticipate they will use almost immediately.

Not all instruction can be considered *training,* however. For instance, in military education programs, learners may be provided with some general instruction in math and reading. These learning experiences can be termed *instruction* because the lessons were developed with some specific goals in mind, such as a certain level of proficiency in reading and mathematics. However, these goals are often not directed toward a specific job task, nor is there anticipation of immediate impact upon a specific job task. The influence on job performance is anticipated to be more diffuse throughout job responsibilities and outside job tasks. Therefore, in our terminology, these learning experiences would not be termed *training.* Similar to the misapprehension of the meaning of instruction, training is sometimes mistakenly identified with a particular style or strategy of teaching. Training is conducted using all of the varieties of method and approach seen in any other form of education: training is distinguished from other forms by *immediacy* of application.

Of all the terms, just discussed *teaching* and *instruction* may be most often used interchangeably. In this text, we will use the term **teaching** to refer to those learning experiences that are facilitated by a human being—not a videotape, textbook, or computer program, but a live teacher. Instruction, on the other hand, includes all learning experiences in which the instructional support is conveyed by teaching and other forms of mediation. As you will discover later, one of the primary tenets of instructional design is that a live teacher is not essential to all instruction.

As Figure 1.1 shows, not all teaching is considered to be instruction. There are occasions in an educational environment in which a teacher does not focus learning experiences toward any particular learning goal. On these occasions teachers may provide many learning activities, and during these activities learning goals may emerge, often from the learners themselves as they encounter the activities. For example, some preschool education falls within this category, such as instances in which learners are provided with a variety of manipulative materials that they can use to pursue many problems. These pursuits might lead to various learning outcomes, not all of which have been specifically anticipated by the teacher.

In summary, this text focuses on instruction. Here, we will consider *instruction* to be a subset of *education*. The term *training* will be considered a subset of *instruction*. In some cases *teaching* will be considered instruction, and in others it will fit the more general category of education but will not have the focus that characterizes instruction. We will concentrate on the design and development of activities that are directed toward identified learning goals.

What Is Design?

Many fields use the term *design* as part of their title; examples include interior design, architectural design, and industrial design. The term **design** implies a systematic or intensive planning and ideation process prior to the development of something or the execution of some plan in order to solve a problem. Fundamentally, design is a type of problem solving and has much in common with problem solving in other professions. In this text, we classify the capability that designers apply as "domain-specific problem solving," which involves the solution of "ill-structured" or "ill-defined" problems. Such problems cannot be solved by following an algorithm, nor will all designers reach the same solution to a particular learning problem. (Readers might wish to refer to Chapter 8, Strategies for Problem Solving Lessons, to clarify what is meant by "domain-specific problem solving.")

Design is distinguished from other forms of instructional planning by the level of precision, care, and expertise that is employed in the planning, development, and evaluation process. Designers employ a high level of precision, care, and expertise in the systematic development of instruction because they perceive that poor planning can result in serious consequences, such as misuse of time and other resources and even in loss of life. Specifically, instructional designers fear that poor instructional design can result in ineffective encounters, inefficient activities, and unmotivated learners—a consequence that can have serious long-term effects. Indeed, experienced instructional designers intensify the degree of precision, care, and expertise expended on a design project relative to the impact of the potential consequences of ineffective, inefficient, or unmotivated learning that can result from less carefully designed instruction. (For more detail on the subject of adjusting design intensity to the learning situation, refer to Chapter 20, Conclusions and Future Directions.)

Design involves the consideration of many factors that may affect or be affected by the implementation of an instructional plan. For example, interior designers must consider the purpose and level of use of a facility, the anticipated traffic patterns, and the needs of the people who will be using the facility. Interior designers must consider the engineer's plans, such as the location and strength of walls. They must follow laws and regulations with regard to accessibility and safety. If they do not consider all these factors and how they interrelate, the designers risk creating a work or living space that is unusable or even dangerous. Just as interior designers have critical factors that they must consider to make their solutions usable and effective, instructional designers have a vast number of factors, which often interact, that they must consider as they create instruction. The rest of this text details factors that instructional designers must consider in designing instruction.

Creativity also has a role in design. Novice designers sometimes have the impression that doing design work is a "cut-and-dried" activity. This is not the case. For example, if one were to give several architects the same conditions—site, materials, and purpose—the plans for the structures that they would create would vary radically. Some would be highly imaginative and innovative, while some might be more mundane and standard. All of the designs may "work" in the sense that, when executed, the buildings would remain standing and serve their purposes. However, some imaginative and ingenious structures may inspire awe, while more mundane structures may be totally forgettable.

Just as the design of the architect benefits from creativity and imagination, so do the designs of the instructional designer. There is a critical need for imagination and ingenuity in all instructional design activities. For example, during context analysis designers may have to exert considerable ingenuity in creating ways to ascertain the true nature of the "problem." Sometimes this involves restructuring the problem to redefine it into one that *can* be solved (Akin, 1994). In addition, designers must make instruction inspiring and memorable. Certainly, evaluation of instruction requires inventiveness. Frequently, assessing the actual goals of an instructional activity seems a practical impossibility. Some designers are ingenious in devising ways of simulating targeted situations, so that learners get to demonstrate activities and processing that are very near the actual goal behavior.

How can instructional designers become more creative in their work? We have noticed some common characteristics of particularly ingenious design students and practitioners in the field. First, highly creative designers are voracious consumers of examples of instructional materials, both those from the instructional design tradition and those from other traditions. Second, although they have conducted a thorough analysis of the component learning requirements (objectives) of the design project, the best designers clearly maintain a sense of the major goal and generalized perception of the content of the materials: They can still see the forest, despite the trees. Third, excellent designers use message design conventions, such as a metaphors, a narrative, or a visual image to lend a sense of continuity, interest, and wholeness to the instruction.

Another key aspect of instructional design is its extensive and demanding nature. Experienced designers (not to mention novices) frequently express concern about the time and effort that they expend applying what is currently known about designing efficient, effective, and appealing instruction. Clearly, there is enough of a "technology" undergirding the design process that a casual approach to either learning or application of skills in instructional design will not do it justice. However, those who are beginning their study of instructional design should know that once the concepts and principles of instructional design are learned, they can be appropriately applied with a wide range of effort, precision, and formality. Even classroom teachers in public schools (who by virtue of their teaching loads do not generally have time to engage in instructional design in a full-blown fashion) can significantly improve the effectiveness of their teaching by informally applying instructional design principles. They may choose to apply these principles mentally and document little, if any, of their thinking on paper. Of course, in instructional design classes learners are asked to document their thought processes so that the instructor can evaluate them and provide remediation where necessary. And, in many contexts—particularly those situations in which teams work together on a design project in which legal liability for the quality of the instruction is an issue—a hard-copy documentation of the design process may be essential.

Recent developments in the field are specifically directed at reducing the time and effort required by the instructional design process. We review a number of these "fast-track" approaches to instructional design in the final chapter of this text.

