CHAPTER 4 Learning

PREVIEW: KEY POINTS

1. Learning occurs when experience leads to a relatively permanent change in an individual's knowledge or behavior.
2. There are many explanations for learning, but the most useful are the behavioral, cognitive, and constructivist perspectives.
3. Behavioral explanations of learning emphasize the importance of antecedents (cues and prompts) and consequences (reinforcement and punishment) in shaping behavior.
4. Functional behavioral assessments with positive behavior supports and homework are applications of the behavioral approach.
5. Cognitive explanations of learning highlight the importance of prior knowledge in focusing attention, making sense of new information, and supporting memory.
6. Information processing is a cognitive theory of memory that describes how information is taken in; processed (combined with prior knowledge); stored in long-term memory in the forms of episodes, productions, images and schemas, and retrieved.
7. Learning strategies (overall plans for learning) and learning tactics such as underlining, highlighting, and graphing are applications of the cognitive approach.
8. Constructivist views of learning explain learning in terms of the individual and social construction of knowledge; knowledge is judged not so much by its accuracy as by its usefulness.
9. Situated learning emphasizes the idea that learning is specific to the situation in which it is learned and that it is difficult to transfer.
10. Features of constructivist applications include complex real-life tasks, social interaction and shared responsibility, multiple representations of content, and student-centered teaching.
11. Three promising applications of the constructivist approach are inquiry or problem-based learning, cognitive apprenticeships, and cooperative learning. Fostering Communities of Learners is a system for integrating inquiry, collaborating, and learning deep disciplinary content.

Leadership Challenge

Your school's social studies department is highly regarded for its innovative approach to teaching. The program is oriented toward inquiry as a process, rather than the retention of historical facts. Typically, curriculum is developed by the department. The teachers are enthusiastic about their program, and it is well received by the students. You do not always agree with the direction of the curriculum, but there is little question that this is a highly skilled and professional group of teachers whom you respect.

Recent reform in the state has argued for back to basics and the use of curricular materials that stress recall of specific persons, places, and events in state and national history. The reform is supported by a battery of state tests. Although the state maintained that no invidious comparisons would be made, your community has made them. The superintendent has her feet to the fire on this issue, and now you, too, are feeling the heat. Recent test scores show that your students are not doing nearly as well in history as they are in science and mathematics. The superintendent has "requested" that you integrate the state curricular materials into the history program to correct the current deficiencies. Your history faculty, on the other hand, claim that this is exactly the wrong tack to take to develop inquiring minds. They are not overly concerned with the students' performance on the state tests because they claim the tests measure the wrong thing. Parents, however, cannot understand why their children are not doing as well in history as they are in math and science; in fact, at the last board meeting the superintendent promised that the history scores would rise.

What do students need to "know" about history?

What is the role of rote memory in learning?

What do the behavioral, cognitive, and constructivist perspectives on learning have to offer?

How does one achieve the right balance of teaching facts and teaching for discovery and understanding?

Source: The above situation has been adapted from Hoy, W. K., & Tarter C. J., (1995). *Administrators solving the problems of practice: Decision making, concepts, cases, and consequences*: Boston: Allyn & Bacon.

What Is Learning?

Learning is at the center of schooling. Learning is a goal and a process—a noun and a verb. As a goal, learning (new knowledge and skills) is the outcome instructional leaders work toward as they interact with teachers. Learning is the teachers' goal with their students. But learning is also a process. In order to design useful learning environments in schools and classrooms, we must understand how people learn. The purpose of this chapter is to examine briefly what is known about learning so that your work with teachers and their work with students can be informed by and compatible with the ways that people learn. We will examine the contemporary contributions to education of three major perspectives on learning: behavioral, cognitive, and constructivist, noting specific strategies for teaching that are consistent with each perspective. Our goal is not to pick the "best" or most popular explanation of learning, but instead to use the best from each explanation, because each tells us something different and useful about the complex phenomenon that is human learning.

When we hear the word *learning*, most of us think of studying and school. We think about subjects or skills we intend to master, such as algebra, history, chemistry, or karate. But learning is not limited to school. We learn every day of our lives. Babies learn to kick their legs to make the mobile above their cribs move, teenagers learn the lyrics to all their favorite songs, and every few years we all learn to find a new style of dress attractive when the old styles go out of fashion. This last example shows that learning is not always intentional. We don't try to like new styles and dislike old; it just seems to happen that way. So what is this powerful phenomenon called learning?

In the broadest sense, **learning** occurs when practice or experience causes a relatively permanent change in an individual's knowledge, behaviors, or attitudes. The change may be deliberate or unintentional, for better or for worse (Hill, 2002). To qualify as learning, this change must be brought about by the interaction of a person with his or her physical or social environment. Changes due simply to maturation, such as growing taller or turning gray, do not qualify as learning. Temporary changes due to illness, fatigue, or hunger are also excluded from a general definition of learning. A person who has gone without food for two days does not learn to be hungry, and a person who is ill does not learn to run more slowly. Of course, learning plays a part in how we respond to hunger or illness.

Our definition specifies that the changes resulting from learning are in the individual's knowledge, attitudes, or behavior. Although most learning theorists would agree with this statement, some tend to emphasize changes in knowledge and attitudes, others the changes in behavior (Gredler, 2005; Swartz, Wasserman, & Robbins, 2002).

> Behavioral psychologists emphasize observable changes in behaviors, skills, and habits.
>
> Cognitive psychologists, who focus on changes in knowledge, believe learning is an internal mental activity that cannot be observed directly. Cognitive psychologists studying learning are interested in unobservable mental processes such as thinking, remembering, and solving problems.
>
> Constructivist psychologists, more commonly known as constructivists, are interested in how people make meaning; learning is seen as the construction of knowledge.

Different theories of learning have had different impacts on education and have supported different practices. In the 1960s and early 1970s, behavioral views of learning dominated education. But beginning in the 1980s, cognitive and constructivist explanations became more prevalent. Even though there are differences in these explanations, each provides insights about some aspect of learning, in part because they focus on different kinds of outcomes. Each perspective provides instructional leaders with tools for improving instruction. We begin our explorations of learning with the behavioral perspective.

Behavioral Views of Learning

The behavioral approach to learning developed out of work by Skinner and others who emphasized the role of antecedents and consequences in behavior change. Learning was defined as a change in behavior brought about by experience, with little concern for the mental or internal aspects of learning. Behavior, like response or action, is simply a word for what a person does in a particular situation. Conceptually, we may think of a behavior as sandwiched between two sets of environmental influences: those that precede it (its antecedents) and those that follow it (its consequences) (Skinner, 1950). This relationship can be shown very simply as antecedent–behavior–consequence, or A–B–C. As behavior is ongoing, a given consequence becomes an antecedent for the next ABC sequence. Research shows that behavior can be altered by changes in the antecedents, the consequences, or both. Early work focused on consequences.

Types of Consequences

According to the behavioral view, consequences determine to a great extent whether a person will repeat the behavior that led to the consequences. The type and timing of consequences can strengthen or weaken behaviors. Consequences that strengthen behaviors are called *reinforcers.*

Reinforcement. Although reinforcement is commonly understood to mean "reward," this term has a particular meaning in learning theory. A **reinforcer** is any consequence that strengthens the behavior it follows. So, by definition, reinforced behaviors increase in frequency or duration. The **reinforcement process** can be diagrammed as follows:

CONSEQUENCE EFFECT
Behavior ⟶ reinforcer ⟶ strengthened or repeated behavior

We can be fairly certain that food will be a reinforcer for a hungry animal, but what about people? It is not clear why an event acts as a reinforcer for an individual, but there are many theories about why reinforcement works. For example, some psychologists suggest that reinforcers satisfy needs, whereas other psychologists believe that reinforcers reduce tension or stimulate a part of the brain (Rachlin, 1991). Whether the consequences of any action are reinforcing probably depends on the individual's perception of the event and the meaning it holds for her or him (Landrum & Kauffman, 2006). For example, students who repeatedly get themselves sent to the principal's office for misbehaving may be indicating that *something* about this consequence is reinforcing for them, even if it doesn't seem desirable to their teachers.

There are two types of reinforcement. The first, called **positive reinforcement,** occurs when the behavior produces (adds) a new stimulus. Examples include wearing a new outfit producing many compliments, or, for a student, falling out of the chair producing cheers and laughter from classmates. When teachers claim that a student misbehaves "just to get attention," the teachers are applying a behavioral explanation based on positive reinforcement, assuming that attention is a positive reinforcer for the student.

Notice that positive reinforcement can occur even when the behavior being reinforced (falling out of a chair or disrupting math class) is not "positive" from the teacher's point of view. In fact, positive reinforcement of inappropriate behaviors occurs unintentionally in many classrooms. Teachers and principals help maintain problem behaviors by inadvertently reinforcing them. We once worked with a principal in a middle school who was concerned about a student. The boy had lost his father a few years earlier and was having trouble in a number of subjects, especially math. The student was sent to the office from math at least twice a week. When he arrived, the boy got the principal's undivided attention for at least ten minutes. After a scolding they talked sports because the principal liked the student and was concerned that he had no male role models. It is easy to spot the reinforcers in this situation, even though the principal did not mean to be part of the problem.

When the consequence that strengthens a behavior is the appearance (addition) of a new stimulus, the situation is defined as *positive* (+) reinforcement. In contrast, when the consequence that strengthens a behavior is the disappearance (subtraction) of a stimulus, the process is called **negative (−) reinforcement**. If a particular action leads to stopping, avoiding, or escaping an aversive situation, that action is likely to be repeated in a similar situation. A common example is the car seat belt buzzer. As soon as you attach your seat belt, the irritating buzzer stops. You are likely to *repeat* this "buckling up" action in the future (so the process is *reinforcement*) because the behavior made an aversive buzzing stimulus *disappear* (so the kind of reinforcement is *negative*).

The student who was repeatedly sent to the principal's office from math class not only spent time with the principal talking sports (positive reinforcement), he also escaped math class (negative reinforcement). Whatever the student did to get kicked out of math class is likely to continue (and it did) because the behavior led to both positive and negative reinforcers. The "negative" in negative reinforcement does not imply that the behavior being reinforced is necessarily bad. The meaning is closer to that of "negative" numbers—something is subtracted. Associate positive and negative reinforcement with adding or subtracting something following a behavior, leading to an increase in that behavior.

Punishment. Negative reinforcement is often confused with punishment. In fact, when you understand the difference between negative reinforcement and punishment, you will know more than most of your colleagues. The process of reinforcement (positive or negative) always involves strengthening behavior. **Punishment**, on the other hand, involves decreasing or suppressing behavior. A behavior followed by a "punisher" is *less* likely to be repeated in similar situations in the future. Again, it is the effect that defines a consequence as punishment, and different people have different perceptions of what is punishing. One student may find suspension from school punishing, while another student wouldn't mind at all. The process of punishment is diagrammed as follows:

$$\begin{array}{ccccc} & & \text{CONSEQUENCE} & & \text{EFFECT} \\ \text{Behavior} & \longrightarrow & \text{punisher} & \longrightarrow & \text{weakened or decreased behavior} \end{array}$$

Like reinforcement, punishment may take one of two forms. The first type has been called Type I punishment, but this name isn't very informative, so we use the term **presentation punishment**. It occurs when the presentation of a stimulus following the behavior suppresses or decreases the behavior. When teachers assign demerits, extra work, running laps, and so on, they are using presentation punishment. The other type of punishment (Type II punishment) we call **removal punishment** because it involves removing a stimulus. When teachers or parents take away privileges after a young person has behaved inappropriately, they are applying removal punishment. With both types, the effect is to decrease or slow down the behavior that led to the punishment. Figure 4.1 summarizes the processes of reinforcement and punishment we have just discussed.

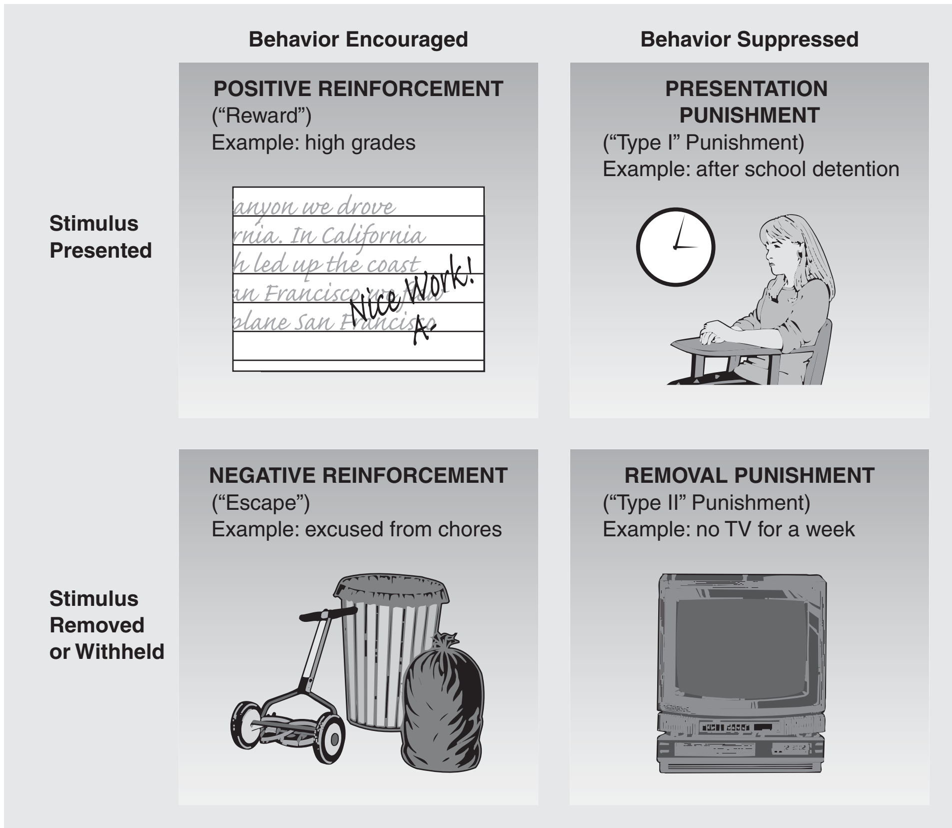

FIGURE 4.1 Kinds of Reinforcement and Punishment
Negative reinforcements and punishment are often confused. It may help you to remember that reinforcement is always associated with increases in behaviors, and punishment always involves decreasing or suppressing behavior.

Source: From Anita Woolfolk, *Educational Psychology: Active Learning Edition*, 10/e (p. 228). Copyright © 2008. Reprinted by permission of Allyn & Bacon.

Antecedents and Behavior Change

Antecedents. The events preceding behaviors, the **antecedents**, provide information about which behaviors will lead to positive consequences and which to negative. We all learn to discriminate—to read situations. When should a principal ask the board for additional resources, after a budget cut or when a good story about the school has appeared in the local paper? The antecedent cue of a school principal standing in the hall helps students discriminate the probable consequences of running or attempting to break into a locker. We often respond to such antecedent cues without fully realizing that they are influencing our behavior. But we can use cues deliberately.

Cueing. By definition, **cueing** is the act of providing an antecedent stimulus just before a particular behavior is to take place. Cueing is particularly useful in setting the stage for behaviors that must occur at a specific time but are easily forgotten. In working with young people, teachers often find themselves correcting behaviors after the fact. For example, they may ask students, "When are you going to start remembering to . . . ?" But the mistake is already made, and the young person is left with only two choices, to promise to try harder or to say, "Why don't you leave me alone?" Neither response is very satisfying. Presenting a nonjudgmental cue, such as a checklist, can help prevent these negative confrontations. When a student performs appropriately after a cue, the teacher can reinforce the student's accomplishment instead of punishing the student's failure.

