Educational Psychology: Understanding Students' Thinking

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CHAPTER 1
Introduction

Chapter Outline

This textbook is about how students learn and how teachers can teach well. Although this textbook assumes no prior knowledge about educational research, it is intended to be much more than just an “introduction” that will lay the groundwork for you to learn to teach later on. On the contrary, as you read this book, you will learn theory- and research-based skills that you could apply right away as a teacher. My expectation is that you will gain a deep understanding of educational theory and practice grounded in many, many examples of classroom learning and instruction. You will have the opportunity to learn teaching skills that will make you a very successful teacher (if you have not taught before) or will help you to become a more successful teacher (if you are already teaching).

This textbook is grounded in my conviction that educational researchers have generated a body of potent knowledge that can help teachers teach very effectively. This knowledge can guide teachers as they develop their goals, their assessments, and their instruction. I am tremendously excited about this research, and I hope that you, too, will “catch” this excitement.

WHY STUDY EDUCATIONAL RESEARCH?

Why study educational research? My answer is simple: Educational researchers have developed very powerful ideas about learning and teaching over the past several decades. By applying these ideas, teachers can teach *much* more effectively than they could had they not learned these ideas.

Let me start with a personal example. After earning a master’s degree in Teaching English as a Foreign Language, I began my teaching career teaching English in Japan. I taught for over four years in Japan before I entered a doctoral program to become an educational researcher. My master’s degree had not focused much on the research on learning and teaching, so my doctoral program was my first exposure to such research. About three years into my doctoral program, it struck me that my ideas about how to teach were now *completely* differently from when I was teaching in Japan, as a result of what I had learned about learning and teaching in my courses. I realized that if I were to go back and teach English in Japan again, I would do virtually everything differently.

What had I learned that was so transformative? I had learned completely new ways of motivating students--ways I had never considered before **Error! Bookmark not defined.**. I had learned about the importance of **metacognition**, which refers to students’ awareness of how they are learning and how they can learn more effectively by using better study strategies (Azevedo & Hadwin, 2005; A. L. Brown, Bransford, Ferrara, & Campione, 1983). (We will discuss metacognition in more detail later in this chapter.) I had completely new ideas about which study strategies are most effective. I had also learned completely new approaches of organizing group work effectively (A. King, 1991, 2002; O'Donnell, 1999, 2006; Webb, 1982; Webb, Farivar, & Mastergeorge, 2002). And perhaps most importantly, I had learned about the importance of paying very detailed attention to my students’ ideas. I had learned that students do not come to learning tasks with “empty heads” waiting to be filled with information provided by the teacher. Instead, students come to class with their own ideas about what they are learning, and these ideas *profoundly* affect what they learn (R. Driver & Easley, 1978; Shtulman, in press). Therefore, to understand how students are learning and how I should teach to help them learn more effectively, I really had to understand my students’ thinking. Indeed, this idea is so important that it has become the subtitle of this textbook: *Understanding students’ thinking.*

Reflecting on all that I had learned in my doctoral program, I wish that I had learned all these powerful ideas before I had begun teaching! Although I worked hard and conscientiously as a teacher in Japan, I now realize that I could have been far more successful if I had only known what I had learned in my doctoral program. My goal in writing this book is to try to help you, as a future or present teacher, learn about these powerful ideas now.

As a researcher working in classrooms, I have repeatedly observed the transformations that occur in classrooms when teachers implement good instruction grounded in research. My research has covered a wide range of topics in both elementary and secondary schools. I have worked with research teams and with teachers on improving discussions in fourth-grade reading classes (Chinn & Anderson, 1998;

Waggoner, Chinn, Anderson, & Yi, 1995), on improving students' thinking and writing in sixth- and eighth-grade social-studies classes (Chinn & Flynn, 1999), and on improving students' science achievement in elementary and middle schools (Chinn, Duschl, Duncan, Pluta, & Buckland, 2008b; Pluta, Buckland, Chinn, Duschl, & Duncan, 2008a). In each of these projects, teachers, principals, and supervisors have been enthusiastic about the new, research-based ways of teaching that we have introduced. The teachers working with us have found that their students are capable of far higher levels of performance than they had imagined. Indeed, when a group of seventh grade teachers participating in my most recent project presented some of their students' work at a recent state science convention (Ambos, Buckland, & Hung, 2007; Robbins, Piegaro, & Chinn, 2007), some of the middle-school teachers in the audience expressed amazement (and even disbelief!) that the work had been done by seventh graders, rather than by older students.