Rowland (1992, 1993, 1994) has studied the process of design across a number of professions and has examined instructional design specifically. Several of his observations of design in general are particularly salient to the design of instruction (1993):

- Design is a goal-directed process in which the goal is to conceive and realize some new thing.
- The new thing that results from designing has practical utility.
- A basic task of designing is to convert information in the form of requirements into information in the form of specifications.
- Design requires social interaction.
- Designing involves problem solving, but not all problem solving is designing.
- In designing, problem understanding and problem solving may be simultaneous or sequential processes.
- Design may be a science, or a combination of science and art, or neither science nor art.
- Designing involves technical skills and creativity and rational and intuitive thought processes.
- A design process is a learning process. (pp. 80–85)

The Instructional Design Process

Another way to define *instructional design* is to describe the process involved in the systematic planning of instruction. At the most basic level, the instructional designer's job is to answer three major questions (Mager, 1984):

1. Where are we going? (What are the goals of the instruction?)
2. How will we get there? (What is the instructional strategy and the instructional medium?)
3. How will we know when we have arrived? (What should our tests look like? How will we evaluate and revise the instructional materials?)

These three questions can be stated as major activities that an instructional designer completes during the design and development process:

1. Perform an instructional analysis to determine "where we're going."
2. Develop an instructional strategy to determine "how we'll get there."
3. Develop and conduct an evaluation to determine "how we'll know when we're there."

These three activities form the foundation of the approach to instructional design* that this book describes. We will expand on these three problem-solving activities throughout the text.

An Overview of the Design Process: Designing Training for Digital-Magic Repair Persons

The following section provides an overview of the entire process of designing instruction. We will describe how designers might prepare a system of instructional materials to train individuals to repair the fictitious Digital-Magic stereophonic 3-D television system that will soon be marketed throughout the world.

Analysis. During the activity the designers will learn as much as they can about the environment in which the learners (repair persons) will be trained, about the learners themselves, and about the repair tasks for which the learners must be prepared. The designer will ask many questions of the managers and supervisors in the Digital-Magic company, the developers of the new television system, those who have provided training for repair persons in the past, and of the learners themselves.

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*We use the term *instructional design* to refer to the entire process of [illegible] development, implementation, and revision of instruction. The term [illegible] *tional development* is a related term, and if it were not so awkward, [illegible] refer to the process as *instructional design and development*. Some [illegible] particularly production, would seem to fit more easily under a [illegible] *development* rather than *design*. Since the term *instructional* [illegible] rently the most widely used of the choices available, we will use [illegible]

They will analyze the learning task itself, asking what learners must know or be able to do to learn to make repairs. The designers will want the answers to questions such as:

1. Will the learners be brought together in a central location or will they be trained in their own work environments?
2. How much time is available for training?
3. Will it be possible for the learners to have access to the new television systems to work with as they learn about them?
4. How do learners feel about the training? What sorts of incentives to learn will they be given?
5. What kinds of people are the prospective learners? What interests them? What kinds of educational backgrounds do they have?
6. Do all of the learners have to reach the same goals?
7. What do the learners already know that will help them learn the new information or skills?
8. What are the skills and knowledge that the learners must acquire in order to make the repairs on the new system? Do they need to know only the technical procedures of repair or do they also need to know the conceptual or theoretical *whys* of the procedures?
9. How should the learners' achievement of the goals be assessed? Is a pencil-and-paper test adequate? Should learners be assessed on actually repairing a Digital-Magic television set? Can this performance be simulated?

Selecting the Instructional Strategy. During this activity, the designers determine the way that instructional material relating to repair of the television sets should be presented. They also decide which learning activities the learners can experience. In addition, the designers determine what sequence of instruction should follow. They choose the medium (a single medium) or media (a combination of multiple media) that will support the instruction. This is the stage at which the designers will determine exactly how instruction will take place.

Some of the questions that Digital-Magic's designers would answer in this activity are the following:

1. What kinds of content must be learned by the students? In what size segments should the content be presented? Should information be presented, or should the content be embedded within an activity?

2. In what activities should the learners engage? What role will learners' activities have? Will activities or projects supplement informational presentations, or will they be the primary means of learning? Should activities include learners answering written questions? Should learners practice troubleshooting problems on the actual equipment? For what topics (if any) will reading be an appropriate learning activity? What topics will require viewing demonstrations and visual examples? Are discussions needed?

3. In what sequence should instruction proceed? Should a "discovery" sequence be followed, or should an "expository" approach be used? If expository, what sequence of presentation should be employed?

4. What media are most appropriate for the support of instruction? Should learners see a live demonstration of repair procedures, a videotaped presentation, or an interactive video presentation? Should they read about it in a text or workbook, or should they use both? Should the students have a job performance aid (such as a manual) available to them for reference?

5. What groupings should learners be placed in for learning? Should they study independently, in a small group, or in a large group?

Notice that instructional design in no way implies that the instructional strategy must be "direct instruction" or something "done to" the learner. Instructional strategy decisions are based on many factors that may influence the method of instruction. (We will discuss this particular issue further in Chapter 7, Instructional Strategy.)

Evaluation. When designing evaluation, the designers plan an approach for evaluating the instructional materials to determine what kinds of changes need to be made in them. At Digital-Magic some of the questions that may be asked include the following:

1. Is the content accurate? Have there been design changes in the Digital-Magic television sets since the instruction was originally developed?

2. What learners should use the materials in order to get information to guide revisions? How should we conduct these tryouts? Should the sample be large or small? Should students be observed one at a time or in groups?

3. What questions should be answered in order to determine problems in the instruction?

4. What revisions should be made in the instruction?

When we use the term **evaluation,** it will often be in reference to the broad topic including both assessment of learners and evaluation of the instruction. When we are talking about evaluation of students' learning, we will generally use the term **assessment** instead of the more familiar but often misleading term *tests* (see Chapter 6), and we will generally use the term *evaluation* in the context of evaluating the instruction itself; the terms *formative evaluation* and *summative evaluation* will be used in this fashion (see Chapter 18).

The Digital-Magic Story: A Postmortem. The instructional designers at Digital-Magic did a good job of instructional design. The training system for repair persons was highly effective and efficient. Not only did the student technicians learn what they needed to learn, but they also enjoyed the process and developed a good attitude about their work. It was a good thing, too, because the new television set was very popular in the market, and the first 10,000 Digital-Magic televisions that were manufactured had a faulty part in them. The well-trained service technicians fixed the problems, and as time passed they acquired the reputation of being excellent repair persons.

Congruence Among the Activities of Instructional Design

Instructional designers insist on creating instruction in which the goals, the instructional strategy, and the evaluation all match. By "match," we mean that the strategy (instructional method) that is used is appropriate for the learning task (goals) and that the tests measure how well the learners have achieved the learning task (assessment).

For example, let's say you are an instructional designer now and that you are working on designing instruction in which students will learn to classify objects as either transparent, translucent, or opaque. **Learning tasks** are the things students are to learn, so being able to classify objects as either transparent, translucent, or opaque is the learning task, and this particular learning task involves *concept learning*. The idea of "matching" learning tasks and instructional strategy means that you would select an instructional strategy that is appropriate for learning concepts; you would ensure that students were given several examples and nonexamples of the concepts to be learned. To match evaluation with the learning task and instructional strategy, you would devise your test to determine whether students have learned the concepts by asking them to classify objects as either transparent, translucent, or opaque. In this instruction, the objective, the learning activities, and the assessment are congruent with one another. In other words, they match.