Prompting. Sometimes students need help in learning to respond to a cue. One approach is to provide an additional cue, called a *prompt*, following the first cue. There are two principles for using a cue and a prompt to teach a new behavior. First, make sure the environmental stimulus that you want to become a cue occurs immediately before the prompt you are using, so students will learn to respond to the cue and not rely only on the prompt. Second, fade the prompt as soon as possible so students do not become dependent on it (Alberto & Troutman, 2006).

An example of cueing and **prompting** is providing students with a checklist or reminder sheet. Figure 4.2 is a checklist for the steps in peer tutoring. Working in pairs is the cue; the checklist is the prompt. As students learn the procedures, the teacher may stop using the checklist, but may remind the students of the steps. When no written or oral prompts are necessary, the students have learned to respond appropriately to the environmental cue of working in pairs; they have learned how to behave in tutoring situations. But the teacher should continue to monitor the process, recognize good work, and correct mistakes. Before a tutoring session, the teacher might ask students to close their eyes and "see" the checklist, focusing on each step. As students work, the teacher could listen to their interactions and continue to coach students as they improve their tutoring skills.

Principals and teachers can make good use of behavioral principles, particularly in their wise and caring applications of reinforcement and punishment. The Theory into Action Guidelines give examples that will help your teachers apply the behavioral theory described above. Instructional leaders not only need to know the theory; they must be able to demonstrate and apply it as they work with their teachers.

Teaching Applications of Behavioral Theories

The behavioral approach to learning has made several important contributions to instruction, including systems for specifying learning objectives (we will look at this topic in Chapter 6 when we discuss planning and teaching) and class management systems such as group consequences, token economies, and contingency contracts. These

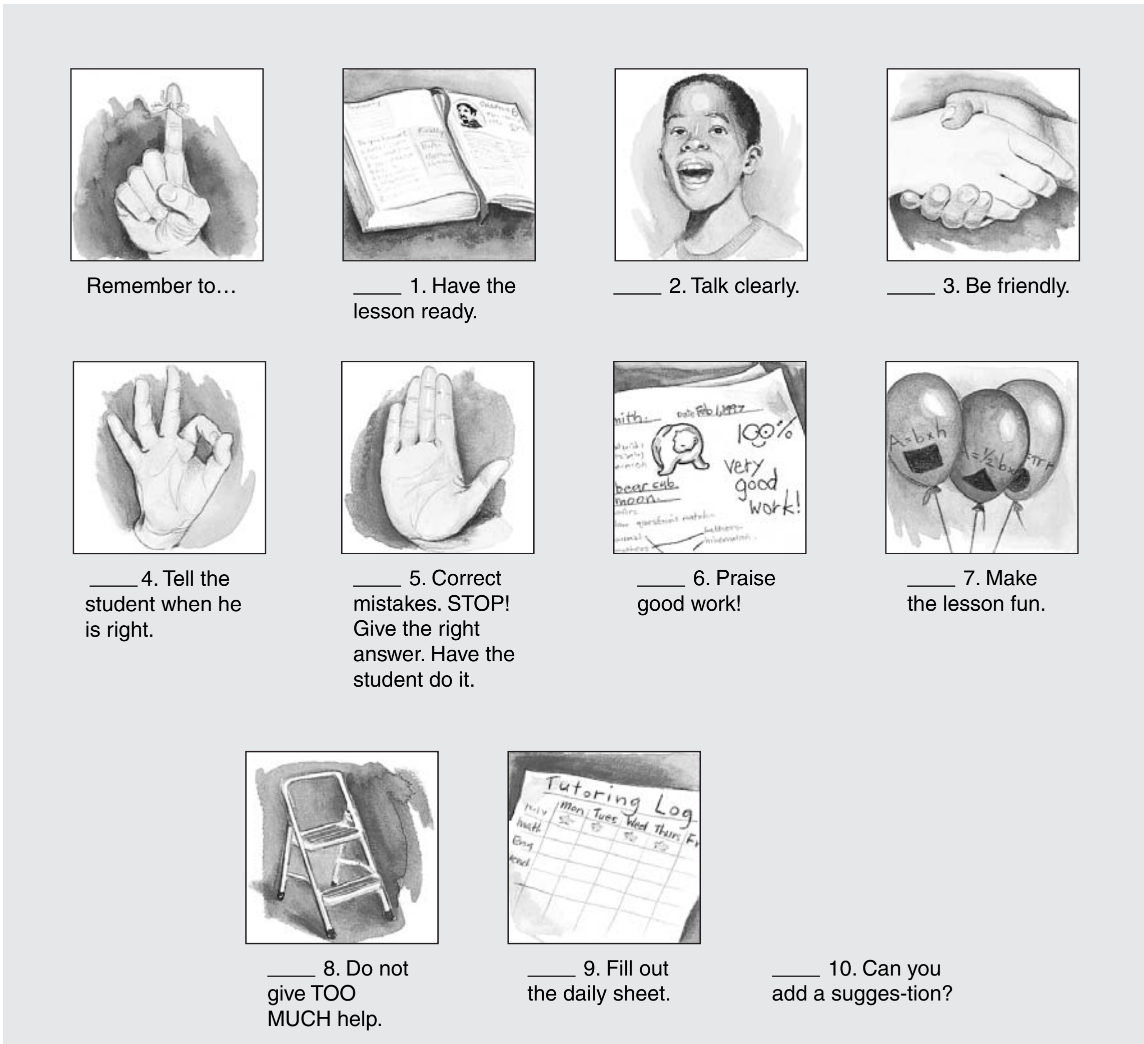

FIGURE 4.2 Written Prompts: A Peer-Tutoring Checklist
By using this checklist, students are reminded how to be effective tutors. As they become more proficient, the checklist may be less necessary.

Source: From *Achieving Educational Excellence: Behavior Analysis for School Personnel* (Figure, p. 89), by B. Sulzer-Azaroff and G. R. Mayer, 1994, San Marcos, CA: Western Image, P. O. Box 427. Copyright © 1994 by Beth Sulzer-Azaroff and G. Roy Mayer. Reprinted by permission of the authors.

approaches are especially useful when the goal is to learn explicit information or change behaviors and when the material is sequential and factual (Alberto & Troutman, 2006; Kazdin, 2001). As an example of a teaching approach, let's consider a system that supports students' positive behaviors rather than punishing mistakes.

THEORY INTO ACTION GUIDELINES

Using Reinforcement and Punishment

Associate positive, pleasant events with learning tasks.

Examples

1. Emphasize group competition and cooperation over individual competition. Many students have negative emotional responses to individual competition that may generalize to other learning.
2. Make division drills fun by having students decide how to divide refreshments equally, then letting them eat the results.
3. Make voluntary reading appealing by creating a comfortable reading corner with pillows, colorful displays of books, and reading props such as puppets (see Morrow & Weinstein, 1986, for more ideas).

Help students to risk anxiety-producing situations voluntarily and successfully.

Examples

1. Assign a shy student the responsibility of teaching two other students how to distribute materials for map study.
2. Devise small steps toward a larger goal. For example, give ungraded practice tests daily, and then weekly, to students who tend to "freeze" in test situations.
3. If a student is afraid of speaking in front of the class, let the student read a report to a small group while seated, then read it while standing, then give the report from notes instead of reading it verbatim. Next, move in stages toward having the student give a report to the whole class.

Be clear, systematic, and genuine in giving praise.

Examples

1. Make sure praise is tied directly to appropriate behavior.
2. Make sure the student understands the specific action or accomplishment that is being praised. Say, "You returned this poster on time and in good condition," not, "You were very responsible."
3. Tie praise to students' improving competence or to the value of their accomplishment. Say, "I noticed that you double-checked all your problems. Your score reflects your careful work."

Attribute the student's success to effort and ability so the student will gain confidence that success is possible again.

Examples

1. Don't imply that the success may be based on luck, extra help, or easy material.
2. Ask students to describe the problems they encountered and how they solved them.

When students are tackling new material or trying new skills, give plenty of reinforcement.

Examples

1. Find and comment on something right in every student's first life drawing.
2. Reinforce students for encouraging each other. "French pronunciation is difficult and awkward at first. Let's help each other by eliminating all giggles when someone is brave enough to attempt a new word."

After new behaviors are established, give reinforcement on an unpredictable schedule to encourage persistence.

Examples

1. Offer surprise rewards for good participation in class.
2. Start classes with a short, written extra-credit question. Students don't have to answer, but a good answer will add points to their total for the semester.
3. Make sure the good students get compliments for their work from time to time. Don't take them for granted.

Make sure all students, even those who often cause problems, receive some praise,

(continued)

THEORY INTO ACTION GUIDELINES Continued

privileges, or other rewards when they do something well.

Examples

1. Review your class list occasionally to make sure all students are receiving some reinforcement.
2. Set standards for reinforcement so that all students will have a chance to be rewarded.
3. Let students suggest their own reinforcers or choose from a "menu" of reinforcers with "weekly specials."

Be consistent in your application of punishment.

Examples

1. Avoid inadvertently reinforcing the behavior you are trying to punish. Keep confrontations private, so that students don't become heroes for standing up to the teacher in a public showdown.
2. Let students know in advance the consequences of breaking the rules by posting major class rules for younger students or outlining rules and consequences in a course syllabus for older students.
3. Tell students they will receive only one warning before punishment is given. Give the warning in a calm way, then follow through.
4. Make punishment as unavoidable and immediate as is reasonably possible.

Focus on the students' actions, not on the students' personal qualities.

Examples

1. Reprimand in a calm but firm voice.
2. Avoid vindictive or sarcastic words or tones of voice. You might hear your own angry words later when students imitate your sarcasm.
3. Stress the need to end the problem behavior instead of expressing any dislike you might feel for the student.

Adapt the punishment to the infraction.

Examples

1. Ignore minor misbehaviors that do not disrupt the class, or stop these misbehaviors with a disapproving glance or a move toward the student.
2. Don't use homework as a punishment for misbehaviors like talking in class.
3. When a student misbehaves to gain peer acceptance, removal from the group of friends can be effective, since this is really time out from a reinforcing situation.
4. If the problem behaviors continue, analyze the situation and try a new approach. Your punishment may not be very punishing, or you may be inadvertently reinforcing the misbehavior.

Functional Behavioral Assessment and Positive Behavior Support

Teachers in both regular and special education classes have had success with a new approach that begins by asking, "What are students getting out of their problem behaviors –what functions do these behaviors serve?" The focus is on the why of the behavior, not on the what (Lane, Falk, & Wehby, 2006). The reasons for problem behaviors generally fall into four categories (Barnhill, 2005; Maag & Kemp, 2003). Students act out to:

1. receive attention from others—teachers, parent, or peers;
2. escape from some unpleasant situation—an academic or social demand;
3. get a desired item or activity;
4. meet sensory needs, such as stimulation from rocking or flapping arms for some children with autism.

If the reason for the behavior is known, then the teacher can devise ways of supporting positive behaviors that will serve the same "why" function. For example, in the situation we described earlier, the student who was repeatedly sent out of math class to the principal's office, it is easy to spot the function of the classroom disruptions—they always led to (1) escape from math class (negative reinforcement) and (2) one-on-one time with the principal (positive reinforcement after a little bit of reprimanding). Working with the principal and math teacher, we developed a way to support the students positive behaviors in math by getting him some extra tutoring and by giving him time with the principal when he completed math problems instead of when he acted up in class. The new positive behaviors served many of the same functions as the old problem behaviors.

Discovering the "Why": Functional Behavioral Assessments. The process of understanding a problem behavior is known as **functional behavioral assessment** (FBA)—"a collection of methods or procedures used to obtain information about antecedents, behaviors, and consequences to determine the reason or function of the behavior" (Barnhill, 2005, p. 132). Many different procedures might help you determine the functions of a behavior. You can simply interview students about their behaviors. In one study, students were asked to describe what they did that got them in trouble in school, what happened just before, and what happened right after they acted out. Even though the students were not always sure why they acted out, they seemed to benefit from talking to a concerned adult who was trying to understand their situation, not just reprimand them (Murdock, O'Neill, & Cunningham, 2005). You also can observe students with these questions in mind: When and where does the problem behavior occur? What people or activities are involved? What happens right before—what do others do or say and what did the target student do or say? What happens right after the behavior—what did you, other students, or the target student do or say? What does the target student gain or escape from—what changes after the student acts out? A more structured approach is shown in Figure 4.3—an observation and planning worksheet for functional behavioral assessment.

With information from a functional behavioral assessment, administrators and teachers can develop an intervention package of positive behavior supports, as we did with the math student.

Positive Behavior Supports. The Individuals with Disabilities Education Act (IDEA, 1997) discussed in Chapter 2 requires positive behavior supports (PBS) for students with disabilities and those at-risk for special education placement. **Positive behavior supports** are interventions designed to replace problem behaviors with new actions that serve the same purpose for the student.

Positive behavior supports based on functional behavioral assessments can help students with disabilities succeed in inclusion classrooms. For example, the disruptive behavior of a five-year-old boy with mental retardation was nearly eliminated in a relatively short time through a PBS intervention that was based on a functional assessment conducted by the regular teaching staff and the special education teacher. The

Student Name: ______________________ **Date:** __________

Target Behavior: Operationally define the behavior that most interferes with the student's functioning in the classroom. Include intensity(high, medium, or low), frequency, and duration.

____

____

When, where, with whom, and in what condition is the target behavior *least* likely to occur?

____

Setting Events or Context Variables (i.e., hunger, lack of sleep, medications, problems on bus):

____

Immediate Antecedents & Consequences

Antecedents	***Problematic Settings***	***Consequences***
____ Demand/Request	____ Unstructured setting	____ Behavior ignored
____ Difficult task	____ Unstructured activity	____ Reprimanded
____ Time of day	____ Individual seat work	____ Verbal redirection
____ Interruption in routine	____ Group work	____ Time-out (duration: ____)
____ Peer tease/provoked	____ Specials	____ Loss of incentives
____ No materials/activities	____ Specific subject/task	____ Physical redirection
____ Could not get desired item	____ Crowded setting	____ Physical restraint
____ People ____________	____ Noisy setting	____ Sent to office
____ Alone	____ Other ____________	____ Suspension
____ Other ____________	____ Other ____________	____ Other ____________

What function(s) does the target behavior seem to serve for the student?

____ Escape from:	____ demand/request	____ person	____ activity/task	____ school	____ other ________
____ Attention from:	____ adult	____ peer	____ other ____________		
____ Gain desired:	____ item	____ activity	____ area	____ other ____________	

____ Automatic sensory stimulation: ______________________

Hypothesis:

When ______________ (antecedent) occurs in the context of ______________ (problematic setting)

the student exhibits ______________ (target behavior) in order to ______________ (perceived function).

This behavior is more likely to occur when ______________ (setting event/context variables).

Replacement or competing behavior that could still serve the same function for the student:

____

Is the replacement behavior in the student's repertoire, or will it need to be taught directly? __________

If so, how will it be taught? ______________________

List some potential motivators for student: ______________________

____

FIGURE 4.3 A Structured Observation Guide for Functional Behavioral Analysis

Source: From "Functional behavior assessment in schools" by G. P. Barnhill, *Intervention in School and Clinic*, 40, p. 138. Copyright 2005 by PRO-ED, Inc. Reprinted with permission.

intervention included making sure tasks assigned were at the right difficulty level, providing assistance with these tasks, teaching the student how to request assistance, and teaching the student how to request a break from assigned work (Soodak & McCarthy, 2006; Umbreit, 1995). But these approaches are not only for students with special needs. Research shows that disciplinary referrals decrease when the whole school uses these approaches for all students (Lewis, Sugai, & Colvin, 1998). Because about 5% of students account for half of the discipline referrals, it makes sense to develop interventions for those students. Positive behavior interventions based on functional assessments can reduce these behavior problems by 80% (Crone & Horner, 2003).