The research literature is filled with many, many examples of how classrooms and schools can be transformed through applying the findings of contemporary educational research (e.g., Britt & Aglinskas, 2002; Chinn, in press-a; Hapgood, Magnusson, & Palincsar, 2004; Langer, 2001; Lehrer & Schauble, 2004; R. Slavin, in press; C. L. Smith, Maclin, Houghton, & Hennessey, 2000; Wilkinson, in press; T. Wood & Sellers, 1996). Many studies document the high levels of student learning and engagement that result when teachers apply instruction grounded in educational research. Educational researchers have developed ideas that can transform teaching and make a tremendous difference in the lives of their students. In writing this textbook, my overarching goal is to help you master many of these ideas so that you can apply them to your own teaching.

THE STRUCTURE OF THIS TEXTBOOK

This textbook has four units: theories of learning and development (chapters 2, 3, and 4), influences on learning (chapters 5, 6, and 7), instructional goals and assessment (chapters 8 and 9), and creating effective learning environments (chapters 10 through 15). This organization of units and chapters has grown out of my thinking about what teachers need to know to be effective teachers. We'll discuss the rationale for this organization in this section.

Unit 1: Theories of Learning and Development

Immediately after this introductory chapter, we begin Unit 1, which presents an overview of theories in three main areas: theories of learning, theories of cognitive development, and theories of social development. Theories in all of these areas can inform educational applications to teaching. There is no one-to-one relationship between theories of learning and educational applications. Most of the educational applications we discuss in this book are closely related to two or more of the theories of learning and development. For example, recommendations about the best study strategies for students to use are closely related to theoretical ideas developed within several different theories of learning and development. My goal is to help you see how important educational applications are related to multiple theories.

To achieve this goal, we will first set the stage by examining the important theories of learning and instruction. Later we will examine how the theories are jointly applied in educational applications. The first three chapters provide a basic overview of theories of learning, theories of cognitive development, and theories of social development. In later chapters, we will note how different educational applications are related to one or more of the theories that you have studied in Chapters 2, 3, and 4. For instance, when we discuss instructional methods for using groups effectively in Chapter 16, we will note how different methods are related to the different theories of learning that we have examined in Chapter 2, different theories of development examined in Chapter 3, and different theories of social development examined in Chapter 4.

One of the features of this textbook is especially designed to help connect educational applications to the theories in Chapters 2, 3, and 4. This feature is the "Link to Theories" feature that recurs throughout the chapters of this book. Each time we see how a theory is related to a new educational application, we will gain new insights into that theory; we will also gain new insights into the application.

Unit 2: Influences on Learning

The second unit of the book contains three chapters about important influences on learning. Chapter 5 discusses individual and group differences and how these differences can influence learning. Chapter 6 addresses students' prior conceptions about academic topics and how these conceptions influence learning. Chapter 7 addresses the strategies (such as study strategies) that students use and how their choice of strategies influences learning. Only by understanding all these influences can teachers design instruction that is maximally effective in helping students learn.

Chapter 5 (Individual and Group Differences) discusses individual and group influences on student learning. **Individual differences** include factors such as students' gender, their intelligence, and whether they are learning disabled. **Group differences** include factors such as cultural norms and the language spoken by a community. It is important for teachers to understand how individual factors such as having a learning disability can affect how students learn. It is also important for teachers to understand how group factors such as a student's cultural background can influence students' learning. Chapter 5 develops initial ideas about individual and group influences on learning that we will continue to expand upon throughout the textbook.

Chapter 6 addresses students' prior conceptions about what they are studying in school. **Prior conceptions** refer to the ideas about the physical, natural, and social worlds that students have before they begin new instruction on these topics. For instance, many students have the conception that water is made up of drops of water. For a student who thinks that water is made up of drops of water, the notion that water is composed of hard, elastic, not-wet molecules is a strange idea that is extremely difficult to understand (Andersson, 1990; Liu & Lesniak, 2006). How could something wet like water be made of hard molecules that are not themselves wet? It makes no sense to these students. Students' prior conceptions can thus make it difficult to learn ideas that conflict with these conceptions. Conversely, when students' prior conceptions are congruent with what they are learning, their prior conceptions can make learning new ideas easier. When students already know some key ideas about the industrial revolution, they will learn more from a lecture about the industrial revolution than students who knew nothing about it.