This consistency between intent and action is seen in other approaches to the improvement of education. For example, in the specialties of curriculum development and teaching methods, the idea of "curriculum alignment" is another reflection of congruence between objectives, instruction, and assessment. Examples of faulty congruence are regrettably commonplace. Most of us have had at least one sad experience with a course in which goals, class work, and tests were unrelated to one another, resulting in poor learning and attitude on students' parts.

Instructional Design Models

[illegible] answer the questions "Where are we going?", How will we [illegible] there?", and "How will we know when we've arrived?", [illegible] designer engages in three major activities: analysis, stra[illegible] development, and evaluation. These three activities are [illegible] of most *instructional design models**. Andrews [illegible] (1980) have described 40 such models for systematic design of instruction. In this text we will recommend a simple model of design (see Figure 1.2). It is similar to the design models suggested by Dick and Carey (1985) and Davis, Alexander, and Yelon (1974).

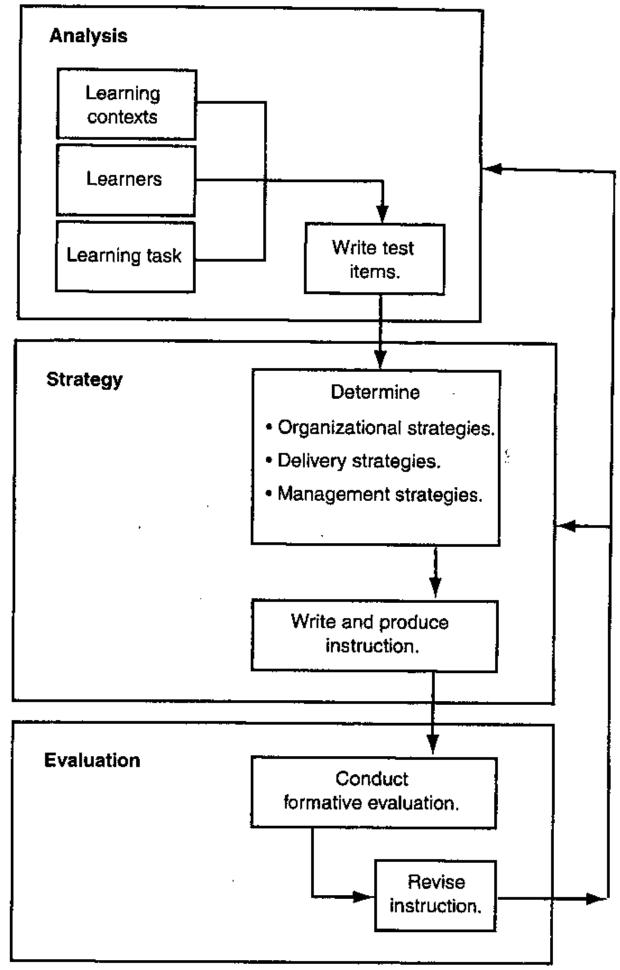


Figure 1.2 An Instructional Design Process Model

We lay no claim of uniqueness to this model. It could be accurately termed "A Common Model of Instructional Design." There are some attributes of it, however, which, though not unique, are not universally seen. These attributes are inclusion of context analysis as a function in the design process, sequencing of test development, and the placement of revision within the formative evaluation phase.

One attribute of the model that is more apparent than we intend is sequentiality. Notice in Figure 1.2 that we have listed some more specific activities of design within each major activity in a particular sequence. We have presented the model in what appears to be a linear sequence in order to *simplify* a discussion of the activities of instructional design and to preview the sequence of that discussion. Both inexperienced and experienced designers may occasionally follow this sequence; however, particular circumstances may cause a designer to modify the sequence of design activities. Many

*[illegible] models may be defined as visualized depictions of in[illegible] emphasizing main elements and their relationships.

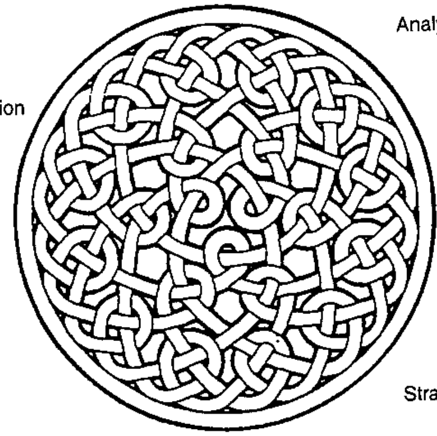


Figure 1.3 A More Realistic Representation of Instructional Design Practice

times the steps within a particular phase may occur concurrently. Indeed, we might depict the activities of practicing instructional designers—especially their mental activities—to resemble more nearly the representation in Figure 1.3.

Figure 1.3 portrays the interwoven, nonlinear nature of actual design activity. Analysis, strategy development, and evaluation activities may, in some cases, occur concurrently, especially if one is following a rapid prototyping technique (described in Chapter 20 of this text). During strategy development, new issues may emerge that send the designer back to more analysis of the learners, task, or context. During analysis, designers are often developing plans for evaluation of the instruction. Inevitably, working on one design activity leads to implications or solutions for other design activities. Unlike foundational models of design, such as Gagné-Briggs (see Gagné, Briggs, & Wager, 1992, Dick & Carey, 1985), that might have implied that instructional design is a linearly sequenced process and that the designer should not even entertain thoughts of a subsequent phase until a previous phase is complete, current models, such as the "ball of worms" model in Figure 1.3 acknowledge the interrelatedness and concurrency of all activities of design.

Although representing design in a fundamentally nonlinear manner more accurately reflects relationships among processes in which instructional designers engage and has the potential to promote "fast tracking" of instructional design (see Chapter 20), there *are* dangers in the concurrency model. For example, moving to strategy development before one has sufficient information regarding the nature of the learners or the characteristics of the learning task may increase the probability that a designer or client fixates on a particular strategy that is inadequate and becomes clearly so when more information about the learners and task becomes available. The concurrency model demands greater flexibility of designer and client so that they do not become dedicated to a solution that is later found to be inappropriate.

For far too long the instructional design literature has placed an inordinate focus on models, particularly their physical attributes. In fact, instructional design models tend only to be modifications and elaborations of a basic problem-solving model tailored to the needs of the instructional design specialty. We do not advocate any particular model but select and modify elements based on demands of the situation. This process of building your own model is enabled by a thorough knowledge of the *principles* that guide design. A model, as exemplified by instructional design models, is no more than a way to begin thinking and learning about important principles in a relationship that assists their initial comprehension. Figure 1.2 will assist to you in building a mental framework, a scaffold, which should help your learning of critical principles, your mastery of which will make the outlines of the original scaffold unnecessary and open to your modification and change as situations require.

Advantages of Using Systematic Instructional Design

For those involved in developing instruction, there are a number of advantages to using a systematic process. Following is a list of some of the advantages of systematic instructional design:

1. *Encourages advocacy of the learner.* To a very large degree, the learner is the focus of instruction. Designers spend a great deal of effort during the beginning stages of a design project trying to find out about the learner. Information about learners should take precedence over other factors that might drive design decisions, including the content itself. Often the designer is not a content expert. In their constant querying of a subject matter expert for clarification, designers are standing in the place of the learner, trying to obtain information to make the content clearer to the learner.

2. *Supports effective, efficient, and appealing instruction.* All of these factors are considered indicators for success. The process of design itself focuses on effective instruction. Efficiency is particularly facilitated by the process of instructional analysis in which inappropriate content is eliminated. The consideration of the learner and the concentration on designing appropriate strategies promotes the appeal of instruction. The process of formative evaluation provides the opportunity to revise instruction to make it more effective, efficient, and appealing.