Homework

One of the implications of the behavioral view is that learning requires practice of correct responses—practice makes permanent. Educators have been studying the effects of homework for over seventy-five years (Cooper, 2004; Cooper & Valentine, 2001; Corno, 2000; Trautwein & Koller, 2003). Homework is one form of practice, but the value of homework has been debated, as you can see in the Point/Counterpoint.

Cognitive Views of Learning

The cognitive perspective is both the oldest and youngest explanation of learning. It is old because discussions of the nature of knowledge, the value of reason, and the contents of the mind date back at least to the ancient Greek philosophers (Hernshaw, 1987). From the late 1800s until a few decades ago, however, cognitive studies fell from favor and behaviorism thrived. Then, research during World War II on the development of complex human skills, the computer revolution, and breakthroughs in understanding language development all stimulated a resurgence in cognitive research. Evidence accumulated indicating that people do more than simply respond to reinforcement and punishment. For example, we plan our responses, use systems to help us remember, and organize the material we are learning in our own unique ways (Miller, Galanter, & Pribram, 1960; Shuell, 1986). With the growing realization that learning is an active mental process, educational psychologists became interested in how people think, learn concepts, and solve problems (e.g., Ausubel, 1963; Bruner, Goodnow, & Austin, 1956).

Interest in concept learning and problem solving soon gave way, however, to interest in how knowledge is represented in the mind and particularly how it is remembered. Remembering and forgetting became major topics for investigation in cognitive psychology in the 1970s and 1980s, and the information-processing model of memory dominated research. Today, there are other models of memory besides information processing. In addition, many cognitive theorists have a renewed interest in learning, thinking, and problem solving.

POINT/COUNTERPOINT Is Homework a Valuable Use of Time?

Like so many methods in education, homework has moved in and out of favor. In the early 1900s, homework was seen as an important path to mental discipline, but by the 1940s, homework was criticized as too much drill and low-level learning. Then in the 1950s, homework was rediscovered as a way to catch up with the Soviet Union in science and mathematics, only to be seen as too much pressure on students during the more laid-back 1960s. By the 1980s, homework was in again as a way to improve the standing of American children compared to students around the world (Cooper & Valentine, 2001). Everyone has done homework—were those hours well spent?

POINT

Homework does not help students learn.
No matter how interesting an activity is, students will eventually get bored with it, so why give them work both in and out of school? They will simply grow weary of learning. And important opportunities are lost for community involvement or leisure activities that would create well-rounded citizens. When parents help with homework, they can do more harm than good—sometimes confusing their children or teaching them incorrectly. And students from poorer families often must work, so they miss doing the homework; then the learning discrepancy between the rich and poor grows even greater. Besides, the research is inconsistent about the effects of homework. For example, one study found that in-class work was better than homework in helping elementary students learn (Cooper & Valentine, 2001).

COUNTERPOINT

Well-planned homework can work for many students.
Harris Cooper and Jeffrey Valentine reviewed many studies of homework and concluded that there is little relationship between homework and learning for young students, but the relationship between homework and achievement grows progressively stronger for older students. There is recent evidence that students in high school who do more homework (and watch less television after school) have higher grades, even when other factors such as gender, grade level, ethnicity, socioeconomic status, and amount of adult supervision are taken into consideration (Cooper & Valentine, 2001; Cooper, Valentine, Nye, & Lindsay, 1999). Consistent with these findings, the National PTA makes these recommendations:

> [F]or children in grades K–2, homework is most effective when it does not exceed 10–20 minutes each day; older students, in grades 3–6, can handle 30–60 minutes a day; in junior and senior high school, the amount of homework will vary by subject. (Henderson, 1996, p. 1)

Knowledge and Learning

Current cognitive approaches suggest that one of the most important elements in the learning process is what the individual brings to the learning situation. What we already know determines to a great extent what we will pay attention to, perceive, learn, remember, and forget (Bransford, Brown, & Cocking, 2002; Bransford, Derry, Berliner, & Hammerness, 2005). Pat Alexander (1996) notes that what we already know—our knowledge base—"is a scaffold that supports the construction of all future learning" (p. 89). Thus knowledge is more than the end product of previous learning; it also guides new learning.

A study by Recht and Leslie (1988) shows the importance of knowledge in understanding and remembering new information. These researchers identified junior high school students who were either very good or very poor readers. They tested the students on their knowledge of baseball and found that knowledge of baseball was not related to reading ability. So the researchers were able to identify four groups of students: good readers/high baseball knowledge, good readers/low baseball knowledge, poor readers/high baseball knowledge, and poor readers/low baseball knowledge. Then all the subjects read a passage describing a baseball game and were tested in a number of ways to see if they understood and remembered what they had read.

The results demonstrated the power of knowledge. Poor readers who knew baseball remembered more than good readers with little baseball knowledge and almost as much as good readers who knew baseball. Poor readers who knew little about baseball remembered the least of what they had read. So a good basis of knowledge can be more important than good learning strategies in understanding and remembering, but extensive knowledge plus good strategies are even better.

There are different kinds of knowledge. Some is general—it applies to many different situations. For example, general knowledge about how to read or write or use a word processor is useful in and out of school. **Domain-specific knowledge**, on the other hand, pertains to a particular task or subject. For example, knowing that the shortstop plays between second and third base is specific to the domain of baseball. Another way of categorizing knowledge is as declarative, procedural, or conditional (Paris & Cunningham, 1996; Paris, Lipson, & Wixson, 1983). **Declarative knowledge** is "knowledge that can be declared, usually in words, through lectures, books, writing, verbal exchange, Braille, sign language, mathematical notation, and so on" (Farnham-Diggory, 1994, p. 468). Declarative knowledge is "knowing that" something is the case. The range of declarative knowledge is tremendous. You can know very specific facts (the atomic weight of gold is 196.967), generalities (leaves of some trees change color in autumn), personal preferences (we don't like lima beans), personal events (what happened at the last faculty meeting), rules (to divide fractions, invert the divisor and multiply). Small units of declarative knowledge can be organized into larger units; for example, principles of reinforcement and punishment can be organized in your thinking into a theory of behavioral learning (Gagné, Yekovich, & Yekovich, 1993).

Procedural knowledge is "knowing how" to do something such as divide fractions or clean a carburetor; procedural knowledge must be demonstrated. Notice that repeating the rule "to divide fractions, invert the divisor and multiply" shows declarative knowledge; the student can state the rule. But to show procedural knowledge, the student must act. When faced with a fraction to divide, the student must divide correctly. Students or teachers demonstrate procedural knowledge when they translate a passage into Spanish or correctly categorize a geometric shape or craft a coherent paragraph.

Conditional knowledge is "knowing when and why" to apply your declarative and procedural knowledge. Given many kinds of math problems, it takes conditional knowledge to know when to apply one procedure and when to apply another to solve each problem. It takes conditional knowledge to know when to read every word in a text

TABLE 4.1 Kinds of Knowledge

	General Knowledge	Domain-Specific Knowledge
Declarative	Hours the library is open	The definition of *hypotenuse*
	Rules of grammar	The lines of the poem "The Raven"
Procedural	How to use your word processor	How to solve an oxidation-reduction equation
	How to drive	How to throw a pot on a potter's wheel
Conditional	When to give up and try another approach	When to use the formula for calculating volume
	When to skim and when to read carefully	When to rush the net in tennis

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and when to skim or when to intervene when new teachers are struggling and when to hold back and let the teachers work it out for themselves. For many people, conditional knowledge is a stumbling block. They have the facts and can do the procedures, but they don't seem to apply what they know at the appropriate time. Table 4.1 shows that we can combine our two systems for describing knowledge. Declarative, procedural, and conditional knowledge can be either general or domain-specific.

To be used, knowledge must be remembered. What do we know about memory?

An Information-Processing Model

One widely used cognitive model of the structure and processes of memory is the information-processing model, based on the analogy between the mind and the computer (Ashcraft, 2006). This model (see Figure 4.4) includes three storage systems: the sensory register, working memory (also called short-term memory), and long-term memory. Let's look at this system in more depth.

Sensory Memory

As you can see, **sensory memory** is the initial processing that transforms incoming stimuli (sights, sounds, smells, and so on) into information so we can make sense of them. We hold information, in the form of images or sounds or other codes, for only a very few seconds. **Attention** (maintaining cognitive focus on something and resisting distractions) is critical at this stage. What is not attended to is lost. This is actually useful because if every variation in color, movement, sound, smell, temperature, and so on ended up in memory, life would be impossible. But attention is *selective*. What we pay attention to is guided to a certain extent by what we already know and what we need to know, so attention is involved in and influenced by all three memory processes—sensory, working, and long-term.

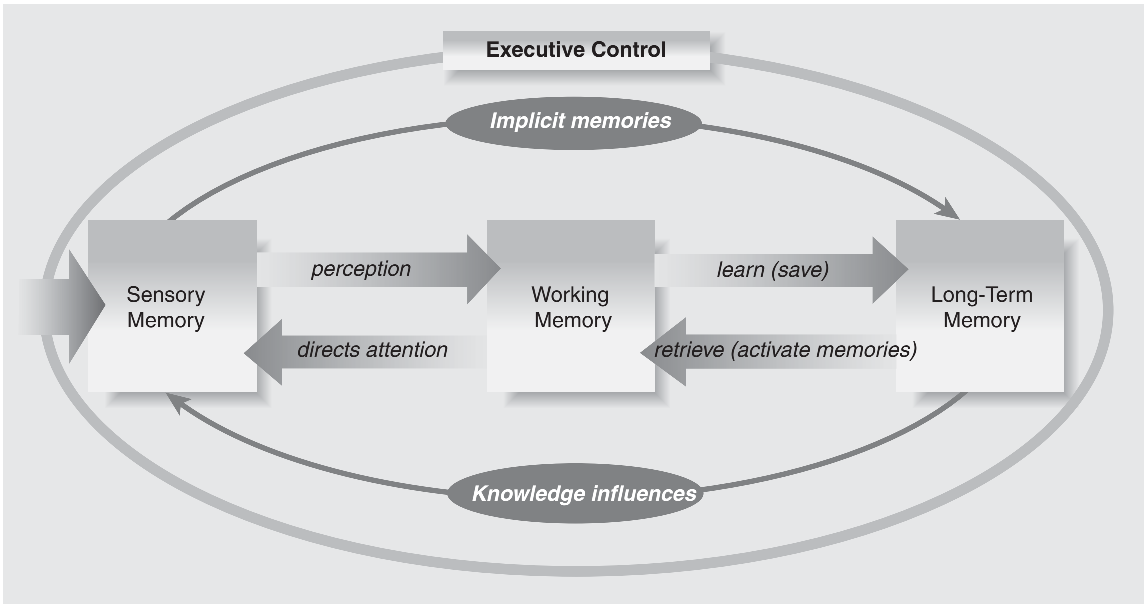

FIGURE 4.4 The Information-Processing System
Information is encoded in sensory memory where perception and attention determine what will be held in working memory for further use. In working memory, new information connects with knowledge from long-term memory. Thoroughly processed and connected information becomes part of long-term memory, and can be activated to return to working memory. Implicit memories are formed without conscious effort.

Source: From Anita Woolfolk, *Educational Psychology: Active Learning Edition*, 10/e (p. 271). Copyright © 2008. Reprinted by permission of Allyn & Bacon.

Attention also is a very limited resource. We can pay attention to only one demanding task at time. For example, if you learned to drive a stick shift, there probably was a time when you couldn't listen to the radio and drive at the same time. After some practice, you could listen, but might turn the radio off when traffic was heavy. After years of practice, some people shave or put on makeup as they drive. This is because many processes that initially require attention and concentration become automatic with practice (Bransford et al., 2005).

So the first step in learning is paying attention. Students cannot process something that they do not recognize or perceive (Lachter, Forster, & Ruthruff, 2004). Many factors in the classroom influence student attention. A teacher might begin a science lesson on air pressure by blowing up a balloon until it pops. Bright colors, underlining, highlighting of written or spoken words, calling students by name, surprise events, intriguing questions, variety in tasks and teaching methods, and changes in voice level, lighting, or pacing can all be used to gain attention. And students have to maintain attention; they have to stay focused on the important features of the learning situation.

THEORY INTO ACTION GUIDELINES

Capturing Attention

Use signals.

Examples

1. Develop a signal that tells students to stop what they are doing and focus on you. Some teachers move to a particular spot in the room, flick the lights, or play a chord on the class piano.
2. Avoid distracting behaviors such as tapping a pencil that interfere with both signals and attention to learning.
3. Give short, clear directions before, not during, transitions.

Make sure the purpose of the lesson or assignment is clear to students.

Examples

1. Write the goals or objectives on the board and discuss them with students before starting. Ask students to summarize or restate the goals.
2. Explain the reasons for learning, and ask students for examples of how they will apply their understanding of the material.
3. Tie the new material to previous lessons—show an outline or map of how the new topic fits with previous and upcoming material.

Emphasize variety, curiosity, and surprise.

Examples

1. Arouse curiosity with questions such as "What would happen if . . . ?"
2. Create shock by staging an unexpected event such as a loud argument just before a lesson on communication.
3. Alter the physical environment by changing the arrangement of the room or moving to a different setting.
4. Shift sensory channels by giving a lesson that requires students to touch, smell, or taste.
5. Use movements, gestures, and voice inflection—walk around the room, point, and speak softly and then more emphatically. (The second author has been known to jump up on his desk to make an important point in his college classes!)

Ask questions and provide frames for answering.

Examples

1. Ask students why the material is important, how they intend to study, and what strategies they will use.
2. Give students self-checking or self-editing guides that focus on common mistakes or have them work in pairs to improve each other's work—sometimes it is difficult to pay attention to your own errors.

How can instructional leaders help teachers develop strategies for capturing and maintaining students' attention? The following Theory into Action Guidelines provide some concrete examples.

Working Memory

Once noticed and transformed into patterns, the information in sensory memory is available for further processing. The working space of the memory system is called (surprise) **working memory.** It is the interface where new information is held temporarily (no more than 20 seconds or so) and combined with knowledge from long-term memory, to solve problems or understand a talk on leadership, for example. Working memory "contains" what you are thinking about at the moment. You may have heard the term *short-term memory*. This is similar to working memory but refers only to the storage space available. Working memory includes both temporary storage and active processing; it is the process or stage where active mental effort is applied to new and old information.

A current view of working memory is that it is composed of at least four elements: the central executive that controls attention and other mental resources (the "worker" of working memory), the phonological loop that briefly holds verbal and acoustical (sound) information, and the visuospatial sketchpad for visual and spatial information. Information from the phonological loop and the visuospatial sketchpad is integrated with information from long-term memory in an episodic buffer. This episodic buffer is the true workbench of working memory—the point where information from many sources is pulled together and processed (Alloway, Gathercole, & Pickering, 2006; Baddeley, 2006; Gathercole, Pickering, Ambridge, & Wearing, 2004).