Students' knowledge of strategies is also important. **Strategies** are the actions that people take to achieve goals. For example, when students have the goal of learning the key ideas in a textbook chapter, they may use strategies such as outlining the chapter or summarizing the main sections of the chapter. When students have the goal of solving a difficult problem, they may use strategies such as brainstorming possible solutions, trying out different alternative solutions, and checking the answer to make sure it makes sense. Students' strategies are an important determinant of what they learn in class (Zimmerman, 1998). Many students use ineffective study strategies instead of the more effective strategies that we will discuss throughout this textbook. An important job for teachers is to help students learn to use more effective strategies.

Together, prior conceptions and prior strategies strongly affect learning. When teachers gain a deep understanding of students' prior conceptions and strategies, they typically find that they cannot teach in their old ways. One of the middle school teachers I have recently been working with said in an interview, "I used to think that my job was to pour information into my students' heads. And then one day I realized that their heads weren't empty. There was already stuff in there! And once you realize that there's stuff in there, your life changes!" Her life had changed because she realized that students' prior conceptions and strategies meant that she needed to teach in new ways that took those conceptions and strategies into account. She found it fascinating to find out about her students' initial conceptions and strategies, and then to figure out how to help them learn new conceptions and strategies that were sometimes dramatically different from their initial conceptions and strategies. A deep understanding of how students think (including their prior conceptions and the strategies they use) is fundamental to good teaching.

Unit 3: Instructional Goals and Assessment

The third unit of the book addresses instructional goals, assessment, and the importance of integrating instructional goals and assessment with instructional activities. **Goals** refer to the objectives or aims that the teacher sets for what students should learn. **Assessments** refer to all the different ways in which teachers gather evidence about how well the students are progressing toward the goals (Mislevy & Haertel, 2006; M. Wilson & Sloane, 2000). Assessments include quizzes, unit tests, and standardized tests. But assessments also include more informal indicators of students' progress, such as daily assignments and even what students say in class. **Instructional activities** are the learning activities that are designed to help students learn what they need to achieve the goals, as evidenced by their performance on the various assessments.

In effective teaching, the teacher's instructional goals, the assessments, and the instruction are tightly coordinated. Designing assessment goes hand in hand with setting the goals for the class. As teachers develop their goals and their assessments, they also design instruction that is closely coordinated with their goals and assessments.

Figure 1.1:
The instructional cycle

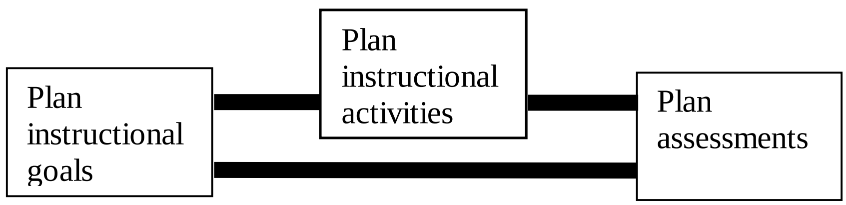


Figure 1.1 highlights the tight alignment that should exist among setting goals, developing assessments, and developing instruction (Smith & DeLisi, 2000). Goals, activities, and assessments need to fit seamlessly together. Serious problems can arise when goals, activities, and assessments are not in alignment. Here is an example. Consider a high school teacher who tells students that her most important learning goal is that they will learn to "think historically." She wants her students to learn to evaluate historical documents to reach their own conclusions about what happened in important historical periods. Accordingly, she focuses her instructional lessons on discussions in which students debate what can be concluded from historical documents. Her exams consist of 30% multiple choice questions about the textbook, 50% short-answer questions about the textbook, and 20% essay questions in which she provides them with original source documents and asks them to draw conclusions and explain their thinking. As the semester progresses, she finds that students participate less and less in the discussions. Lately she has been dreading going to class. She supposes that her students just don't like to think.