3. *Supports coordination among designers, developers, and those who will implement the instruction.* The systematic process and resulting written documentation allow for communication and coordination among individuals involved in designing, producing, and delivering instruction. It allows for common language and general procedure. The written plans (goals, description of target audience, and analysis of task) and the written products that are results of instructional design efforts assist the process of review and revision of work in progress in a coordinated team effort.

4. *Facilitates diffusion/dissemination/adoption.* Because the products of systematic instructional design are in fact physical "products," they may be duplicated, distributed, and used in the field. In addition, because design and development have employed information about the learners and setting, products will have a high likelihood of being practical, workable, and acceptable solutions to the instructional problems that they are designed to solve.

5. *Supports development for alternate delivery systems.* Much of the work that goes into an instructional design project is independent of the specific form that the finished product takes (such as print, computer, or video). The front-end analysis and consideration of instructional strategies will be valid beginning points for projects that employ delivery systems other than that used by the original project.

6. *Facilitates congruence among objectives, activities, and assessment.* The systematic approach to instructional design helps ensure that what is taught is what is needed for learners to achieve stated goals for learning and that evaluation will be accurate and appropriate.

7. *Provides a systematic framework for dealing with learning problems.* Frequently, creative individuals not trained in systematic instructional design will develop ingenious approaches to instruction that are rather like "solutions looking for a problem." Although these approaches may add to the repertoire of possible approaches, they seldom appeal to high-level management in government or business, to school system administrators, or to other funding agencies. The innovations that are generally appealing are those that have clarified the problem into a learning goal, have developed an instructional approach that gives reason to believe that the problem can be solved and the learning goals will be met, and has a well-constructed plan for gathering evidence to determine whether the approach has solved the initial problem and what undesirable effects it might have.

Limitations of Systematic Instructional Design

Instructional design does have limits of applicability; it's not the solution to all the ills and problems of education and training, nor is it the only method for creating education. In particular, instructional design has limited applicability to educational experiences in which (a) learning goals cannot be identified in advance, or (b) no particular goals are ever identified (i.e., non-instructional education). In such cases, because there is no "lead time" to the education, and since reflection and planning are central to instructional design, there is limited opportunity to apply many of its principles and procedures. An example of such a situation might be an advanced graduate class or other educational environment in which the learners have exceptional prior knowledge of the content; these students would have well-developed cognitive strategies and be required to identify the goals of the course, devise the educational strategies, and assess their learning themselves. If a teacher is available in this situation, a skilled instructor might be able to process information rapidly enough so that as learners identify goals and devise strategies, the instructor could make suggestions for better or alternative strategies. In such a case the teacher's knowledge of instructional design may be very helpful in his consultant role; however, he may not have time to employ much of the instructional design process and principles. In a situation without prespecified learning goals, if a teacher is not available, then the responsibility for structuring the learning experience rests totally on the learners, and their success depends on their own cognitive strategies, prior knowledge, and motivation. The educational process rests on an almost completely *generative* strategy (see Chapter 7 for a discussion of instructional strategies).

In addition to goal-free learning environments, there are many other problems and situations that are not amenable to instructional design. (In Chapter 3 we will discuss solutions, such as management, policy, and incentives, that are not instructional solutions). Finally, instructional design is not intended to take the place of expertise in particular teaching methods for individual subject areas (although instructional design can be a helpful undergirding for such methods).

People Who Do Instructional Design

Training Designers

Probably the most identifiable group of individuals who practice instructional design are trainers of adults in business, industry, government, and private agencies. Trainers may be part of a Human Resources Department or they may have their own separate department. They may work in a centralized location, consulting with any of the divisions of the organization that may request their assistance, or they may be permanently attached to a particular division, providing all of the training that that division requires.

Not all trainers are instructional designers. Some trainers are experts in their skill or subject area, who are either permanently or temporarily assigned to conduct training in that area. Other trainers are technical writers, videographers, or other production specialists and have high skill levels in communication within their medium. Many trainers come from an adult education background that emphasizes adult development. Human Resource Development (HRD) programs also prepare trainers for employment in this area.

Many instructional designers who are involved in training design have developed additional competencies in a more inclusive specialty that is termed "performance technology." These individuals are prepared to develop interventions that address contributors to poor employee performance (other than not knowing how to do the job). These other causes are discussed in Chapter 3 in the section on "needs assessment." The trend toward preparing instructional designers as performance technologists is discussed in Chapter 20.

Teachers as Designers

Some individuals employed as teachers are directly involved in the design of new instruction (or new "curricula," as is more commonly described in public and private K–12 and postsecondary education). These teachers may be involved in ongoing and long-term projects. Certainly, instructional design procedures and principles can be employed effectively in their curriculum design and development activities. These instructional design practices may be as formal, precise, and well documented as any other instructional design project due to the need for group communication and the development of a record that codifies the decisions that they have made and why they have made them.

Do teachers not involved in curriculum design projects use instructional design principles and procedures? Indeed they do. Although they may receive goal statements based on statewide initiatives, they do consider these goals, and may add goals or identify subgoals (objectives) that will lead to these goals with aid from curriculum guides, textbooks, or their own task analysis reflection. Teachers select or develop activities and information sources that will assist learners in reaching these goals. The development of engaging activities seems to be a particular strength of practicing teachers. Teachers also select or develop ways to assess learners' progress toward reaching goals. These assessment approaches may include written tests, performance tests, observation, oral questioning, and a variety of other techniques for assessing learning. Teachers use information from their testing to revise their instruction, especially for remediation. These design activities are completed both planfully in advance of implementation and spontaneously as circumstances suggest their use.

Both teachers who have taken courses in instructional design and teachers who have not engage in these types of instructional design activities (Martin, 1990). However, those trained in systematic instructional design tend to engage in these activities more consistently, thoroughly, and reflectively than their untrained colleagues (Reiser & Mory, 1991). Most often, these instructional design activities are conducted mentally with little documentation of the decisions made.

Other Designers

Instructional designers are also engaged in developing instruction that is embodied in textbooks, multimedia, instructional software, and videos used in K–12 and postsecondary settings. Such individuals are often employed in settings such as publishing houses and regional educational laboratories. We also see instructional designers as members of development teams of educational videos, such as "Sesame Street" and "Reading Rainbow."

Exercises

1. What activities other than those of an engineer are similar to the role of an instructional designer? Describe these similarities in your own words.

2. Following is a description of the design procedures that an instructional designer is conducting. Identify by writing on the line beside the description which phase—analysis (A), strategy development (SD), or evaluation (E)—the designer is completing.

_____a. The designer determines that the prospective learners are able to read (on the average) at the ninth-grade reading level.

_____b. The designer decides to use a simulation method as part of training a department store's customer service representatives.

_____c. The designer determines what the learners need to know in order to learn to balance chemical equations.

_____d. After a tryout of the prototype of a computer-based instruction (CBI) lesson on writing instructional objectives, the designer adds additional practice items on identifying the "conditions" of an objective.