Capacity and Contents. Working memory capacity is limited. In experimental situations it appears that the capacity of working memory is only about five to nine separate new items at once (Miller, 1956). For example, if you get a phone number from information, you can remember it long enough to dial the number, but would you try to remember two numbers? Two new phone numbers (fourteen digits) probably cannot be stored simultaneously. We are discussing the recall of *new* information. In daily life we certainly can hold more than five to nine bits of information at once. While you are dialing that seven-digit phone number you just found, you are bound to have other things "on your mind" (in your memory), such as how to use a telephone, whom you are calling, and why. You don't have to pay attention to these things; they are not new knowledge. Some of the processes, such as dialing the phone, have become automatic. However, because of the working memory's limitations, if you were in a foreign country and were attempting to use an unfamiliar telephone system, you might very well have trouble remembering the phone number because you were trying to figure out the phone system at the same time.

It is clear that the duration of information in working memory is short, about 5 to 20 seconds. This is why working memory has been called short-term memory. It may seem to you that a memory system with a 20-second time limit is not very useful. But without this system, you would have already forgotten what you read in the first part of this sentence before you came to these last few words. This would clearly make understanding sentences difficult.

Retaining Information in Working Memory. Because information in working memory is fragile and easily lost, it must be kept activated to be retained. When activation fades, forgetting follows. To keep information activated in working memory for longer than 20 seconds, most people keep rehearsing the information mentally.

There are two types of rehearsal. **Maintenance rehearsal** involves repeating the information in your mind. As long as you repeat the information, it can be maintained in working memory indefinitely. Maintenance rehearsal is useful for retaining something you plan to use and then forget, like a phone number. **Elaborative rehearsal** involves connecting the information you are trying to remember with something you already know, that is, with information from long-term memory. For example, if you meet someone at a party whose name is the same as yours, you don't have to repeat the name to keep it in memory, you just have to make the association. This kind of rehearsal not only retains information in working memory but helps move information from short-term to long-term memory. Rehearsal is thus an *executive control process* that affects the flow of information through the information-processing system.

The limited capacity of working memory can also be somewhat circumvented by the control process of **chunking.** Because the number of bits of information, not the size of each bit, is the limitation for working memory, you can retain more information if you can group individual bits of information. For example, if you have to remember the six digits 3, 5, 4, 8, 7, and 0, it is easier to put them together into three chunks of two digits each (35, 48, 70) or two chunks of three digits each (354, 870). With these changes, there are only two or three bits of information rather than six to hold at one time. Chunking helps you remember a telephone number or a Social Security number.

Long-Term Memory

Working memory holds the information that is currently activated, such as a telephone number you have just found and are about to dial. Long-term memory holds the information that is well learned, such as all the other telephone numbers you know.

Capacity and Duration of Long-Term Memory. Information enters working memory very quickly. To move information into long-term storage requires more time and a bit of effort. Whereas the capacity of working memory is limited, the capacity of long-term memory appears to be, for all practical purposes, unlimited. In addition, once information is securely stored in long-term memory, it can remain there permanently. Theoretically, we should be able to remember as much as we want for as long as we want. Of course, the problem is finding the right information when it is needed. Our access to information in working memory is immediate because we are thinking about the information at that very moment. But access to information in long-term memory requires time and effort.

Contents of Long-Term Memory. Most cognitive psychologists distinguish three categories of long-term memory: episodic, procedural, and semantic. Memory for information tied to a particular place and time, especially information about the events of your own life, is called episodic memory. **Episodic memory** keeps track of the order of things, so it is also a good place to store jokes, gossip, or plots from films. Memories for dramatic or emotional episodes in your life are called **flashbulb memories**. This kind of episodic memory is vivid and complete, as if your brain demanded "record this moment." Under stress, more glucose energy goes to fuel brain activity while stress-induced hormones signal the brain that something important is happening (Myers, 2005). So when we have strong emotional reactions, memories are stronger and more lasting. Many people have vivid memories of very positive or very negative events in school, winning a prize or being humiliated, for example. You probably know just where you were and what you were doing on 9/11.

Memory for how to do things is called **procedural memory**. It may take a while to learn a procedure—such as how to ski, serve a tennis ball, or factor an equation—but once learned, this knowledge tends to be remembered for a long time. Procedural memories are represented as condition–action rules, sometimes called *productions.* Productions specify what to do under certain conditions: if A occurs, then do B. A production might be something like, "If you want to snow ski faster, lean back slightly," or "If your goal is to increase student attention, and a student has been paying attention a bit longer than usual, then praise the student." People can't necessarily state all their condition–action rules, but they act on them nevertheless. The more practiced the procedure, the more automatic the action (Anderson, 1995). **Semantic memory** is memory for meaning. Two important ways that these memories are stored are images and schemas. Because these are very important concepts for teaching, we will spend some extra time on them.

Images are representations based on perceptions, on the structure or appearance of the information (Anderson, 1995). As we form images we try to remember or recreate the physical attributes and spatial structure of information. For example, when asked how many windowpanes are in their living room, most people call up an image of the windows "in their mind's eye" and count the panes—the more panes, the longer it takes to respond (Mendell, 1971). Images are useful in making many practical decisions such as how a sofa might look in your living room or how to line up a golf shot. Images may also be helpful in abstract reasoning. Physicists, such as Faraday and Einstein, report creating images to reason about complex new problems (Gagné, Yekovich, & Yekovich, 1993).

Schemas (sometimes called "schemata") are abstract knowledge structures that organize vast amounts of information. A schema (the singular form) is a pattern or guide for understanding an event, a concept, or a skill. The schema tells you what features are typical of a category, what to expect. The schema is like a pattern, specifying the "standard" relationships in an object or situation. And schemas are individual. For example, a museum curator and a salesperson may have very different schemas about antiques.

Another type of schema, a *story grammar* (sometimes called a schema for text or story structure) helps students to understand and remember stories (Gagné, Yekovich, & Yekovich, 1993; Rumelhart & Ortony, 1977). A story grammar could be something like this: murder discovered, search for clues, murderer's fatal mistake identified, trap set to trick suspect into confessing, murderer takes bait . . . mystery solved! In other words, a story grammar is a typical general structure that could fit many specific stories. To comprehend a story, we select a schema that seems appropriate. Then we use this framework to decide which details are important, what information to seek, and what to remember. It is as though the schema is a theory about what should occur in the story. The schema guides us in "interrogating" the text, filling in the specific information we expect to find so that the story makes sense. If we activate our "murder mystery schema" we may be alert for clues or a murderer's fatal mistake (Resnick, 1981). Without the appropriate schema, trying to understand a story, textbook, or classroom lesson is a very slow, difficult process, something like finding your way through a new town without a map.

Storing and Retrieving Information in Long-Term Memory

How can we make the most effective use of our practically unlimited capacity to learn and remember? The way you learn information in the first place—the way you process it at the outset—seems to affect its recall later. One important requirement is that you integrate new material with information already stored in long-term memory as you construct an understanding. Here elaboration, organization, and context play a role.

Elaboration is the addition of meaning to new information through its connection with already existing knowledge. In other words, we apply our schemas and draw on already existing knowledge to construct an understanding and often change our existing knowledge in the process. We often elaborate automatically. For example, a paragraph about a historic figure in the seventeenth century tends to activate our existing knowledge about that period; we use the old knowledge to understand the new. Material that is elaborated when first learned will be easier to recall later. First, as we saw earlier, elaboration is a form of rehearsal. It keeps the information activated in working memory long enough to have a chance for permanent storage in long-term memory.

Second, elaboration builds extra links to existing knowledge. The more one bit of information or knowledge is associated with other bits, the more routes there are to follow to get to the original bit. To put it another way, you have several "handles," or retrieval cues, by which you can recognize or "pick up" the information you might be seeking (Schunk, 2004). The more students elaborate new ideas, the more they "make them their own," the deeper their understanding and the better their memory for the knowledge. We help students to elaborate when we ask them to translate information into their own words, create examples, explain to a peer, draw the relationships, or apply the information to solve new problems. Of course, if students elaborate new information by making incorrect connections or developing misguided explanations, these misconceptions will be stored and remembered too.

Organization is a second element of processing that improves learning. Material that is well organized is easier to learn and to remember than bits and pieces of information, especially if the information is complex or extensive. Placing a concept in a structure will help you learn and remember either general definitions or specific examples. The structure serves as a guide back to the information when you need it. For example, Table 4.1 (on page 00) organizes information about kinds of knowledge.

Context is a third element of processing that influences learning. Aspects of physical and emotional context—places, rooms, how we are feeling on a particular day, who is with us—are learned along with other information (Ashcraft, 2002). Later, if you try to remember the information, it will be easier if the current context is similar to the original one. So studying for a test under "testlike" conditions may result in improved performance. Of course, you can't always go back to the same place you learned in order to recall something. But you can picture the setting, the time of day, and your companions, and you may eventually reach the information you seek.

Craik and Lockhart (1972) suggested that what determines how long information is remembered is how completely the information is analyzed and connected with other information. The more completely information is processed, the better our chances of remembering it. For example, according to the levels of processing theory, if you were asked to sort pictures of dogs based on the color of their coats, you might not remember many of the pictures later. But if asked to rate each dog on how likely it is to chase you as you jog, you probably would remember more of the pictures. To rate the dogs as dangerous you must pay attention to details in the pictures, relate features of the dogs to characteristics associated with danger, and so on. This rating procedure requires "deeper" processing and more focus on the meaning of the features in the photos.

Retrieving Information from Long-Term Memory. When we need to use information from long-term memory, we search for it. Sometimes the search is conscious, as when you see a friend approaching and you search for her name. At other times locating and using information from long-term memory is automatic, as when you call your home or solve a math problem without having to search for each step. Think of long-term memory as a huge shelf full of tools and supplies ready to be brought to the workbench of working memory to accomplish a task. The shelf (long-term memory) stores an incredible amount, but it may be hard to quickly find what you are looking for. The workbench (working memory) is small, but anything on it is immediately available. Because it is small, however, supplies (bits of information) sometimes are lost when the workbench overflows or when one bit of information covers (interferes with) another (Gagné, 1985).

The size of the long-term memory network is huge, but only one small area is activated at any one time. Only the information we are currently thinking about is in working memory. Information is retrieved in this network through the spread of activation. When particular information is active—when we are thinking about it—other closely associated knowledge can be activated as well, and activation can spread through the network (Anderson, 1993; Gagné, Yekovich, & Yekovich, 1993). Thus, as you focus on the thought, "I'd like to go for a drive to see the fall leaves today," related ideas such as, "I should rake leaves," and "The car needs an oil change," come to mind. As activation spreads from the "car trip" to the "oil change," the original thought, or active memory, disappears from working memory because of the limited space.

In long-term memory the information is still available, even when it is not activated, even when you are not thinking about it at the moment. If spreading activation does not "find" the information we seek, then we might still come up with the answer through *reconstruction*, a problem-solving process that makes use of logic, cues, and other knowledge to construct a reasonable answer by filling in any missing parts. Sometimes reconstructed recollections are incorrect. For example, in 1932, F. C. Bartlett conducted a series of famous studies on remembering stories. He read a complex, unfamiliar Native American tale to students at England's Cambridge University and after various lengths of time, asked the students to recall the story. Students' recalled stories were generally shorter than the original and were translated into the concepts and language of the Cambridge student culture. The story told of a seal hunt, for instance, but many students remembered "a fishing trip," an activity closer to their experiences and more consistent with their schemas.

Forgetting and Long-Term Memory. Information lost from working memory truly disappears. No amount of effort will bring it back. But information stored in long-term memory may be available, given the right cues. Information appears to be lost from long-term memory through time decay and interference. For example, memory for Spanish–English vocabulary decreases for about three years after a person's last course in Spanish, then stays level for about 25 years, then drops again for the next 25 years. One explanation for this decline is that neural connections, like muscles, grow weak without use (Anderson, 1995). Finally, newer memories may interfere with or obscure older memories, and older memories may interfere with memory for new material.

Even with decay and interference, long-term memory is remarkable. In a review of almost 100 studies of memory for knowledge taught in school, Semb and Ellis (1994) concluded that, "contrary to popular belief, students retain much of the knowledge taught in the classroom" (p. 279). It appears that teaching strategies that encourage student engagement and lead to higher levels of initial learning (such as frequent reviews and tests, elaborated feedback, high standards, mastery learning, and active involvement in learning projects) are associated with longer retention. But initial learning is not enough; students have to practice their understanding. In fact, many cognitive psychologists believe that the failures of education, such as the inability of many Harvard graduates to explain why it is colder in winter than summer, are really failures to retain what was once understood (Pashler, 2006). What can instructional leaders do to use the principles of information processing to improve instruction? See the Theory into Action Guidelines.

Metacognition, Regulation, and Individual Differences

One question that intrigues many educators and cognitive psychologists is why some people learn and remember more than others. For those who hold an information-processing view, part of the answer lies in the **executive control processes** shown earlier in Figure 4.4 that guide the flow of information through the system. We have already discussed a number of control processes, including selective attention, maintenance rehearsal, elaborative rehearsal, organization, and elaboration. These executive control processes are sometimes called **metacognition**, defined as our awareness of our own "cognitive machinery and how the machinery works" (Meichenbaum, Burland, Gruson, & Cameron, 1985, p. 5). Metacognition literally means cognition about cognition, or knowledge about knowledge.

There are three essential metacognitive skills: planning, monitoring, and evaluation (Brown, 1987; Nelson, 1996). *Planning* involves deciding how much time to give to a task, which strategies to use, how to start, what resources to gather, what order to

THEORY INTO ACTION GUIDELINES

Applying Information Processing

Make sure you have the students' attention.

Examples

1. Develop a signal that tells students to stop what they are doing and focus on you. Make sure students respond to the signal—don't let them ignore it. Practice using the signal.
2. Move around the room, use gestures, and avoid speaking in a monotone.
3. Begin a lesson by asking a question that stimulates interest in the topic.
4. Regain the attention of individual students by walking closer to them, using their names, or asking them a question.

Help students separate essential from nonessential details and focus on the most important information.

Examples

1. Summarize instructional objectives to indicate what students should be learning. Relate the material you are presenting to the objectives as you teach: "Now I'm going to explain exactly how you can find the information you need to meet Objective One on the board—determining the tone of the story."
2. When you make an important point, pause, repeat, ask a student to paraphrase, note the information on the board in colored chalk, or tell students to highlight the point in their notes or readings.

Help students make connections between new information and what they already know.

Examples

1. Review prerequisites to help students bring to mind the information they will need to understand new material: "Who can tell us the definition of a quadrilateral? Now, what is a rhombus? Is a square a quadrilateral? Is a square a rhombus? What did we say yesterday about how you can tell? Today we are going to look at some other quadrilaterals."
2. Use an outline or diagram to show how new information fits with the framework you have been developing. For example, "Now that you know the duties of the FBI, where would you expect to find it in this diagram of the branches of the U.S. government?"
3. Give an assignment that specifically calls for the use of new information along with information already learned.

Provide for repetition and review of information.

Examples

1. Begin the class with a quick review of the homework assignment.
2. Give frequent, short tests.
3. Build practice and repetition into games, or have students work with partners to quiz each other.

Present material in a clear, organized way.

Examples

1. Make the purpose of the lesson very clear.
2. Give students a brief outline to follow. Put the same outline on an overhead so you can keep yourself on track. When students ask questions or make comments, relate these to the appropriate section of the outline.
3. Use summaries in the middle and at the end of the lesson.

Focus on meaning, not memorization.