This teacher's problem is a mismatch between her goals and activities, on the one hand, and her assessments, on the other. Although nearly all of her classes are focused on historical thinking, which matches her stated goals for the class, only 20% of her exams focus on her stated goals. It is no wonder that students become less and less willing to participate in activities that are poorly represented on the exams. They become angry that she is not preparing them for the tests she gives. This is an example of a teacher's failure to align assessments with goals and instruction.

Here is another example of a mismatch among goals, assessments, and instruction. Consider another high school history teacher who has the same goal of promoting historical thinking. Unlike the first teacher, this teacher's exams are clearly focused on this goal. But during his classes, although he does engage students in debate about historical documents, he never teaches them how to do it. He does not help them learn any particular strategies for thinking about historical documents but assumes that they will somehow just learn just by doing it. He is baffled at the end of the year when he discovers on RateMyTeacher.com that that almost all of the students who rated him think that he is a bad teacher who does not actually teach them anything.

This history teacher's problem is a mismatch between his goals and assessments, on the one hand, and his class activities, on the other. His assessments are admirably tied to his goals, but he does not provide instruction during class activities that prepares students properly for the assessments. He does not teach them useful strategies that can help them think about historical documents. If he wants students to learn the difficult strategies involved in thinking like a historian, he must provide instruction that helps them understand how to tackle historical documents—how to interpret them, how to evaluate their credibility, and how to draw conclusions from them. This instruction would enable his students to benefit from the many opportunities he gives them to engage in historical thinking.

These two examples illustrate some of the problems that can arise when goals, class activities, and instruction are not tightly aligned. Goals, assessments, and instruction must be considered together.

Unit 3 emphasizes that assessment needs to be part of each and every lesson—not just the unit test at the end of a set of lessons. In each lesson, effective teachers are gathering evidence from a variety of formal and informal assessments of students' understanding, and this evidence should feed back into teachers' day-to-day plans. Teachers assess student learning through a diverse array of methods—not only through formal tests and quizzes but also through short quizzes, students' written assignments, carefully listening to students during group work and class discussion, and so on. These frequent assessment activities are called **formative assessments**, because they guide teachers as they form their ideas about how to teach each day.

Let's consider a third high-school history teacher, this time focusing on the teacher's formative assessment. Like the second history teacher, this history teacher tightly aligns her assessments with her goal of promoting historical thinking using primary source documents. Unlike the second teacher, this teacher also strives each day to help students learn to think historically with primary source documents. Over a period of six weeks, she coaches students and conducts mini-lessons on different strategies for engaging in historical thinking. Her students seem quite interested and excited about the classes. Then, at the end of the six weeks, she gives them the unit test and discovers, to her dismay, that her students have not performed as well as she had expected. She realizes from the tests that the students had difficulty understanding that the authors of historical documents may be biased, and they did not know how to take these biases into account when they evaluated the documents. Regrettably, she did not gather any formative assessment data during the unit that would have allowed her to provide some remedial help.

Frequent formative assessment could have greatly improved this third teacher's unit. Because she waited until the end of the unit to gather careful information about how her students were doing, she lost the chance to revise her instruction mid-course. If she had systematically gathered information about how her students were doing week by week along the way, she could have made needed changes to her instruction before it was too late.

We will discuss formative assessments as well as other kinds of assessments in Chapters 8 and 9. These chapters will give you many ideas about how you can use assessments to improve your instruction.

Unit 4: Creating Learning Environments

The fourth and final unit of the book is about creating effective learning environments. Learning environments refer to everything that is part of a situation in which students are learning. It includes the physical setting (e.g., a history classroom), the instructional purposes (e.g., to help students understand the significance of the civil rights movement), the instructional materials that are used (e.g., a table full of books, audio, and video materials on the civil rights movement; websites with historical information), any technological tools (e.g., computers to create PowerPoint presentations and to browse websites), the instructional methods (lectures, individual reading, group collaborations, and teacher-led discussions), and so on. Our goal in Unit 4 will be to learn how to design learning environments that are effective in promoting student learning. Chapters 10 through 15 will present a variety of compelling ideas on how to create effective learning environments.

Educational research has transformed the thinking of educators regarding how students learn and how teachers can teach more effectively. This research can guide the design of effective learning environments. Moreover, this research has changed our understanding of what the very *goals* of effective learning environments should be. Effective learning environments are designed to promote *engagement*, *understanding*, *self-regulated learning*, *transfer*, and *collaboration*.