_____e. The designer writes test items to assess whether learners have achieved the objectives of a CBI lesson.

3. Which of the following activities would be education, instruction, training, and/ or teaching? Circle the term or terms that apply.

a. The teacher presents a lesson in which she hopes that the learners will learn the difference between polygons and nonpolygons. She has carefully planned activities in which she will present examples and nonexamples of polygons and will help students determine the differences. She will test the students at the end of instruction to confirm that they have learned to identify those geometric figures that are polygons.

education instruction teaching training

b. The instructional designer for a large corporation has developed a print-based instructional package for managers who are involved in hiring to prepare them to follow legal practices during the hiring process. The learning materials inform them of the rules and show them examples and nonexamples of the rules' application. The tests provide a copy of an interview dialog between a manager and a potential employee. The learners must indicate whether all laws were followed. If they were not followed, learners must identify which laws were broken and what should have been said to avoid breaking the law.

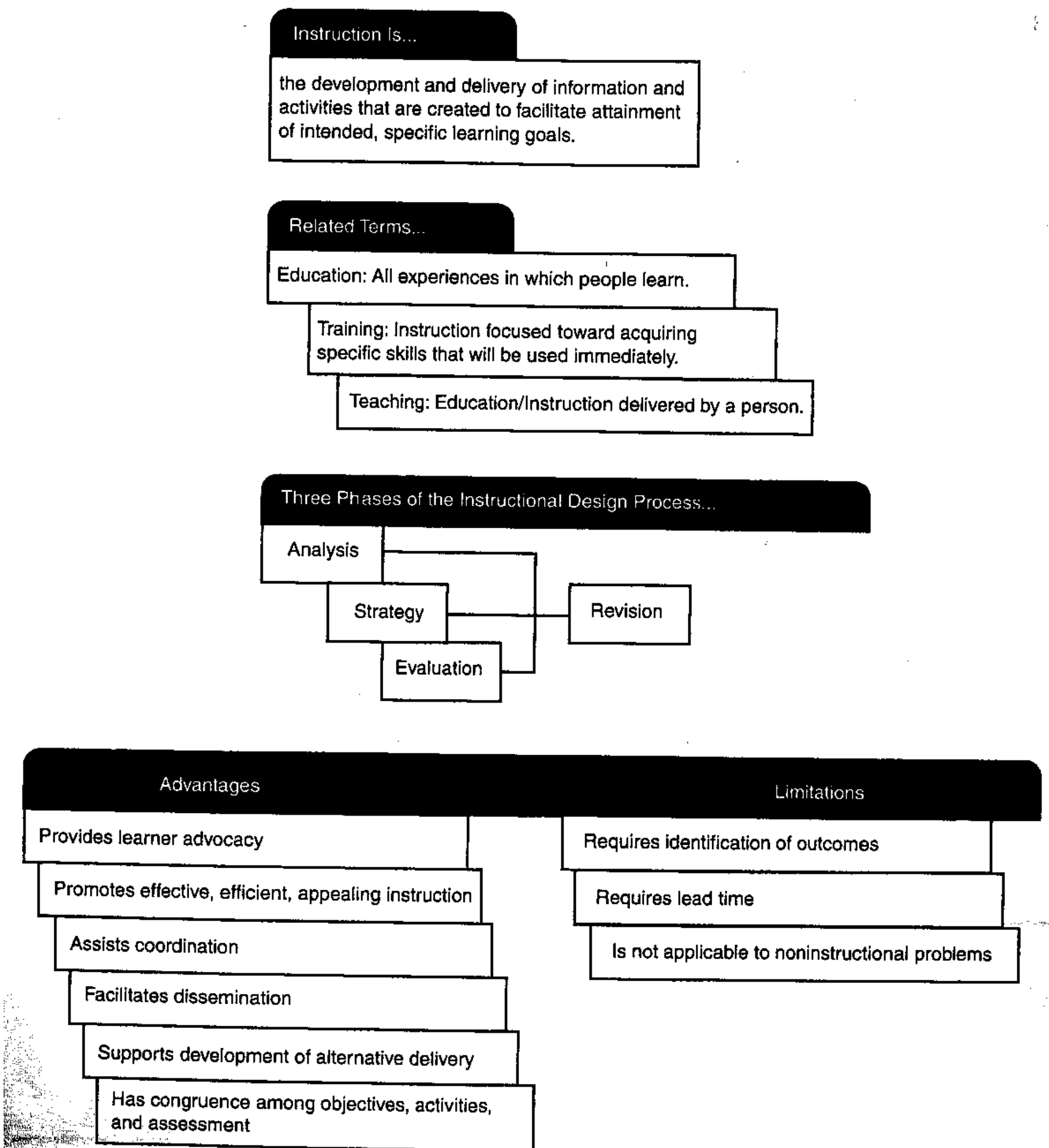
education instruction teaching training

c. A television documentary presents information on types of whales, where whales live, what whales do, what whales eat, and the history of whales. Viewers tend to remember and learn different things from the program depending on what they already knew and their interests.

education instruction teaching training

Summary

One of the reasons that the quality of much instructional material is poor is because it is not carefully planned. Instructional design activities offer a process for the systematic planning of instruction that may improve the effectiveness of the materials. The design process includes the activities of analysis, strategy development, evaluation, and revision. Although the instructional design process may often be portrayed as linear, in practice it is frequently iterative, moving back and forth between activities as the project develops. Some implementations of instructional design include rapid prototyping in which a trial version of the completed instructional plans and materials are produced early during the process and are revised and elaborated upon as new information becomes available. The components of instruction—goals, learning activities and information resources—and assessment tools, which are the products of the design process, should be congruent with each other. Before you begin actually designing and producing your own materials, you will learn in the following chapters a few of the fundamental principles and procedures of instructional design. Figure 1.4 summarizes the major points in this chapter thus far.



Summary Diagram for Chapter 1

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two Foundations of Instructional Design

Chapter Objectives

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

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

Why Discuss Philosophy and Theory in an Instructional Design Text?

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

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

This chapter briefly describes philosophies and theories that have formed the basis of instructional design. It is an introductory treatment and is not intended to represent a sufficient background of theory or philosophy for professional instructional designers. We recommend that the education of instructional designers include as much preparation in learning theory and instructional theory as possible. In addition, it should also include as much reading as possible about philosophy as it relates to learning and instruction. In particular, references by Anderson (1995); Driscoll (1994); E. Gagné, C. Yekovich, and F. Yekovich (1993); R. Gagné (1985); and Jonassen (1997) will supply critical learning theory background for instructional designers. These and other references at the end of the chapter should provide a good starting point.

The Philosophical Perspectives of Instructional Designers

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

Fields of study, such as instructional design, do not have educational philosophies; people who study in these fields do. This personal nature of educational philosophy makes it very difficult to make general statements about a particular philosophical perspective. However, we will briefly describe three educational philosophies that seem to have a strong influence on instructional designers. We will begin with constructivism, as it is the most recently popular position within many educational communities. After discussing constructivism, a much shorter treatment of two other commonly held philosophical perspectives, empiricism and pragmatism, will be presented. Space does not permit a full discussion of philosophical systems, but the treatment here of a few particularly relevant philosophies should assist in providing perspective on differing fundamental orientations.