Examples

1. In teaching new words, help students associate the new word to a related word they already understand: "*Enmity* is from the same base as *enemy*."
2. In teaching about remainders, have students group twelve objects into sets of 2, 3, 4, 5, 6, and ask them to count the "leftovers" in each case.

follow, what to skim and what to give intense attention, and so on. *Monitoring* is the online awareness of "how I'm doing." Monitoring means asking, "Is this making sense? Am I trying to go too fast? Have I practiced enough?" *Evaluation* involves making judgments about the processes and outcomes of thinking and learning. Should I change strategies? Get help? Give up for now? Is this report (proposal, budget, painting, formula, model, poem, plan, etc.) finished yet, or does it need more work? Many planning, monitoring, and evaluation processes are not necessarily conscious. Especially in adults, these processes can be automatic. Because people differ in their metacognitive knowledge and skills, they differ in how well and how quickly they learn (Brown, Bransford, Ferrara, & Campione, 1983; Morris, 1990). Experts in a field may plan, monitor, and evaluate as second nature; they have difficulty describing their metacognitive knowledge and skills (Schraw & Moshman, 1995).

Some differences in metacognitive abilities are due to development. Metacognitive abilities begin to develop around ages five to seven and improve throughout school. Most children go through a transitional period when they can apply a particular strategy if reminded, but will not apply it on their own (Flavell, Green, & Flavell, 1995; Perner, 2000; Sigler, 1998). Nancy Perry found that asking students two questions helped them become more metacognitive. The questions were: "What did you learn about yourself as a reader/writer today?" and "What did you learn that you can do again and again and again?" When teachers asked these questions regularly during class, even young students demonstrated fairly sophisticated levels of metacognitive understanding and action (Perry, VandeKamp, & Mercer, 2000).

Not all differences in metacognitive abilities have to do with age or maturation. Some individual differences probably are caused by biological differences or by variations in learning experiences. In fact, many students diagnosed as having learning disabilities actually have attention disorders (Hallahan & Kauffman, 2006), particularly with long tasks (Pelham, 1981). Thus, there is great variability even among students of the same developmental level, but these differences do not appear to be related to intellectual abilities. In fact, superior metacognitive skills can compensate for lower levels of ability, so these metacognitive skills can be especially important for students who often have trouble in school (Swanson, 1990).

Cognitive Contributions: Learning Strategies and Tactics

Most teachers will tell you that they want their students to "learn how to learn." Years of research indicate that using good learning strategies helps students learn and that these strategies can be taught (Hamman, Berthelot, Saia, & Crowley, 2000). But were you taught "how to learn"? Powerful and sophisticated learning strategies and study skills are seldom taught directly until high school or even college, so students have little practice with these powerful strategies. In contrast, early on students usually discover repetition and rote learning on their own, so they have extensive practice with these strategies. And, unfortunately, some teachers think that memorizing is learning (Hofer & Pintrich, 1997; Woolfolk Hoy & Murphy, 2001). This may explain why many students cling to flash cards and memorizing; they don't know what else to do to learn (Willoughby, Porter, Belsito, & Yearsley, 1999).

Let's examine several good learning strategies and tactics.

Deciding What Is Important

Learning begins with focusing attention—deciding what is important. But distinguishing the main idea from less important information is not always easy. Often students focus on the "seductive details" or the concrete examples, perhaps because they are more interesting (Gardner, Brown, Sanders, & Menke, 1992). Finding the central idea is especially difficult if you lack prior knowledge in an area and the amount of new information provided is extensive. Teachers can give students practice in using signals in texts such as headings, bold words, outlines, or other indicators to identify key concepts and main ideas. Teaching students to summarize material can be helpful, too (Lorch, Lorch, Ritchey, McGovern, & Coleman, 2001).

Summaries. Creating summaries can help students learn, but students have to be taught how to summarize (Byrnes, 1996; Dole et al., 1991; Palincsar & Brown, 1989). Jeanne Ormrod (1999, p. 333) summarizes these suggestions for helping students create summaries:

- Begin doing summaries of short, easy, well-organized readings. Introduce longer, less organized, and more difficult passages gradually.
- For each summary, ask students to find or write a *topic sentence* for each paragraph or section, identify *big ideas* that cover several specific points, find some *supporting information* for each big idea, and delete any *redundant information* or unnecessary details.
- Ask students to compare their summaries and discuss what ideas they thought were important and why—what's their evidence?

Two other study strategies that are based on identifying key ideas are *underlining* texts and *taking notes.*

Underlining and Highlighting. Underlining and note taking are probably two of the most commonly used strategies among high school and college students. Yet few students receive any instruction in the best ways to take notes or underline, so it is not surprising that many students use ineffective strategies.

One common problem is that students underline or highlight too much. It is far better to be selective. In studies that limit how much students can underline—for example, only one sentence per paragraph—learning has improved (Snowman, 1984). In addition to being selective, students also should actively transform the information into their own words as they underline or take notes. Teach students not to rely on the words of the book. Encourage them to note connections between what they are reading and other things that they already know. Draw diagrams to illustrate relationships. Finally, look for organizational patterns in the material and use them to guide underlining or note taking (Irwin, 1991; Kiewra, 1988).

Taking Notes. Research indicates that taking notes serves at least two important functions:

- Taking notes focuses attention during class. In order to record key ideas in your own words, you have to translate, connect, elaborate, and organize, which helps move information to long-term memory. Of course, if taking notes distracts you from actually listening to and making sense of the lecture, then note taking may not be effective (DiVesta & Gray, 1972; Kiewra, 1989; Van Meter, Yokoi, & Pressley, 1994).
- Notes provide extended external storage that allows students to return and review. Students who use their notes to study tend to perform better on tests, especially if they take many high-quality notes—more is better as long as the students are capturing key ideas, concepts, and relationships, not just intriguing details (Kiewra, 1985, 1989).

To help students organize their note taking, some teachers provide matrices or maps, such as the one in Figure 4.5. When students are first learning to use these maps, teachers often fill in some of the spaces for them. Also, it is helpful for students to exchange their filled-in maps and explain their thinking to each other.

Mnemonics

Mnemonics are systematic procedures for improving memory (Atkinson et al., 1999; Levin, 1994; Rummel, Levin, & Woodward, 2003). If students need to remember information for long periods of time, an acronym may be the answer. An acronym is a form of abbreviation, a word formed from the first letter of each word in a phrase, for example HOMES to remember the Great Lakes (Huron, Ontario, Michigan, Erie, Superior). Another method forms phrases or sentences out of the first letter of each word or item in a list, for example, Every Good Boy Does Fine to remember the lines on the G clef—E, G, B, D, F. Because the words must make sense as a sentence, this approach also has some characteristics of chain mnemonics, methods that connect the first item to be memorized with the second, the second item with the third, and so on. In one type of chain method, each item on a list is linked to the next through some visual association or story. Another chain-method approach is to incorporate all the items to be memorized into a jingle like "i before e except after c."

The mnemonic system that has been most extensively researched in teaching is the **keyword method.** Joel Levin and his colleagues (Carey & Levin, 2000; Jones,

FIGURE 4.5 A Map to Guide Note Taking
The compare/contrast map allows students to organize their listening or reading as they consider two ideas, concepts, time periods, authors, experiments, theories, and so on.

Source: From *Organizing Thinking: Book 1*, by S. Parks and H. Black, 1992, Critical Thinking Books and Software. Copyright © 1992 Critical Thinking Books and Software. 1-800-458-4849 (www.criticalthinking.com). All rights reserved.

Levin, Levin, & Beitzel, 2000) use a mnemonic (the *3 Rs*) to teach the keyword mnemonic method:

> *recode* the to-be-learned vocabulary item as a more familiar, concrete keyword—this is the keyword;
>
> *relate* the keyword clue to the vocabulary item's definition through a sentence;
> *retrieve* the desired definition.

For example, to remember that the English word *carlin* means *old woman*, you might recode *carlin* as the more familiar keyword *car.* Then make up a sentence such as *The old woman was driving a car.* When you are asked for the meaning of the word *carlin*, you think of the keyword *car*, which triggers the sentence about the car and the *old* *woman*, the meaning. (Jones, Levin, Levin, & Beitzel, 2000). A similar approach has been used to help students connect artists with particular aspects of their paintings. For example, students are told to imagine that the heavy dark lines of paintings by Rouault are made with a *ruler* (Rouault) dipped in black paint (Carney & Levin, 2000). Figure 4.6 is an example of using mnemonic pictures as aids in learning complicated science concepts (Carney & Levin, 2002).

One problem, however, is that the keyword method does not work well if it is difficult to identify a keyword for a particular item. Many words and ideas that students need to remember are quite a challenge to associate with keywords (Hall, 1991). Also, vocabulary learned with keywords may easily be forgotten if students are given keywords and images instead of being asked to supply the words and images. When the teacher provides the memory links, these associations may not fit the students' existing knowledge and may be forgotten or confused later, so remembering suffers (Wang & Thomas, 1995; Wang, Thomas, & Ouelette, 1992). Younger students have some difficulty forming their own images. For them, memory aids that rely on auditory cues—

This illustration tells a story that provides a frame for remembering and pegs for hanging the concept names in the biological subdivision of angiosperms.

To remember that the subdivision **angiosperms** includes the class **dicotyledons**, which in turn includes the three orders **rubales**, **sapindales**, and **rosales**, study the picture of the angel with the pet **dinosaur** that is walking up the **Rubik's cubes** so that he can lick the sweet **sap** that drips down from the **rose** tree.

Source: From "Pictorial Illustrations Still Improve Students' Learning From Text," by R. N. Carney and J. R. Levin, *Educational Psychology Review, 14.* Copyright © 2002 by Kluwer Academic Publishers. Reprinted with permission of the publisher and authors.

FIGURE 4.6 Using Mnemonics to Learn Complex Content

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rhymes such as "Thirty days hath September . . ."—seem to work better (Willoughby et al., 1999).

Reading Strategies

Effective learning strategies and tactics should help students focus attention, invest effort (elaborate, organize, summarize, connect, translate) so they process information deeply, and monitor their understanding. A number of strategies have been developed to support these processes in reading. Many use mnemonics to help students remember the steps involved. For example, one strategy for fourth grade or above is READS:

R *Review* headings and subheadings.
E *Examine* boldface words.
A *Ask*, "What do I expect to learn?"
D *Do* it—Read!
S *Summarize* in your own words (Friend & Bursuck, 2006).

A strategy that can be use in reading literature is CAPS:

C Who are the *characters*?
A What is the *aim* of the story?
P What *problem* happens?
S How is the problem *solved*?

There are literally hundreds of strategies that can be taught. Ours has been a brief and selective look. The point for teachers is to teach subject-appropriate learning strategies directly and support strategic learning through coaching and guided practice. Teaching strategies based on cognitive views of learning, particularly information processing, highlight the importance of attention, organization, rehearsal (practice), and elaboration in learning and provide ways to give students more control over their own learning by developing and improving their own metacognitive skills. The focus is on what is happening "inside the head" of the learner. Using the cognitive theory just explicated, principals can give their teachers hands-on examples to develop more effective ways to teach learning strategies. The Theory into Action Guidelines illustrate both the principles and practices of such strategies for students.

Constructivist Theories of Learning

In this section we look beyond the individual to expand our understanding of learning and teaching. Consider this situation:

> A young child who has never been to the hospital is in her bed in the pediatric wing. The nurse at the station down the hall calls over the intercom above the bed, "Hi Chelsea,

THEORY INTO ACTION GUIDELINES

Learning Strategies

Make sure you have the necessary declarative knowledge (facts, concepts, ideas) to understand new information.

Examples

1. Keep definitions of key vocabulary available as you study.
2. Review required facts and concepts before attempting new material.

Find out what type of test the teacher will give (essay, short answer), and study the material with that in mind.

Examples

1. For a test with detailed questions, practice writing answers to possible questions.
2. For a multiple-choice test, use mnemonics to remember definitions of key terms.

Make sure you are familiar with the organization of the materials to be learned.

Examples

1. Preview the headings, introductions, topic sentences, and summaries of the text.
2. Be alert for words and phrases that signal relationships, such as *on the other hand*, *because*, *first*, *second*, *however*, *since*.

Know your own cognitive skills and use them deliberately.

Examples

1. Use examples and analogies to relate new material to something you care about and understand well, such as sports, hobbies, or films.
2. If one study technique is not working, try another—the goal is to stay involved, not to use any particular strategy.

Study the right information in the right way.

Examples

1. Be sure you know exactly what topics and readings the test will cover.
2. Spend your time on the important, difficult, and unfamiliar material that will be required for the test or assignment.
3. Keep a list of the parts of the text that give you trouble and spend more time on those pages.
4. Process the important information thoroughly by using mnemonics, forming images, creating examples, answering questions, making notes in your own words, and elaborating on the text. Do not try to memorize the author's words—use your own.

Monitor your own comprehension.

Examples

1. Use questioning to check your understanding.
2. When reading speed slows down, decide if the information in the passage is important. If it is, note the problem so you can reread or get help to understand. If it is not important, ignore it.
3. Check your understanding by working with a friend and quizzing one another.

Source: Adapted from B. B. Armbruster and T. H. Anderson, "Research synthesis on study skills," *Educational Leadership*, *39*, pp. 154–156. Reprinted by permission of the Association for Supervision and Curriculum Development.

how are you doing? Do you need anything?" The girl looks puzzled and does not answer. The nurse repeats the question with the same result. Finally, the nurse says emphatically, "Chelsea, are you there? Say something!" The little girl responds tentatively, "Hello, Wall—I'm here."

Chelsea encountered a new situation—a talking wall. The wall is persistent. It sounds like a grown-up wall. She shouldn't talk to strangers, but she is not sure about walls. She uses what she knows and what the situation provides to *construct* meaning and to act.

Here is another example of constructing meaning taken from Berk (2001, p. 31). This time a father and his four-year-old son co-construct understandings as they walk along a California beach, collecting litter after a busy day:

BEN: (*running ahead and calling out*) Some bottles and cans. I'll get them.

MEL: If the bottles are broken, you could cut yourself, so let me get them. *(Catches up and holds out the bag as Ben drops items in)*

BEN: Dad, look at this shell. It's a whole one, really big. Colors all inside!

MEL: Hmmm, might be an abalone shell.

BEN: What's abalone?

MEL: Do you remember what I had in my sandwich on the wharf yesterday? That's abalone.

BEN: You eat it?

MEL: Well, you can. You eat a meaty part that the abalone uses to stick to rocks.

BEN: Ewww. I don't want to eat it. Can I keep the shell?

MEL: I think so. Maybe you can find some things in your room to put in it. *(Points to the shell's colors)* Sometimes people make jewelry out of these shells.

BEN: Like mom's necklace?

MEL: That's right. Mom's necklace is made out of a kind of abalone with a very colorful shell—pinks, purples, blues. It's called Paua. When you turn it, the colors change.

BEN: Wow! Let's look for Paua shells!

MEL: You can't find them here, only in New Zealand.

BEN: Where's that? Have you been there?

MEL: No, someone brought Mom the necklace as a gift. But I'll show you New Zealand on the globe. It's far away, halfway around the world.

Look at the knowledge being co-constructed about sea creatures and their uses for food or decoration, safety, environmental responsibility, and even geography. Constructivist theories of learning focus on how people make meaning, both on their own like Chelsea and in interaction with others like Ben.

Different Versions of Constructivism

Constructivism, that "vast and woolly area in contemporary psychology, epistemology, and education" (von Glaserfeld, 1997, p. 204), is a broad term used by philosophers, curriculum designers, psychologists, educators, and others. Most people who use the term emphasize "the learner's contribution to meaning and learning through both individual and social activity" (Bruning, Schraw, & Ronning, 1999, p. 215). Constructivist perspectives are grounded in the research of Piaget, Vygotsky, the Gestalt psychologists (e.g., Kohler and Duncker), Bartlett, and Bruner as well as the educational philosophy of John Dewey, to mention just a few intellectual roots.