- ***Engagement***. Effective learning environments sustain *engagement* among students. This means that students are actively immersed in learning tasks and are absorbed in mastering the concepts and strategies needed to succeed at these tasks.
- ***Understanding***. Effective learning environments are designed with the aim of helping students *understand* important ideas, rather than having students simply memorize those ideas or memorize a list of facts.
- ***Self-regulated learning***. Effective learning environments help students learn to learn on their own. This means that students develop the ability to regulate or control their own learning, without needing a teacher to help them constantly along the way. Self-regulated learners set their own learning goals, and they select on their own the learning strategies that can help them achieve these goals. They also check how well they are doing in achieving their goals, and if they are not doing well enough, they select and use new strategies that may work better. Through all these processes, self-regulated learners manage their own learning effectively.
- ***Transfer***. Effective learning environments are designed with the goal of promoting transfer. *Transfer* refers to using what one has learned in new situations. The ultimate goal of most learning is transfer: teachers want their students to be able to use what they have learned outside their classes—ultimately in the real world.
- ***Collaboration***. Effective learning environments incorporate *collaboration*—students working together. Well-designed use of collaboration among students can promote all of the goals listed above--engagement, understanding, self-regulated learning, and transfer. In addition, during collaboration, students learn to create knowledge collaboratively with their peers, which is itself a valuable form of learning.

Because these five goals are so central to effective teaching, the last part of the textbook is organized around how to create learning environments that effectively achieve these five goals. Chapters 10 and 11 are about creating learning environments in which students are engaged. Chapter 12 focuses on how to teach in ways that promote understanding. Chapter 13 is about how to teach in ways that help students learn to regulate their own learning. Chapter 14 is explains how to teach for transfer so that students will be able to use what they learn when they step out of the classroom. Lastly, chapter 15 discusses how to organize group learning so that students can learn collaboratively and create knowledge collaboratively.

CORE GOALS FOR LEARNING ENVIRONMENTS

The last six chapters in this textbook are devoted to designing instruction that promotes the five goals outlined above. Because of the importance of these five goals, we will examine them in further detail in this section.

Engagement

Students are **engaged** in the classroom if their thoughts and actions are fully directed toward learning tasks, and they are actively immersed in learning. More engaged students learn more than less engaged students; more engaged students are also more satisfied and more positive about school (Phyllis C. Blumenfeld, Kempler, & Krajcik, 2006; Fredricks, Blumenfeld, & Paris, 2004; N. E. Perry, Turner, & Meyer, 2006). Engagement is a valuable goal in its own right, as most teachers want students to be satisfied and motivated to participate in class. Engagement is also valuable in that it helps promote other goals, such as understanding and transfer.

This modern view of engagement contrasts with a common view that says that students are engaged if and only if they are listening or working quietly. I recently led a workshop for middle school teachers in which I introduced them to teaching methods that engage students in active debate and inquiry. During the workshop, several of the teachers disclosed that administrators in their district discouraged any such activities because they believed that students need to be quiet in order to learn. There is no doubt that quiet listening and individual work has a place in effective instruction. But research on both learning and motivation has shown that learning must be active to be effective (Phyllis C. Blumenfeld et al., 2006; A. L. Brown et al., 1983; J. S. Krajcik & Blumenfeld, 2006). If students only hear and read ideas, they will not learn as much as if they also talk and write about those ideas (D. L. Schwartz & Martin, 2004); sometimes students will get a little noisy as they are engaged in group discussions on academic topics.

Figure 1.2 illustrates the importance of active, engaged learning. If students simply read the statements in Figure 1.2, they learn less than if they visualize these facts vividly in their mind's eye, or if they try to explain these facts to themselves (Ozgungor & Guthrie, 2004; Willoughby, Wood, McDermott, & McLaren, 2000; Woloshyn, Pressley, & Schneider, 1992). If students vividly imagine the facts or explain them to themselves, they are more actively engaged in the learning process, and they learn more than if they simply read the facts without actively visualizing or explaining the facts. In general, learning is more effective when students are actively engaged in mental activities that use ideas—creating visual images, talking about the ideas, writing about them, and so on. Therefore, an essential goal for teachers is to learn to develop instruction that actively engages students in learning processes.