Constructivism

Constructivism is an educational philosophy within a larger category of philosophies that are described as "rationalism." A rationalist philosophy is characterized by the belief that

*Some readers may find the discussion of constructivism irrelevant, uninteresting, or difficult to follow. If you do find it difficult to "connect" with it, we urge you to skim it briefly and come back to it at some time in the future, particularly after reading the section on "generative instructional strategies" in Chapter 7 or after reading Chapter 8's discussion of strategies for instruction in problem solving. However, we do hope that you will read and reflect on this section at some point, as it examines some Really Big Questions regarding the nature of knowledge and how we come to acquire it (epistemology).

reason is the primary source of knowledge and that reality is constructed rather than discovered. Most rationalists would propose that there is not a single reality to be discovered, but that each individual has constructed a personal reality.

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

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

Individual Constructivism

The key assumptions of individual constructivism are the following:

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

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

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

Radical constructivists propose that since learners' particular combination of prior experiences are unique, it is inappropriate to propose goals for these learners because educators do not know what the learners' need or want to learn, and designers should not develop particular sequences of instruction, provide specific aids to learning, or restrict the content presented on the learning topic. More moderate constructivists suggest that the active and personal construction of meaning does not necessarily require that all of the responsibility for developing a learning environment be demanded of the learner. Some constructivist designers would propose that the amount of responsibility for arranging the situation for learning should be variable depending upon a number of learner, task, and context factors. (For more on this position, see our discussion of generative and supplantive learning strategies in Chapter 7.) Indeed, some designers who ascribe to the general tenets of individual constructivism would point out that to assume that individuals who neither possess an expert's knowledge in either a subject matter or in instructional design would have great difficulty in determining what they need to know in order to devise a satisfactory approach to acquire this knowledge. Delegating all information processing load of instruction on learners may place an unrealistic burden on most learners for the vast majority of learning goals. Of course, many contexts, both public education and training environments, have long-term goals that learners become competent as self-regulated, life-long learners. However, many educators suggest that this capability is acquired over time and is not an inherent ability of learners.

Social Constructivism

One key assumption follows:

- Learning is collaborative with meaning negotiated from multiple perspectives.

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

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

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

Contextualism

The key assumptions of contextualism are the following:

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

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

The second constructivist assumption that can be attributed to contextualism is that assessment should be "authentic." Swanson, Norman, and Linn (1995) proposed that authentic assessment is synonymous with "performance assessment," defining performance assessment as "testing complex, 'higher order' knowledge and skills in the real-world context in which they are actually used, generally with open-ended tasks that require substantial examinee time to complete" (p. 5). Authentic assessment is generally integrated in a seamless manner with learning activities, not as a separate event. Some constructivists would caution that although it is important that learners perceive assessment to be part of the process of learning, initial activities, or initial tries at solving a type of problem, should be considered "practice," which along with feedback would take place during the initial phases of learning. They would propose that all assessments are indicators of learning at some point in the learning process, but a more accurate reflection of what learners have learned can be obtained *after* some initial opportunities to process both practice and feedback.

Contributions and Limitations of Constructivism

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

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

Constructivism as it is currently and generally conceptualized is far from providing an adequate single basis from which instructional designers can operate. Indeed, there are educational scholars who suggest that constructivism has no implications at all for instruction (e.g., Gruender, 1996). Constructivism is frequently presented as a theory but we concur with a number of scholars that it is an educational philosophy that particularly addresses epistemology. Indeed, constructivism has very little to offer as a theory that explains the processes that occur in the cognition that accompanies learning. Many constructivists reject the explanations of learning cognitions offered by information processing theory, but as yet, they have not proposed a substitute theory. Some constructivists' concentration on the relationship of perception, action, and the environment might put them closer to behaviorism than would make them comfortable (Anderson, 1995).

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

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

[illegible] the greatest danger that we perceive regarding [illegible]ism is that practitioners in our own field will be [illegible] by extreme positions to eliminate from their prac-[illegible] of the most singular and beneficial tools of instruc-[illegible] design. For example, some constructivists would rec-[illegible] the elimination of statements of goals and [illegible] Of course, untold harm has been done by educa-[illegible] goals and objectives to describe relatively trivial [illegible] failing to express the difficult-to-portray goals [illegible] that reflect higher-order thinking, such as problem solving. However, goals and objectives do not lead to trivial and low-level learning; low-level goals do. With effort, learning goals can represent the high-level goals that constructivists advocate. Some constructivists advocate the elimination of task analysis and the identification of prerequisite learning, suggesting that they lead to piecemeal and inert knowledge. Of course, it is how these task and prerequisite analyses are used that can lead to disconnected learning, not the tools themselves. Certainly there are occasions that the degree of precision with which these tools are used may be less or more (Wedman & Tessmer, 1990); however, this does not suggest that the tools should not be in an instructional designer's repertoire. Dunn (1994) suggested that the tools of objectives, learning analysis, and evaluation are instructional design tools that would allow constructivist designers to meet their goals of higher-order learning more effectively.

Empiricism

A second philosophical tradition is empiricism, sometimes termed *objectivism*, and it postulates that knowledge is acquired through experience. Most empiricists would propose that this experience allows an individual to come to know a reality that is objective and singular. That is, most experience is defined as sensory experience, as opposed to any "experience" that one might obtain through a "mental life" of reconceptualization and interpretation. Empiricism is also often typified by "reductionism," efforts to reduce complex entities to their more simple components, and "associationism," a tendency to relate ideas if they are experienced contiguously in either space or time. John Locke (1689) is often identified as a major empiricist philosopher. Locke is well known for his belief that little, if any, knowledge or ability comes "wired" in an individual. Not all empiricists would agree with this perspective.

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

Pragmatism might be considered a "middle ground" between rationalism (constructivism) and empiricism (Driscoll, 1994). Although pragmatists, like empiricists, believe that knowledge is acquired through experience, they believe that this knowledge is interpreted through reason and is temporary and tentative. Most pragmatists are not too concerned with whether there is a common reality, such as general principles of learning that are "out there" to be discovered. Pragmatists propose that the question of whether there is a "real" reality is an unproductive question, since, if there is a reality, it can never be totally known. When faced with the issue of reality, pragmatists "would simply like to change the subject." (Rorty, 1982, p. xiv). Pragmatists suggest that knowledge in a particular field is negotiated based upon an agreement of experts as to a common interpretation of experience. They would describe knowledge in terms of "truth for now." Pragmatists propose that knowledge is built up by testing this "truth for now" hypothesis and revising or discarding this "truth" as common experience and interpretation implies it should be modified.

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

Assumptions Underlying Instructional Design

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

1. To design instruction, the designer must have a clear idea of what the learner should learn as a result of the instruction.

2. The "best" instruction is that which is effective (facilitates learners' acquisition of the identified knowledge and skills), efficient (requires the least possible amount of time necessary for learners to achieve the goals), and appealing (motivates and interests learners, encouraging them to persevere in the learning task).

3. Students may learn from many different media; a "live teacher" is not always essential for instruction.

4. There are principles of instruction that apply across all age groups and all content areas. For example, students must participate actively, interacting mentally as well as physically with material to be learned.

5. Evaluation should include the evaluation of the instruction as well as the evaluation of the learner's performance. Information from the evaluation of instruction should be used to revise the instruction in order to make it more efficient, effective, and appealing.

6. When the purpose of assessment is to determine whether learners have achieved learning goals, the learners should be evaluated in terms of how nearly they achieve those instructional goals rather than how they "stack up" against their fellow students.