There is no one constructivist theory of learning, but "most constructivists share two main ideas: that learners are active in constructing their own knowledge and that social interactions are important to knowledge construction" (Bruning, Schraw, Norby, & Ronning, 2004, p. 195). Constructivism views learning as more than receiving and processing information transmitted by teachers or texts. Rather learning is the active and personal construction of knowledge (de Kock, Sleegers, & Voeten, 2004). There are constructivist approaches in science and mathematics education, in educational psychology and anthropology, and in computer-based education. Even though many psychologists and educators use the term *constructivism,* they often mean very different things (Driscoll, 2005; McCaslin & Hickey, 2001; Phillips, 1997).

One way to organize constructivist views is to talk about two forms of constructivism: psychological and social construction (Palincsar, 1998; Phillips, 1997). We could oversimplify a bit and say that psychological constructivists focus on how individuals use information, resources, and even help from others to build and improve their mental models and problem-solving strategies. In contrast, social constructivists see learning as increasing our abilities to participate with others in activities that are meaningful in the culture (Windschitl, 2002). Let's look a bit closer at each type of constructivism.

Psychological/Individual Constructivism. The **psychological constructivists** "are concerned with how *individuals* build up certain elements of their cognitive or emotional apparatus" (Phillips, 1997, p. 153). These constructivists might be interested in individual knowledge, beliefs, self-concept, or identity, so they are sometimes called *individual* constructivists; they all focus on the inner psychological life of people. Chelsea talking to the wall in the previous section was making meaning using her own individual knowledge and beliefs about how to respond when someone (or something) talks to you. She was using what she knew to impose intellectual structure on her world (Piaget, 1971; Windschitl, 2002).

Using these standards, the most recent information-processing theories are constructivist (Mayer, 1996). Information-processing approaches to learning regard the outside world as a source of input, but once the sensations are perceived and enter working memory, the important work is assumed to be happening "inside the head" of the individual (Schunk, 2004; Vera & Simon, 1993). But even though information-processing theorists talk about meaning and knowledge construction, many psychologists believe that information processing is "trivial constructivism" because the individual's only constructive contribution is to build accurate representations of the outside world (Derry, 1992; Garrison, 1995; Marshall, 1996).

In contrast, Piaget's psychological constructivist perspective is less concerned with "correct" representations and more interested in meaning as constructed by the individual. Piaget proposed a sequence of cognitive stages that all humans pass through.

Thinking at each stage builds on and incorporates previous stages as it becomes more organized and adaptive and less tied to concrete events. Piaget's special concern was with logic and the construction of universal knowledge that cannot be learned directly from the environment, knowledge such as conservation of volume or mental reversibility of actions (Miller, 2002). Such knowledge comes from reflecting on and coordinating our own thoughts, not from mapping external reality. Piaget saw the social environment as an important factor in development, but did not believe that social interaction was the main mechanism for changing thinking (Moshman, 1997).

Some educational and developmental psychologists have referred to Piaget's kind of constructivism as "**first wave constructivism**" or "solo" constructivism, with its emphasis on individual meaning-making (DeCorte, Greer, and Verschaffel, 1996; Paris, Byrnes, & Paris, 2001).

At the extreme end of individual constructivism is the notion of **radical constructivism**. This perspective holds that there is no reality or truth in the world, only the individual's perceptions and beliefs. Each of us constructs meaning from our own experiences, but we have no way of understanding or "knowing" the reality of others (Woods & Murphy, 2002). A difficulty with this position is that, when pushed to the extreme of relativism, all knowledge and all beliefs are equal because they are all valid individual perceptions. There are problems with this thinking for educators. First, teachers have a professional responsibility to emphasize some values, such as honesty or justice, over others, such as bigotry and deception. All perceptions and beliefs are not equal (Schunk, 2000).

Vygotsky's Social Constructivism. Vygotsky believed that social interaction, activity, and cultural tools shape individual development and learning, just as Ben's interactions on the beach with his father shaped Ben's learning about sea creatures, safety, environmental responsibility, and geography. By participating in a broad range of activities and using tools with others (both actual tools such as calculators and psychological signs and symbols such as language and number systems), learners *appropriate* (take for themselves) the outcomes produced by working together (Gredler, 2005; Palincsar, 1998). Putting learning in social and cultural context is "**second wave" constructivism** (Paris, Byrnes, & Paris, 2001).

Because his theory relies heavily on social interactions and the cultural context to explain learning, most psychologists classify Vygotsky as a **social constructivist** (Palincsar, 1998; Prawat, 1996), but some theorists categorize Vygotsky as a psychological constructivist because he was primarily interested in development within the individual (Moshman, 1997; Phillips, 1997). In a sense, he is both. One advantage of his theory of learning is that it gives us a way to consider both the psychological and the social; he bridges both camps. For example, Vygotsky's concept of the zone of proximal development—the area where a child can solve a problem with the help (scaffolding) of an adult or more able peer—has been called a place where culture and cognition create each other (Cole, 1985). Culture creates cognition when the adult uses tools and practices from the culture (language, maps, computers, looms, music, etc.) to steer the child toward goals the culture values (reading, writing, weaving, dance). Cognition creates culture as the adult and child together generate new practices and problem solutions to add to the cultural group's repertoire (Serpell, 1993). One way of integrating individual and social constructivism is to think of knowledge as individually constructed and socially mediated (Windschitl, 2002).

The term *constructivism* is sometimes used to talk about how public knowledge is created. Although this is not our main concern, it is worth a quick look.

Sociological Constructivism. Sociological constructivists (sometimes called construc*tionists*) do not focus on individual learning. Their concern is how public knowledge in disciplines such as science, math, economics, or history is constructed. Beyond this kind of academic knowledge, sociological constructivists also are interested in how commonsense ideas, everyday beliefs, and commonly held understandings about the world are communicated to new members of a sociocultural group (Gergen, 1997; Phillips, 1997). Questions raised might be who determines what constitutes history or the proper way to behave in public or how to get elected class president. There is no true knowledge, according to these theorists. All of knowledge is socially constructed, and, more important, some people have more power than others do in defining what constitutes such knowledge. Relationships between and among teachers, students, families, and the community are the central issues. Collaboration to understand diverse viewpoints is encouraged, and traditional bodies of knowledge often are challenged (Gergen, 1997). The philosophies of Jacques Dierrida and Michel Foucault are important sources for constructionists. Vygotsky's theory, with its attention to how cognition creates culture, has some elements in common with constructionism.

We think of the three main learning theories as three pillars for teaching. Students must first understand and make sense of the material (constructivist); then they must remember what they have understood (cognitive—information processing); and then they must practice and apply (behavioral) their new skills and understanding to make them more fluid and automatic, a permanent part of their repertoire. Failure to attend to any part of the process means lower-quality learning. Table 4.2 presents the behavioral and selected constructivist perspectives on learning.

Teaching Applications of Constructivist Perspectives

We have looked at some areas of disagreement among the constructivist perspectives, but what about areas of agreement? All constructivist theories assume that knowing develops as learners, like Chelsea and Ben, try to make sense of their experiences. "Learners, therefore, are not empty vessels waiting to be filled, but rather active organisms seeking meaning" (Driscoll, 2005, p. 487). These learners construct mental models or schemata and continue to revise them to make better sense of their experiences. Their constructions do not necessarily resemble external reality; rather they are the unique interpretations of the learner, like Chelsea's friendly persistent wall. This doesn't mean that all constructions are equally useful or viable. Learners test their understandings

TABLE 4.2 Four Views of Learning

There are variations within each of these views of learning that differ in emphasis.
There is also an overlap in constructivist views.

		Cognitive	Constructivist	
	Behavioral	*Information Processing*	*Psychological/Individual*	*Social/Situated*
	Skinner	**J. Anderson**	**Piaget**	**Vygotsky**
Knowledge	Fixed body of knowledge to acquire Stimulated from outside	Fixed body of knowledge to acquire Stimulated from outside Prior knowledge influences how information is processed	Changing body of knowledge, individually constructed in social world Built on what learner brings	Socially constructed knowledge Built on what participants contribute, construct together
Learning	Acquisition of facts, skills, concepts Occurs through drill, guided practice	Acquisition of facts, skills, concepts, and strategies Occurs through the effective application of strategies	Active construction, restructuring prior knowledge Occurs through multiple opportunities and diverse processes to connect to what is already known	Collaborative construction of socially defined knowledge and values Occurs through socially constructed opportunities
Teaching	Transmission Presentation (Telling)	Transmission Guide students toward more "accurate" and complete knowledge	Challenge, guide thinking toward more complete understanding	Co-construct knowledge with students
Role of Teacher	Manager, supervisor Correct wrong answers	Teach and model effective strategies Correct misconceptions	Facilitator, guide Listen for student's current conceptions, ideas, thinking	Facilitator, guide Co-participant Co-construct different interpretations of knowledge; listen to socially constructed conceptions
Role of Peers	Not usually considered	Not necessary but can influence information processing	Not necessary but can stimulate thinking, raise questions	Ordinary part of process of knowledge construction
Role of Student	Passive reception of information Active listener, direction-follower	Active processor of information, strategy user Organizer and reorganizer of information Rememberer	Active construction (within mind) Active thinker, explainer, interpreter, questioner	Active co-construction with others and self Active thinker, explainer, interpreter, questioner Active social participator

Source: From *Reconceptualizing Learning for Restructured Schools* by H. H. Marshall. Paper presented at the Annual Meeting of the American Educational Research Association, April 1992. Copyright © Hermine H. Marshall. Adapted with permission.

against experience and the understandings of other people—they negotiate and co-construct meanings like Ben did with his father.

Constructivists share similar goals for learning. They emphasize knowledge in use rather than the storing of inert facts, concepts, and skills. Learning goals include developing abilities to find and solve ill-structured problems, critical thinking, inquiry, self-determination, and openness to multiple perspectives (Driscoll, 2005).

Elements of Constructivist Teaching

Even though there is no single constructivist theory, many constructivist teaching approaches recommend

1. authentic tasks and complex, challenging learning environments;
2. social negotiation and shared responsibility as a part of learning;
3. multiple representations of content;
4. understanding that knowledge is constructed;
5. student-centered instruction (Driscoll, 2005; Marshall, 1992).

Let's look more closely at these dimensions of constructivist teaching.

Authentic Tasks. Constructivists believe that students should not be given stripped down, simplified problems and basic skills drills, but instead should deal with complex situations and "fuzzy," ill-structured problems. The world beyond school presents few simplified problems or step-by-step directions, so schools should be sure that every student has experience solving complex problems. These problems should be embedded in authentic tasks and activities, the kinds of situations that students will face as they apply what they are learning to real-world problems (Needles & Knapp, 1994).

Social Negotiation. Many constructivists share Vygotsky's belief that higher mental processes develop through social interaction, so collaboration in learning is valued. The Language Development and Hypermedia Group (1992) suggests that a major goal of teaching is to develop students' abilities to establish and defend their own positions while respecting the positions of others. To accomplish this exchange, students must talk and listen to each other.

Multiple Representations. When students encounter only one representation of content—one model, analogy, or way of understanding complex content—they often oversimplify as they try to apply that one approach to every situation. Rand Spiro and his colleagues (1991) suggest that "revisiting the same material, at different times, in re-arranged contexts, for different purposes, and from different conceptual perspectives is essential for attaining the goals of advanced knowledge acquisition" (p. 28). This idea is not entirely new. Years ago Jerome Bruner (1966) described the advantages of a spiral curriculum. This is a way of teaching that introduces the fundamental structure of all subjects—the "big ideas"—early in the school years, then revisits the subjects in more and more complex forms over time.

Understanding Knowledge Construction. The assumptions we make, our beliefs, and experiences shape what each of us comes to "know" about the world. Different assumptions and different experiences lead to different knowledge. Constructivists stress the importance of understanding the knowledge construction process so that students will be aware of the influences that shape their thinking; thus they will be able to choose, develop, and defend positions in a self-critical way while respecting the positions of others.

Student-Centered Instruction. The last characteristic of constructivist teaching listed by Driscoll (2005) is student-centered instruction. Following are four examples of student-centered instruction that are consistent with the other dimensions of constructivist teaching as well—inquiry learning, problem-based learning, cognitive apprenticeships, and cooperative learning.

Inquiry Learning

John Dewey described the basic **inquiry learning** format in 1910. There have been many adaptations of this strategy, but the form usually includes the following elements (Echevarria, 2003; Lashley, Matczynski, & Rowley, 2002): The teacher presents a puzzling event, question, or problem. The students

1. formulate hypotheses to explain the event or solve the problem;
2. collect data to test the hypotheses;
3. draw conclusions;
4. reflect on the original problem and on the thinking processes needed to solve it.

Shirley Magnusson and Annemarie Palincsar have developed a teachers' guide for planning, implementing, and assessing different phases of inquiry science units (Palincsar, Magnusson, Marano, Ford, & Brown, 1998). The model, called Guided Inquiry Supporting Multiple Literacies (or GIsML), is shown in Figure 4.7.

The teacher first identifies a curriculum area and some general guiding questions, puzzles, or problems. For example, an elementary teacher chooses communication as the area and asks this general question: "How and why do humans and animals communicate?" Next several specific focus questions are posed. "How do whales communicate? How do gorillas communicate?" The focus questions have to be carefully chosen to guide students toward important understandings. One key idea in understanding animal communication is the relationship between the animal's structures, survival functions, and habitat. Animals have specific *structures*, such as large ears or echo-locators, that *function* to find food or attract mates or identify predators, and these structures and functions are related to the animals' *habitats.* So focus questions must ask about animals with different structures for communication, different functional needs for survival, and different habitats. Questions about animals with the same kinds of structures or the same habitats would not be good focus points for inquiry (Magnusson & Palincsar, 1995).

The next phase is to engage students in the inquiry, perhaps by playing different animal sounds, having students make guesses and claims about communication, and asking the students questions about their guesses and claims. Then the students con-

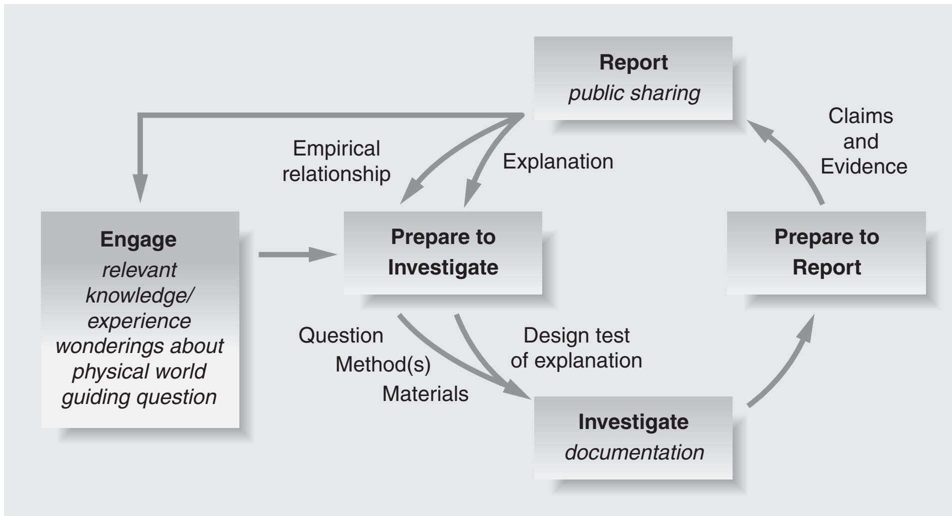

FIGURE 4.7 Learning Community: Program of Study

Source: From "Designing a Community of Practice: Principles and Practices of the GIsML Community," by A. S. Palincsar, S. J. Magnuson, N. Marano, D. Ford, and N. Brown, 1998, *Teaching and Teacher Education, 14*, p. 12. Adapted with permission.

duct both first-hand and second-hand investigations. *First-hand investigations* are direct experiences and experiments, for example, measuring the size of bats' eyes and ears in relation to their bodies (using pictures or videos, not real bats!). In *second-hand investigations*, students consult books, the Internet, interviews with experts, and so on to find specific information or get new ideas. As part of investigating, the students begin to identify patterns. The curved line in Figure 4.7 shows that cycles can be repeated. In fact, students might go through several cycles of investigation, pattern identification, and reporting results before moving on to constructing explanations and making final reports. Another possible cycle is to evaluate explanations before reporting by making and then checking predictions, applying the explanation to new situations.