Two chapters in Unit 4 focus especially on engagement: Chapters 10 (Creating Engaged Classes) and 11 (Classroom Management). Chapter 10 focuses on motivational practices that enhance engagement. Chapter 11 focuses on how teachers can manage classrooms to reduce discipline problems and increase engagement. The remaining four chapters in Unit 4 also touch regularly on engagement. The instructional practices we discuss in Chapters 11 through 14 are all designed to promote student engagement in addition to other goals.

Figure 1.2:
Learning Facts about the Great Plains states

At the top of the figure is an image of lined papers with these facts about the Great Plains of the U.S.:

The High Plains are prairie grasslands at a relatively high elevation.
The High Plains span parts of states from New Mexico through Kansas and Colorado to Wyoming and Montana.
The High Plains often experience periods of drought.
Wheat agriculture is one main industry.
Cattle ranching is another main industry.
The population density of the High Plains is lower than that of many other parts of the U.S.

Then images of three fifth-grade students are shown.

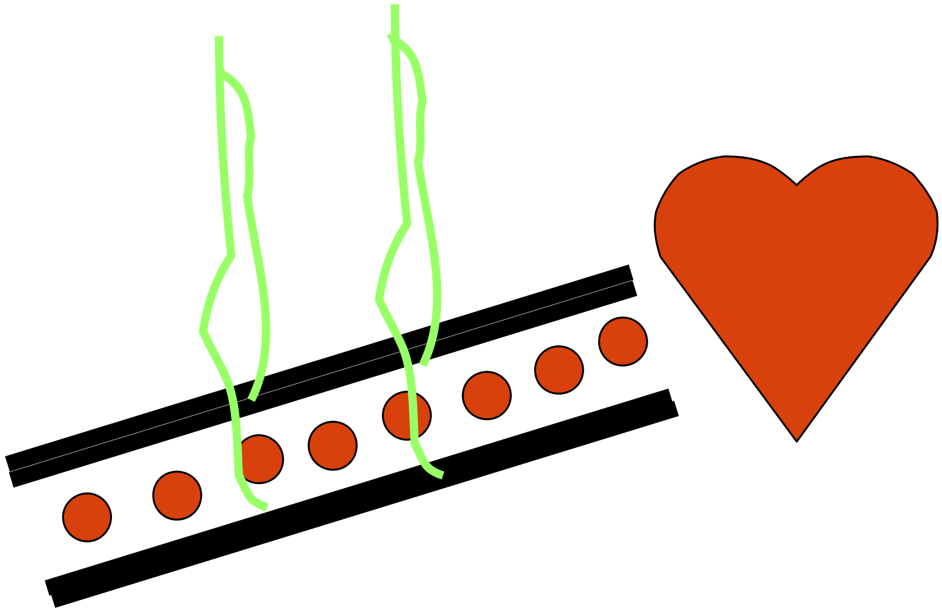
The caption for the first student says:
Summer simply reads to herself.
A thought bubble shows: "… Cattle ranching is another main industry. …"

The caption for the second student says:
Kayla makes vivid images of each fact.
An image of a cattle ranch is shown with a thought bubble.

The caption for the first student says:
Shaina tries to explain ideas to herself.
A thought bubble shows: "Cattle ranching could be a main industry because cattle ranches typically have grass that cattle eat, and a place that doesn't get a lot of rain will tend to have lots of grass that can survive without much rain. And that's the grass that the cattle eat."

Figure 1.3:
Arteries and veins

a



This artery has thick walls, and it is being held up with elastic rubber bands. (Veins are the opposite).

b Art(ery) was thick around the middle so he wore elastic suspenders.

Vanity (Vein) was thin enough to be a gymnast, but she was too inelastic (inflexible) c <This part of the figure shows a schematic drawing of a heart, with two arteries emerging from it, one going down and one upward. Both show exaggerated "ovals" where spurts of blood are appearing at regular intervals. The arteries then taper off into capillaries which then lead into smooth veins that lead back into the heart. Each artery-capillary-vein system makes a rough schematic oval. >

Caption: Arteries must be thick and elastic to accommodate the powerful spurts of blood sent out by the heart as it pumps. In addition, the elasticity allows the arteries to close behind each spurt, thus preventing blood traveling upward to the brain from falling back into the heart. Veins need not accommodate such spurts of pressure, because the pressure spurts dissipate by the point at which the blood travels through the capillaries so they are thinner and inelastic.