7. There should be a congruence among goals, learning activities, and assessment. Along with learners' characteristics and learning context, learning goals should be the driving force behind decisions about activities and assessment.

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

What Is a Theory?

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

Major Theory Bases Contributing to Instructional Design

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

Learning Theories

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

(1985, p. 2). Mayer (1982) elaborated on this concept in his definition of learning:

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

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

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

Behaviorism

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

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

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

The principles of behaviorism in terms of classical and operant conditioning, specifically the influence of reinforcers in building stimulus-response associations, have relatively no influence on instructional design practice today. (This assertion is also supported by Case and Bereiter, 1984.) However, some of the applications of behaviorism, such as programmed instruction, have had a lasting impact. Although programmed instruction did not revolutionize education as many thought it would, its legacy has been significant. Innovations that were a part of programmed instruction include recognition that effective nonhuman mediated instruction could be developed and that evaluation and revision of the materials through an empirical test of their effects could improve the effectiveness of instruction. As you can see from the key assumptions of instructional design listed earlier in this chapter, these two ideas are major building blocks in the principles of instructional design. They have had an enormous impact on the design of quality instruction for education and training contexts.

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

Cognitive Learning Theories

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

> (a) the view of learning as an active, constructive process; (b) the presence of high-level processes in learning; (c) the cumulative nature of learning and the corresponding role played by prior knowledge; (d) concern for the way knowledge is represented and organized in memory; and (e) concern for analyzing learning tasks and performance in terms of the cognitive processes that are involved. (p. 415)

Clearly, cognitive learning theory focuses on explaining the development of cognitive structures, processes, and representations that mediate between instruction and learning. In attending to these structures and processes, the role of the learner as an active participant in the learning process takes on great importance. The learner is viewed as constructing meaning from instruction, rather than being a recipient of meaning residing alone within instruction (a perspective that is very compatible with a constructivist philosophy). Therefore, cognitive learning theories attempt to explain learning in terms of cognitive processes, structures, and representations that are hypothesized to operate within the learner.

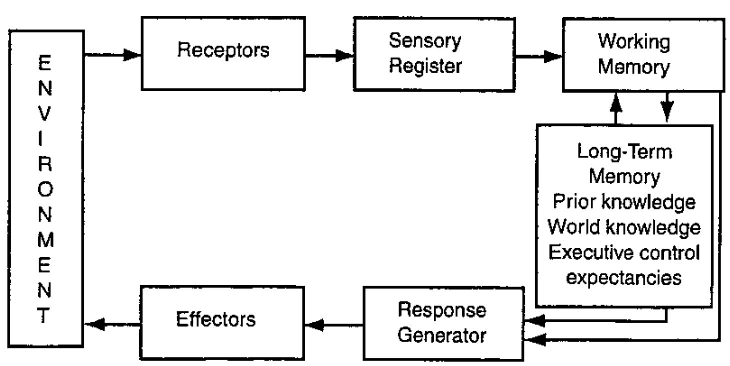
Information-Processing Theory

One of the most influential contributions from cognitive learning theory to instructional design practice is information-processing theory. Most current cognitive learning theorists advocate a theory (actually a set of theories) called *information processing*. **Information-processing theories**, in strong contrast to behavioral theories, describe learning as a series of transformations of information (i.e., processing) through a series of postulated structures within the brain. These structures currently are merely hypothesized and utilized to explain learning processes. To date, brain research has not identified specific locations of these particular structures, nor have information-processing theorists ever considered them in a physical sense. One of the most influential information processing theories is the conceptualization of "Multi-Store Models." These models explain learning as a series of transformations of information through several types of storage or memory. Atkinson and Shiffrin (1968) were the first to model a Multi-Store Model. R. Gagné's (1974) elaboration of this model illustrates the structures and processes of information processing (see Figure 2.1).

Two other influential information-processing theories, Schema theory (Rummelhart, 1980) and Level of Processing theory (Craik & Lockhart, 1972) were originally posited as alternatives to Multi-Store theory. However, in recent years they have been viewed more as theories that are compatible with Multi-Store theory and capable of explaining subprocesses or structures within it. In the following section we will briefly summarize these theories, but we encourage you to read more complete descriptions, such as those texts suggested earlier in this chapter.

Sensory Register and Selective Perception. We receive information from our environment through our sensory receptors, our senses. The sensations are converted to electrochemical messages and sent to the brain where these impulses are stored very briefly (approximately one quarter of a second for visual images [Sperling, 1960], slightly longer for auditory information) in a structure, or a cluster of structures, labeled the **sensory register**. Perceptions of many environmental stimuli enter this register, but very few receive the attention, sometimes termed **selective perception**, to be further processed within the brain. The unattended stimuli receive no further consideration. Without such a process, we would be overwhelmed by the multitude of environmental stimuli we encounter in every instant. Our prior experience,

Figure 2.1 An Information Processing Model of Learning and Memory



including our expectancies, values, and beliefs, influence the stimuli to which we attend. For example, you may have noticed how easily you overhear your own name in a conversation at a party, or how easily you can find your name in an extensive list.

Working Memory. Information to which attention has been paid passes into a structure called **working memory**, sometimes equated with an older concept called *short-term memory*. Working memory has been likened to a desktop or workbench, which is where everything actually happens but which can only hold a finite amount on its surface. Working memory is also similar to the RAM memory of a computer, which is certainly limited in size, but within which everything must at least momentarily reside to be processed. Working memory and other structures hypothesized by information theory are increasingly seen as dynamic and flexible entities, the qualities of which are seen in interaction with factors such as development and expertise (Case, 1993; Kantowitz, 1987).

Under traditional information-processing theory, working memory is characterized by its limited capacity, in terms of amount of information that it can retain (seven plus or minus two units of information [Miller, 1956]), and its short duration, in terms of the limited amount of time that information can be retained there (10 seconds [Murdock, 1961] to 20 seconds [R. Gagné, 1985]). As you can see from the bidirectional arrows in Figure 2.1, there is continuous transfer of information between long-term and working memory. Information is brought out of long-term memory into working memory (retrieval) in order to make sense out of new, incoming information. This activity is controlled by executive control processes. Not all information that enters working memory is transferred to long-term memory. We have all experienced such a dropout of information when we have retained a phone number only long enough to be able to redial it. We can keep that information in working memory longer than 10 to 20 seconds by rehearsing or repeating it. However, such a process would be an impossible method to retain all the information we need. Therefore, information that we remember for more than a short period of time is transferred, or encoded, into long-term memory.

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

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

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

In addition to network-based representations, some scholars suggest a specific type of propositional networks termed *schemata* (the singular is *schema*). **Schemata** are data structures that represent the generic concepts, such as "face," "restaurant," and "burglary," that are stored in memory and have "slots" that are filled with information related to a specific situation (Rummelhart, 1980). Other scholars propose another type of memory representation termed *mental model*. **Mental models** are similar to schemata but in addition to the concepts and their relationships that are stored in schema, mental models contain information about task demands and task performances that are used for problem solving. Theorists suggest that learners use a mental model representation to store information regarding how machines work or how situations are organized. Cognitive theorists, such as Anderson (1995), suggest that a different type of knowledge (i.e., procedural knowledge) is stored and represented in a form quite different from propositions. They theorize that procedural knowledge is stored in a *production*, an IF-THEN statement that connects conditions (in the IF part of the production) with actions (in the THEN part of the production). (We will provide a lot of examples of these productions in Chapter 5 and later chapters that discuss intellectual skills.)