Inquiry teaching allows students to learn content and process at the same time. In the examples above, students learned about animal communication and habitats. In addition, they learned the inquiry process itself: how to solve problems, evaluate solutions, and think critically. Inquiry has much in common with guided discovery learning in that inquiry methods require great preparation, organization, and monitoring to be sure everyone is engaged and challenged (Kindsvatter, Wilen, & Ishler, 1988).

Problem-Based Learning

In **problem-based learning**, students are confronted with a real problem that has meaning for them. This problem launches their inquiry as they collaborate to find solutions. In true problem-based learning, the problem is real and the students' actions matter.

"Problem-based learning turns instruction topsy-turvy. Students meet an ill-structured problem before they receive any instruction. In place of covering the curriculum, learners probe deeply into issues searching for connections, grappling with complexity, and using knowledge to fashion solutions" (Stepien & Gallagher, 1993, p. 26).

An example problem presented to one group of seventh and eighth graders in Illinois is, "What should be done about a nuclear waste dump site in our area?" The students soon learn that this real problem is not a simple one. Scientists disagree about the dangers. Environmental activists demand that the materials be removed, even if this bankrupts the company involved, one that employs many local residents. Some members of the state assembly want the material taken out-of-state, even though no place in the country is licensed to receive the toxic materials. The company believes the safest solution is to leave the materials buried. The students must research the situation, interview parties involved, and develop recommendations to be presented to state experts and community groups. "In problem-based learning students assume the roles of scientists, historians, doctors, or others who have a real stake in the proposed problem. Motivation soars because students realize it's their problem" (Stepien & Gallagher, 1993, p. 26). Other authentic problems that might be the focus for student projects are tracking pollution in local rivers, resolving student conflicts in school, raising money for the school computer lab, or building a playground for young children.

The teacher's role in problem-based learning is summarized in Table 4.3.

TABLE 4.3 The Teacher's Role in Problem-Based Learning

Phase	Teacher Behavior
Phase 1 Orient students to the problem	Teacher goes over the objectives of the lesson, describes important logistical requirements, and motivates students to engage in self-selected problem-solving activity.
Phase 2 Organize students for study	Teacher helps students define and organize study tasks related to the problem.
Phase 3 Assist independent and group investigation	Teacher encourages students to gather appropriate information, conduct experiments, and search for explanations and solutions.
Phase 4 Develop and present artifacts and exhibits	Teacher assists students in planning and preparing appropriate artifacts such as reports, videos, and models and helps them share their work with others.
Phase 5 Analyze and evaluate the problem-solving process	Teacher helps students to reflect on their investigations and the processes they used.

Source: From *Classroom Instruction and Management* (p. 161), by R. I. Arends, New York: McGraw-Hill.

Research on Inquiry and Problem-Based Learning. Inquiry methods are similar to discovery and share some of the same problems, so inquiry must be carefully planned and organized, especially for less prepared students who may lack the background knowledge and problem-solving skills needed to benefit. Some research has shown that discovery methods are ineffective and even detrimental for lower-ability students (Corno & Snow, 1986; Slavin, Karweit, & Madden, 1989). A distinction is usually made between pure discovery learning, in which the students work on their own to a very great extent, and **guided discovery,** in which the teacher provides some direction.

We know that working memory is severely limited when it is dealing with novel information from the outside, but almost unlimited when it is dealing with familiar, well-practiced and organized information from long-term memory. Because most inquiry and problem-based lessons require student to deal with the former—novel information and fuzzy problems—many educational psychology researchers believe that unguided discovery methods do not fit our information-processing capabilities and often put a strain on working memory (Kirschner, Swell, & Clark, 2006, 2007). Reviewing thirty years of research on pure discovery learning, Richard Mayer (2004) concludes:

> Like some zombie that keeps returning from its grave, pure discovery continues to have its advocates. However, anyone who takes an evidence-based approach to educational practice must ask the same question: Where is the evidence that it works? In spite of calls for free discovery in every decade, the supporting evidence is hard to find. (p. 17)

Activity-based teaching in science appears to be better than traditional methods in terms of students' understanding of the scientific method and creativity, but about the same for learning science content (Bredderman, 1983).

In terms of problem-based learning, Cindy Hmelo-Silver (2004) reviewed the research and found good evidence that problem-based learning supports the construction of flexible knowledge and the development of problem solving and self-directed learning skills, but there is less evidence that participating in problem-based learning is intrinsically motivating or that it teaches students to collaborate. In addition, most of the research has been done in higher education, especially medical schools.

In medical school, students learning with problem-based methods as opposed to traditional approaches appear to be better at clinical skills such as problem formation and reasoning, but worse in their basic knowledge of science and less prepared in science (Albanese & Mitchell, 1993). And some students, those who are better at self-regulation, benefit more from problem-based methods (Evensen, Salisbury-Glennon, & Glenn, 2001). The best approach may be a balance of content-focused and inquiry or problem-based methods (Arends, 2004). For example, Eva Toth, David Klahr, and Zhe Chen (2000) tested a balanced approach for teaching fourth graders how to use the controlled variable strategy in science to design good experiments. The method had three phases: (1) in small groups, students conducted exploratory experiments to identify variables that made a ball roll farther down a ramp; (2) the teacher led a discussion, explained the controlled variable strategy, and modeled good thinking about experiment design; and (3) the students designed and conducted application experiments to isolate which variables caused the ball to roll farther. The combination of inquiry, discussion, explanation, and modeling was successful in helping the students understand the concepts.

Cognitive Apprenticeships

Over the centuries, apprenticeships have proved to be an effective form of education. By working alongside a master and perhaps other apprentices, young people have learned many skills, trades, and crafts. Why are they so effective? Apprenticeships are rich in information because the master knows a great deal about the subject. Working with more knowledgeable guides provides models, demonstrations, and corrections, as well as a personal bond that is motivating. The performances required of the learner are real and important and grow more complex as the learner becomes more competent (Collins, Brown, & Holum, 1991; Collins, Brown, & Newman, 1989; Hung, 1999).

Collins and his colleagues (1989) suggest that knowledge and skills learned in school have become too separated from their use in the world beyond school. To correct this imbalance, some educators recommend that schools adopt many of the features of apprenticeships. But rather than learning to sculpt or dance or build a cabinet, apprenticeships in school would focus on cognitive objectives such as reading comprehension or writing or mathematical problem solving. There are many **cognitive apprenticeship** models, but most share six features:

1. Students observe an expert (usually the teacher) model the performance.
2. Students get external support through coaching or tutoring (including hints, feedback, models, reminders).
3. Conceptual scaffolding (in the form of outlines, explanations, notes, definitions, formulas, procedures, etc.) is provided and then gradually faded as the student becomes more competent and proficient.
4. Students continually articulate their knowledge, putting into words their understanding of the processes and content being learned.
5. Students reflect on their progress, comparing their problem solving to an expert's performance and to their own earlier performances.
6. Students are required to explore new ways to apply what they are learning, ways that they have not practiced at the master's side.

One way to connect learning to the outside world is to include parents in students' learning. The Principal's Perspective tells how an actual elementary principal accomplished this goal.

A Principal's Perspective

Mindful of the research on the impact of home environment on student achievement (Marzano, 2003; Reeves, 2000), D. W. knew that, to make the academic gains in reading she envisioned for her elementary school, she would have to somehow enhance parental involvement at home. Combining the resources of a statewide reading grant and an established school-business partnership with a local hospital, D. W. purchased an assortment of books, games, and information cards to include in 150 book bags that students could take home for a couple of days at a time to read together with their parents, grandparents, babysitters, and even siblings. The bags also included a journal in which parents could share feedback and general comments with the school.

But D. W. also knew that making quality reading materials more accessible to families was not enough. If parents were to be true partners in their children's education they also would need strategies and techniques to most effectively use the reading materials at home. So she enlisted the expertise of her teaching staff and organized a series of family reading nights throughout the school year. At these events, teachers taught parents how to use decoding and questioning techniques familiar to the students from school and gave them the confidence and the strategies to be genuine partners in their children's reading development.

Marzano, R. J. (2003). *What works in schools: Translating research into action.* Alexandria, VA: Association of Supervision and Curriculum Development:.

Reeves, D. B. (2000). *Accountability in action: A blueprint for learning organizations.* Denver, CO: Advanced Learning Press.

Group Work and Cooperation in Learning

Clearly, collaboration and cooperation are important in many visions of innovation and school reform. Teachers are expected to collaborate with parents, administrators, and each other. Cooperative learning structures and approaches are seen as valuable; interdependence, reciprocal learning, and learning communities are mentioned often as desirable features of teaching and learning. For example, the second of three recommendations for strengthening middle grades' teacher preparation published by the National Middle School Association (Scales & McEwin, 1994) is "greater variety of developmentally responsive teaching and assessment techniques, especially cooperative learning, interdisciplinary curriculum and team teaching, student exhibitions, and portfolios" (p. 5).

The History of Cooperative Learning. Collaboration and cooperative learning have a long history in American education. In the early 1900s, John Dewey criticized the use of competition in education and encouraged educators to structure schools as democratic learning communities. These ideas fell from favor in the 1940s and 1950s, replaced by a resurgence of competition. In the 1960s, there was a swing back to individualized and cooperative learning structures, stimulated in part by concern for civil rights and interracial relations (Webb & Palincsar, 1996).

Today, evolving constructivist perspectives on learning fuel interest in collaboration and cooperative learning. Two characteristics of constructivist teaching—complex, real-life learning environments and social interaction (Driscoll, 2005)—are consistent with the use of cooperative learning structures. As educators focus on learning in real contexts, "there is a heightened interest in situations where elaboration, interpretation, explanation, and argumentation are integral to the activity of the group and where learning is supported by other individuals" (Webb & Palincsar, 1996, p. 844).

Theoretical Underpinnings of Cooperative Learning. Advocates of different theories of learning find value in cooperative learning, but not for the same reasons.

In terms of *academic/cognitive goals*, information-processing theorists suggest that group discussion can help participants rehearse, elaborate, and expand their knowledge. As group members question and explain, they have to organize their knowledge, make connections, and review, all processes that support information processing and memory. Advocates of a Piagetian perspective assert that the interactions in groups can create the cognitive conflict and disequilibrium that lead an individual to question his or her understanding and try out new ideas or, as Piaget (1985) said, "to go beyond his current state and strike out in new directions" (p. 10). Educators who favor Vygotsky's theory suggest that social interaction is important for learning because higher mental functions such as reasoning, comprehension, and critical thinking originate in social interactions and are then internalized by individuals. Thus, cooperative learning provides the social support and scaffolding that students need to move learning forward. Table 4.4 summarizes the functions of cooperative learning from different perspectives, and describes some of the elements of each kind of group.

In terms of *interpersonal/social goals*, research indicates that cooperative learning has a positive impact on interracial friendships, prejudice reduction, acceptance of disabled students, self-esteem, peer support for academic goals, altruism, empathy, social perspective-taking, liking fellow classmates and feeling liked, sense of responsibility and control over learning, and time on-task. Positive effects often are attributed to the process of working toward common goals as equals, which was shown in laboratory studies years ago to increase liking and respect among individuals from different racial or social groups (Allport, 1954). The motivation growing from the praise and encouragement of peers working toward a common goal also brings positive effects (Deutsch, 1949). Thus, cooperative strategies have been touted as particularly useful in combating the detrimental social effects of cliques in middle school and high schools, the negative effects of competition on student self-esteem, and the alienation of students who are not members of popular social groups (Aronson, 2000; Aronson & Patnoe, 1997).

Elements of Cooperative Learning. David and Roger Johnson (1999a) list five elements that define true **cooperative learning** groups. Students *interact face-to-face* and close together, not across the room. Group members experience *positive interdependence:* They need each other for support, explanations, and guidance. Even though they work together and help each other, members of the group must ultimately demonstrate learning on their own; they are held *individually accountable* for learning, often through individual tests or other assessments. *Collaborative skills* are necessary for effective group functioning. Often these skills, such as giving constructive feedback, reaching consensus, and involving every member, must be taught and practiced before the groups tackle a learning task. Finally, members monitor *group processes* and relationships to make sure the group is working effectively and to learn about the dynamics of groups. They take time to ask, "How are we doing as a group? Is everyone working together?"

What Can Go Wrong: Misuses of Group Learning. Without careful planning and monitoring by the teacher, group interactions can hinder learning and reduce rather

TABLE 4.4 Different Forms of Cooperative Learning for Different Purposes

Different forms of cooperative learning (Elaboration, Piagetian, and Vygotskian) fit different purposes, need different structures, and have their own potential problems and possible solutions.

Considerations	Elaboration	Piagetian	Vygotskian
Group size	Small (2–4)	Small	Dyads
Group composition	Heterogeneous/ homogeneous	Homogeneous	Heterogeneous
Tasks	Rehearsal/integrative	Exploratory	Skills
Teacher role	Facilitator	Facilitator	Model/guide
Potential problems	Poor help-giving Unequal participation	Inactive No cognitive conflict	Poor help-giving Providing adequate time/dialogue
Averting Problems	Direct instruction in help-giving Modeling help-giving Scripting interaction	Structuring controversy	Direct instruction in help-giving Modeling help-giving

Source: From “Learning from Peers: Beyond the Rhetoric of Positive Results,” by A. M. O’Donnell and J. O’Kelly, 1994, *Educational Psychology Review*, *6*, p. 327. Reprinted with permission of Kluwer Academic/Plenum Publishers and Angela O’Donnell.

than improve social relations in classes. For example, if there is pressure in a group for conformity—perhaps because rewards are being misused or one student dominates the others—interactions can be unproductive and unreflective. Misconceptions might be reinforced or the worst, not the best, ideas may be combined to construct a superficial understanding (Battistich, Solomon, & Delucci, 1993). Students who work in groups but arrive at wrong answers may be more confident that they are right—a case of “two heads are worse than one” (Puncochar & Fox, 2004). Also, the ideas of low-status students may be ignored or even ridiculed while the contributions of high-status students are accepted and reinforced, regardless of the merit of either set of ideas (Anderson, Holland, & Palincsar, 1997; Cohen, 1986). The next sections examine how teachers can avoid these problems and encourage true cooperation.

Setting Up Cooperative Groups. O’Donnell & O’Kelly (1994) note that determining the size of a group depends in part on the purpose of the group activity. If the purpose is for the group members to review, rehearse information, or practice, larger groups (between four and six students) are useful. But if the goal is to encourage each student to participate in discussions, problem solving, or computer learning, then groups of two to four members work best. Also, some research indicates that when there are just a few girls in a group, they tend to be left out of the discussions unless they are the most able or assertive members. By contrast, when there are only one or two boys in the group, they tend to dominate and be "interviewed" by the girls unless these boys are less able than the girls or are very shy. In general, for very shy and introverted students, individual learning may be a better approach (Webb, 1985; Webb & Palincsar, 1996).