In recent years **connectionism** has attempted to describe how thinking might occur at the neuron-level without permanent memory representations. According to Parallel Distributed Processing theory (McClelland & Rummelhart, 1988), information is represented in patterns of activation among neural elements. These basic elements are nodes that are subsymbolic; that is, they alone do not constitute a concept or rule. It is the pattern of activation among neurons that creates meaningful constructs, such as concepts and principles. Input from the environment activates the connections among nodes, making some links stronger and others weaker. So some links have stronger weights than others. (This concept of "weight of memory link" is reminiscent of the "strength of a memory trace" described earlier in the discussion of Levels of Processing.) Bereiter (1991) pointed out that according to theory, all knowledge resides in weights themselves.

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

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

Retrieval and Response Generator. As we described earlier, memories of relevant information are retrieved from long-term memory into working memory to allow us to understand incoming information and in order to integrate the new information with the old. In some cases, this information is simply re-coded in its enriched form and restored in long-term memory. In other cases, in addition to this re-coding and storage, people may act upon the information by speaking or writing an answer, manipulating objects, or any of a number of other physical responses. The form, organization, and sequence of the response is determined by the response generator. This information is sent to the effectors, muscles, nerves, and glands, which in turn act and affect the environment.

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

Influence of Cognitive Psychology on Instructional Design. We will now briefly review how each of the phases of design (analysis, strategy development, and evaluation) is affected by cognitive psychology.

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

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

One of the points at which cognitive psychology has had its strongest influence is in the way that a learning task is analyzed. In the past, a task was analyzed by noting the observable behaviors that had to be completed to do a particular task. This procedure has been greatly enriched and supplemented by attention to the mental tasks required in order to perform the observable tasks. This type of analysis is called an *information-processing analysis* or a *cognitive task analysis.* Some designers may even analyze the difference between the ways novices and various levels of experts complete mental and physical tasks in order to understand the levels of expertise that can be learned. This emphasis on the cognitive as well as the performance aspects of the task is reflected in the types of goals and objectives that are developed. Attention is given within objectives to tapping the "understanding" underlying a performance. For example, it is not uncommon to find objectives that ask learners to explain the reasoning processes behind their performance.

The development of the instructional strategy is the area in which cognitive psychology, including gestalt psychology, has its greatest influence. Instructional designers draw upon the conclusions of cognitive psychologists' research to infer principles for design. Where no conclusive research findings exist, designers draw upon theories themselves to infer instructional treatments that may support particular learning outcomes. Gestalt psychology, in particular, influences the techniques used in instructional message display (the way information is arranged on a page or screen). The chapters on strategy development in this text contain many references to this influential research and theory.

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

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

Developmental Theories

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

Piaget

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

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

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

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

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

Vygotsky

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

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

Information-Processing Developmental Theories

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

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

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

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

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

Contributions to Instructional Design

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

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

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

Instructional Theories

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

> Theories of instruction attempt to relate specified events comprising instruction to learning processes and learning outcomes, drawing upon knowledge generated by learning research and theory. Often instructional theories are prescriptive in the sense that they attempt to identify conditions of instruction which will optimize learning, retention, and learning transfer. . . . To be classified as theories, these formulations may be expected, at a minimum,

to provide a rational description of causal relationships between procedures used to teach and their behavioral consequences in enhanced human performance. (p. 264)

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

As an example, we will describe one general instruction theory—Bloom's Model of Mastery Learning. In addition, many other instructional theories will be described throughout the text, including Gagné's Theory on Conditions of Learning, Reigeluth's Elaboration Model, Collins's Theory of Inquiry Teaching, and Keller's ARCs Model of Motivation.

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

Through the years, Bloom has proceeded to investigate variables within learners and instruction that can be altered to promote "mastery learning" for almost all learners. He has identified two learner characteristics—cognitive entry behaviors and affective entry behaviors—and quality of instruction as factors that can be altered to promote mastery (Bloom, [illegible]). In his discussion of cognitive entry behaviors, he supported the identification of specific task prerequisites within instruction. If entry skills are missing, he suggested a number of ways to ameliorate the situation. With regard to affective [illegible] behaviors, Bloom asserted that learners "vary in what [illegible] are emotionally prepared to learn as expressed in their [illegible] attitudes, and self-views" (p. 74). While he felt that [illegible] affective characteristics may be difficult to change, he [illegible] that quality instruction that promotes successful [illegible] experiences and ensures that the learner finds re-[illegible] successful experiences will aid in promoting a posi-[illegible] toward learning.

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

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

The instructional theories included in this text are not exhaustive. There are a number of other theories that might be included. We attempted to select those theories that have had or that we expect to have the greatest impact in the field. Refer to Reigeluth's texts on instructional design theories (1983, 1987) and Gagné and Dick's review article of instructional psychology (1983) for additional information in this area.

Exercises

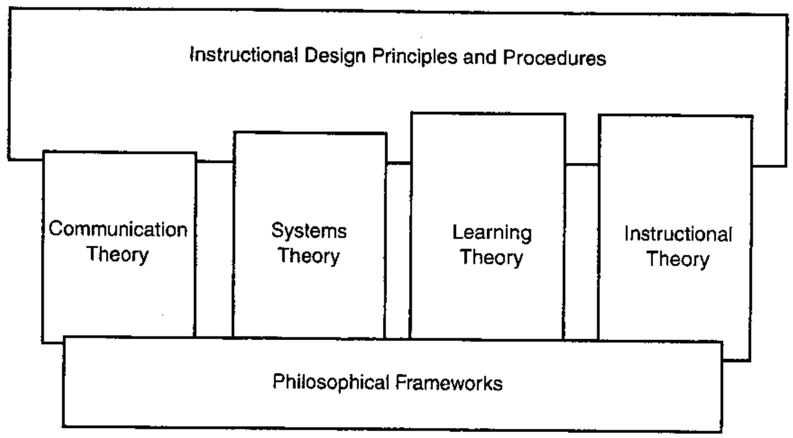
1. In your own words, explain why it is important for instructional designers to be able to describe and explain the philosophical foundations and theory bases of their field.
2. Discuss how the major educational philosophies of constructivism/rationalism, empiricism, and pragmatism relate to behaviorism and cognitive learning theories.
3. Describe the major differences between behaviorism and cognitive learning theories.

4. Ted is sitting in class listening to his teacher explain the difference between the concepts "liberal" and "conservative." Using the model of information processing described in this chapter, explain how this information flows through Ted's cognitive processes and structures. Give particular attention to the processes of selective perception, encoding, and retrieval.

Summary

Both philosophy and theory provide foundations for instructional designers. In the first section of this chapter, we attempted to portray how educational philosophies may influence educators' beliefs about what knowledge is and how it is acquired. In the subsequent section we discussed another way of viewing these same questions via the development and testing of learning theories. While this chapter does not exhaustively cover the philosophies and theories that have contributed to instructional design, it is our goal that as you read subsequent chapters, you will be able to relate assertions and principles that are stated to their particular philosophy and theory base. We also hope that we have pointed you toward additional sources of information to which you may refer throughout your career. Figure 2.2 summarizes key points in this chapter.

Figure 2.2 Summary Diagram for Chapter Two



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