In practice, the effects of learning in a group vary, depending on what actually happens in the group and who is in it. If only a few people take responsibility for the work, these people will learn, but the nonparticipating members probably will not. Students who ask questions, get answers, and attempt explanations are more likely to learn than students whose questions go unasked or unanswered. In fact, there is evidence that the more a student provides elaborated, thoughtful explanations to other students in a group, the more the *explainer* learns. Giving good explanations appears to be even more important for learning than receiving explanations (Webb, Farivar, & Mastergeorge, 2002; Webb & Palincsar, 1996). In order to explain, you have to organize the information, put it into your own words, think of examples and analogies (which connect the information to things you already know), and test your understanding by answering questions. These are excellent learning strategies (King, 1990, 2002; O'Donnell & O'Kelly, 1994).

Some teachers assign roles such as reporter or discussion manager to students to encourage cooperation and full participation. Such roles should be assigned with engagement and learning in mind. In groups that focus on practice, review, or mastery of basic skills, roles should support persistence, encouragement, and participation. In groups that focus on higher-order problem solving or complex learning, roles should encourage thoughtful discussion, sharing of explanations and insights, probing, brainstorming, and creativity. Teachers must be careful, however, not to communicate to students that the major purpose of the groups is simply to do the roles, in order to avoid having roles become ends in themselves (Woolfolk Hoy & Tschannen-Moran, 1999).

Jigsaw. An early format for cooperative learning, **Jigsaw** emphasized high interdependence. This structure was invented by Elliot Aronson and his graduate students in 1971 in Austin, Texas, "as a matter of absolute necessity to help defuse a highly explosive situation" (Aronson, 2000). The Austin schools had just been desegregated by court order. White, African American, and Hispanic students were together in classrooms for the first time. Hostility and turmoil ensued with fistfights in corridors and classrooms. Aronson's answer was the Jigsaw classroom.

In Jigsaw, each group member was given part of the material to be learned by the whole group and became an "expert" on his or her piece. Students had to teach each other, so everyone's contribution was important. A more recent version, Jigsaw II, adds expert groups where the students who have the same material from each learning group confer to make sure they understand their assigned part and then plan ways to teach the information to their learning group members. Next, students return to their learning groups, bringing their expertise to the sessions. In the end, students take an individual test covering all the material and earn points for their learning team score.

Teams can work for rewards or simply for recognition (Aronson & Patnoe, 1997; Slavin, 1995).

In his first test of Jigsaw, Aronson reports that teachers "spontaneously told us of their great satisfaction with the way the atmosphere of their classrooms had been transformed. Adjunct visitors (such as music teachers and the like) were little short of amazed at the dramatically changed atmosphere in the classroom" (Aronson, 2000). Students expressed less prejudice, were more confident, liked school better, and had higher scores on objective examinations. The overall improvements in test scores came mostly from increases in minority group children; Anglo students maintained their previous levels of performance. These findings are consistent with recent research on cooperative learning, as reviewed by Slavin (1995).

There are many other forms of cooperative learning used in schools today. It would be difficult to complete a teacher preparation program without encountering encouragement to use these methods. Kagan (1994) and Slavin (1995) have written extensively on the subject and developed many formats. No matter what the format, however, the key to learning in groups appears to be the *quality of the discussions* among the students. Talk that is interpretive—that analyzes and discusses explanations, evidence, reasons, and alternatives—is more valuable than talk that is merely descriptive. And teachers play an important role; they cannot leave the students unguided, but rather have to seed the discussion with ideas and alternatives that push and prod student thinking (Palincsar, 1998; Woolfolk Hoy & Tschannen-Moran, 1999).

Sometimes when schools adopt innovative teaching practices there are objections from families. The following Theory into Action Guidelines for principals and teachers suggest ways of working with families and the community when schools adopt innovations.

Dilemmas of Constructivist Practice

Years ago, Larry Cremin (1961) observed that progressive, innovative pedagogies require infinitely skilled teachers. Today, the same could be said about constructivist teaching. We have already seen that there are many varieties of constructivism and many practices that flow from these different conceptions. We also know that all teaching today happens in a context of high-stakes testing and accountability. In these situations, constructivist teachers face many challenges. Mark Windschitl (2002) identified four teacher dilemmas of constructivism in practice, summarized in Table 4.5. The first is conceptual: How do I make sense of cognitive versus social conceptions of constructivism and reconcile these different perspectives with my practice? The second dilemma is pedagogical. How do I teach in truly constructivist ways that honor my students' attempts to think for themselves but still ensure that they learn the academic material? Third are cultural dilemmas about what activities, cultural knowledge, and ways of talking will build a community in a diverse classroom. How do I build on students' cultural funds of knowledge while acknowledging but seeing beyond my own past experiences? Finally there are political dilemmas. How can I teach for deep understanding and critical thinking but still satisfy the accountability demands of parents and the requirements of No Child Left Behind?

THEORY INTO ACTION GUIDELINES

Explaining Innovations

Be confident and honest.

Examples

1. Write out your rationale for the methods you are using—consider likely objections and craft your responses.
2. Admit mistakes or oversights—explain what you have learned from them.

Treat parents as equal partners.

Examples

1. Listen carefully to parents' objections, take notes, and follow up on requests or suggestions. Remember, you both want the best for the child.
2. Give parents the telephone number of an administrator who will answer their questions about a new program or initiative.
3. Invite families to visit your room or assist in the project in some way.

Communicate effectively.

Examples

1. Use plain language and avoid jargon. If you must use a technical term, define it in accessible ways. Use your best teaching skills to educate parents about the new approach.
2. Encourage local newspapers or television stations to do stories about the "great learning" going on in your classroom or school.
3. Create a lending library of articles and references about the new strategies.

Have examples of projects and assignments available for parents when they visit your class.

Examples

1. Encourage parents to try math activities. If they have trouble, show them how your students (and their child) are successful with the activities and highlight the strategies the students have learned.
2. Keep a library of students' favorite activities to demonstrate for parents.

Develop family involvement packages.

Examples

1. Once a month, send families, via their children, descriptions and examples of the math, science, or language to be learned in the upcoming unit. Include activities children can do with their parents
2. Make the family project count, for example, as a homework grade.

Source: From M. Meyer, M. Delgardelle, and J. Middleton. "Addressing parents' concerns over curriculum reform." *Educational Leadership*, *53*(7), p. 57. Adapted by permission of the Association for Supervision and Curriculum Development.

Summary

Although theorists disagree about the definitions of *learning*, most would agree that learning occurs when experience causes a change in a person's knowledge or behavior.

Behavioral views of learning focus on the role of external events—antecedents and consequences—in changing observable behaviors. Consequences that increase behaviors are called reinforcers, and consequences that decrease behaviors are called punishers. A behavioral perspective is most useful in understanding and dealing with classroom management issues. For example, positive behavior supports are an application of

TABLE 4.5 Teachers' Dilemma of Constructivism in Practice

Teachers face conceptual, pedagogical, cultural, and political dilemmas as they implement constructive practices. Here are explanations of these dilemmas and some representative questions that teachers face as they confront them.

Teachers' Dilemma category	Representative Questions of Concern
I. *Conceptual dilemmas:* Grasping the underpinnings of cognitive and social constructivism; reconciling current beliefs about pedagogy with the beliefs necessary to support a constructivist learning environment.	Which version of constructivism is suitable as a basis for my teaching? Is my, classroom supposed to be a collection of individuals working toward conceptual change or a community of learners whose development is measured by participation in authentic disciplinary practices? If certain ideas are considered correct by experts, should students internalize those ideas instead of constructing their own?
II. *Pedagogical dilemmas:* Honoring students' attempts to think for themselves while remaining faithful to accepted disciplinary ideas; developing deeper knowledge of subject matter; mastering the art of facilitation; managing new kinds of discourse and collaborative work in the classroom.	Do I base my teaching on students' existing ideas rather than on learning objectives? What skills and strategies are necessary for me to become a facilitator? How do I manage a classroom where students are talking to one another rather than to me? Should I place limits on students' construction of their own ideas? What types of assessments will capture the learning I want to foster?
III. *Cultural dilemmas:* Becoming conscious of the culture of your classroom; questioning assumptions about what kinds of activities should be valued; taking advantage of experiences, discourse patterns, and local knowledge of students with varied cultural backgrounds.	How can we contradict traditional, efficient classroom routines and generate new agreements with students about what is valued and rewarded? How do my own past images of what is proper and possible in a classroom prevent me from seeing the potential for a different kind of learning environment? How can I accommodate the worldviews of students from diverse backgrounds while at the same time transforming my own classroom culture? Can I trust students to accept responsibility for their own learning?
IV. *Political dilemmas:* Confronting issues of accountability with various stakeholders in the school community; negotiating with key others the authority and support to teach for understanding.	How can I gain the support of administrators and parents for teaching in such a radically different and unfamiliar way? Should I make use of approved curriculums that are not sensitive enough to my students' needs, or should I create my own? How can diverse problem-based experiences help students meet specific state and local standards? Will constructivist approaches adequately prepare my students for high-stakes testing for college admissions?

Source: M. Windschitl (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research*, 72, p. 133. Copyright © 2002 by the Americana Educational Research Association. Reproduced with permission of the publisher.

behavioral learning. Another example you may have used is contracts. The teacher draws up an individual contract with each student, describing exactly what the student must do to earn a particular privilege or reward. In some programs, students participate in deciding on the behaviors to be reinforced and the rewards that can be gained. A teacher must use these programs with caution, emphasizing learning and not just "good" behavior.

Cognitive views of learning focus on the human mind's active attempts to make sense of the world. Knowledge is a central force in cognitive perspectives. The individual's prior knowledge affects what he or she will pay attention to, recognize, understand, remember, and forget. Knowledge can be general or domain-specific and declarative, procedural, or conditional, but to be useful, knowledge must be remembered. One influential model of memory is information processing, which describes how information moves from sensory memory (which holds a wealth of sensations and images very briefly) to working memory (where the information is elaborated and connected to existing knowledge) to long-term memory (where the information can be held for a long time, depending on how well it was learned in the first place and how interconnected it is to other information). People vary in how well they learn and remember based in part on their metacognitive knowledge, their abilities to plan, monitor, and regulate their own thinking. There are many teaching applications of cognitive views including mnemonics, imagery, and other learning strategies to help organize and elaborate material.

Constructivist views of learning emphasize the importance of students' construction of knowledge; however, there are many different constructivist explanations of learning. Psychological constructivists are concerned with how *individuals* make sense of their worlds. These constructivists might be interested in individual knowledge, beliefs, self-concept, or identity, so they are sometimes called *individual* constructivists; they all focus on the inner psychological life of people. Social constructivists believe that social interaction, cultural tools, and activity shape individual development and learning. By participating in a broad range of activities with others, learners appropriate (take for themselves) the outcomes produced by working together; they acquire new strategies and knowledge of their world. Finally, sociological constructivists are interested in how public knowledge in disciplines such as science, math, economics, or history is constructed as well as how everyday beliefs and commonly held understandings about the world are communicated to new members of a sociocultural group.

Constructivist approaches to teaching recommend complex, challenging learning environments; social negotiation and collaboration; multiple representations of content; understanding that knowledge is a human construction; and student-centered methods such as inquiry learning, problem-based learning, cognitive apprenticeships, and cooperative learning.

Each of these three perspectives provides valuable insights into learning; hence, the issue is not which perspective is best but rather what each perspective brings to bear in understanding a variety of the teaching and learning problems. Just as there is no one best way to teach (Chapter 6), this is no one best way to learn. Behavioral, cognitive, and constructivist viewpoints of learning complement each other and enhance our understanding of learning.

KEY TERMS

antecedents (97)
attention (107)
chunking (111)
cognitive apprenticeship (134)
conditional knowledge (106)
constructivism (124)
cooperative learning (136)
cueing (98)
declarative knowledge (106)
domain-specific knowledge (106)
elaboration (113)
elaborative rehearsal (111)
episodic memory (111)
executive control processes (115)
first wave constructivism (126)
flashbulb memory (111)
functional behavioral assessment (FBA) (102)
guided discovery (133)
inquiry learning (130)
Jigsaw (138)
keyword method (119)
learning (93)
maintenance rehearsal (110)
metacognition (115)
mnemonics (119)
negative reinforcement (96)
positive behavioral supports (102)
positive reinforcement (95)
presentation punishment (96)
problem-based learning (131)
procedural knowledge (106)
procedural memory (112)
prompting (98)
psychological constructivists (125)
punishment (96)
radical constructivism (126)
reinforcement process (95)
reinforcer (95)
removal punishment (96)
schemas (112)
second wave constructivism (126)
semantic memory (112)
sensory memory (107)
situated learning (92)
social constructivist (126)
working memory (109)

DEVELOPING YOUR PORTFOLIO

1. As principal, you have decided that your elementary school needs a writing program that is a good balance of skills and composition. Prepare a short position paper on the advantages and disadvantages of each approach. Then prepare a plan that incorporates the best of both approaches. Support your argument with current research and theory on learning.
2. Prepare a PowerPoint presentation on the strengths and weaknesses of each of the learning perspectives discussed in this chapter: behavioral, cognitive, and constructivist. Be sure to discuss the situations for which each perspective is most appropriate. For example, list the tasks or situations for which the behavioral approach is best. Give at least one example for each approach.
3. Reread the Leadership Challenge at the beginning of this chapter and assume you are the principal in that school.
   a. Develop a plan for working with the history department to resolve the issue such that both extremes (the traditionalists and the constructivists) are satisfied.
   b. Consult the Theory into Action Guidelines about explaining innovations and devise a process for introducing the new plan to the community.

INSTRUCTIONAL LEADER'S TOOLBOX

Readings

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Wiggins, G., & McTighe, J. (2005). *Understanding by design: Expanded 2nd edition.* Alexandria, VA: Association for Supervision and Curriculum Development.

Videos

Memory: Fabric of the mind. 28 minutes. What kind of brain chemistry can explain memory? Are different types of memory located at different areas of the brain? What is the process of forgetting? Is it possible to improve memory? This program seeks answers to these and other fascinating questions about the brain and memory at several internationally renowned memory-research labs. Order from Films for the Humanities & Sciences, Inc., P.O. Box 2053, Princeton, NJ, 08543, or 800–257–5126.

Websites

www.ericdigests.org/pre-924/critical.htm
Critical Thinking in the Social Studies

www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/15/45/88.pdf
Improving the Quality of Student Notes

edweb.sdsu.edu/courses/ET650_online/MAPPS/Strats.html
Learning Strategies Matrix

www.tutorials.com/fd/tutorials.asp
Learn To: provides thousands of step-by-step tutorials on a variety of skills

www.indiana.edu/~reading/ieo/digests/d96.html
Metacognition and Reading to Learn

www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/11/0a/c3.pdf
Metacomprehension

www.psychwww.com/mtsite/
Mindtools

www.ericdigests.org/1993/early.htm
Problem Solving in Early Childhood Classrooms

www.ericdigests.org/pre-9212/problem.htm
Teaching Problem Solving—Secondary School Science

Organizations

www.wolftrap.org/institute/
Wolf Trap Institute for Early Learning through the Arts: Organization to help early childhood professionals use the arts as part of their care and instruction of young children. The Institute is accessible on the Web by going to the main site for Wolf Trap and then selecting "education."

www.ascd.org/
Association for Supervision and Curriculum Development

www.ciera.org/
Center for the Improvement of Early Reading Achievement