Understanding

A second essential goal of instruction is student understanding (Duschl & Grandy, 2008; Fennema & Romberg, 1999; Gardner & Boix-Mansilla, 1994; Mayer, 2005). The goal of learning should not be simply for students to memorize ideas without understanding them. The goal should be understanding. Only when students understand ideas can they apply the ideas to solve new problems or to answer new novel, unfamiliar questions.

An example that highlights the importance of understanding has been described by learning scientists John Bransford, Ann Brown, and Rodney Cocking (John D. Bransford, Brown, & Cocking, 1999). Their example focuses on the topic of learning about arteries and veins. How would you help high school students learn that arteries carry blood away from the heart and have thick, elastic walls, whereas veins carry blood back to the heart and have thin, inelastic walls? I have posed this problem many times to my own classes; invariably the students come up with teaching devices such as the ones shown in Figure 1.3a and Figure 1.3b. Figures 1.3a and 1.3b are both designed to help students memorize the facts that arteries have thick, elastic walls and veins have thin, inelastic walls. Neither of these devices *explains why* arteries and veins have these properties. And, critically, because there is no explanation, students cannot use the information about arteries and veins to solve new problems. For example, as Bransford et al. note, students who have learned only the information in Figures 1.3a and 1.3b would not be able to answer questions such as these:

- How would you design an artificial artery? Does it have to be elastic?
- What are the health implications of hardening of the arteries?

To answer these questions, students need to understand *why* arteries are thick and elastic. They need to understand what would happen if arteries were *not* thick and elastic. They need to understand what the function of thick, elastic arteries is.

In contrast, consider the explanation provided in Figure 1.3c. This explanation provides an *understanding* of *why* arteries are thick and elastic and veins are thin and inelastic. With the understanding that is promoted by the explanation in Figure 1.3c, it is possible to generate plausible answers to the two questions listed above. Does an artificial artery need to be elastic? As the explanation in Figure 1.3c shows, the elasticity of the arteries functions to accommodate the increased pressure of the spurts of blood that pass through the arteries and to keep blood traveling upward from falling back into the heart. If an artificial artery had other ways to serve these functions, it would not need to be elastic. For instance, if it were made of a strong material that could accommodate pressure spurts without expanding, and if it had one-way valves to keep the blood from falling back downward, then there would be no need for the artery to be elastic. Similarly, the question about hardening of arteries can be answered using the explanation in Figure 1.3c. Hard arteries might be less able to accommodate the spurts, and so they might burst. Now students can understand why hardened arteries are vulnerable to aneurisms.

On many topics, textbooks stop short of providing adequate explanations. A science textbook may simply inform students that arteries are thick and elastic, without explaining why. In these instances, the teacher will need to know the explanation so that she can provide it to students, or she will need to know how to help students find the explanation on their own. This requires knowledge that goes beyond the textbook.

Chapter 11 focuses on designing learning environments that promote understanding. In addition, most of the instructional methods discussed throughout Unit 4 include understanding as a core goal, so we will be addressing understanding throughout Unit 4.

Self-regulated learning. The past several decades of educational research have affirmed the importance of a third educational goal: the development of self-regulated learning. Self-regulated learning is valuable because when students develop the ability to learn and think on their own, they can learn by themselves inside or outside school, without the teacher's guidance.

An important kind of knowledge that self-regulated learners have is *metacognition*. **Metacognition** refers to people's awareness of their own thinking and learning processes. People have metacognitive competence if they are aware of their own thinking processes, if they use effective strategies for learning and thinking, and if their awareness of their strategies allows them to make good decisions about which strategies to use. For example, consider a student (Louis) writing a paper. Louis is aware that he does not understand his topic very well, so he decides to do some extra reading. He then realizes that he doesn't yet have good ideas for how to organize the paper, so decides to spend more time on the brainstorming and planning phases of writing. These actions show that Louis is aware of his thinking processes and of different strategies (such as planning and brainstorming) that he can use to succeed in writing. He deliberately uses his knowledge of his goals and his own thinking processes to choose the strategies that he will use next. Through these actions, Louis demonstrates a high degree of metacognitive competence. His metacognitive competence allows him to set his own goals and work out how to achieve these goals and to regulate his own learning.

Ineffective learners often use ineffective learning strategies. Teachers can help students become more effective learners and problem solvers if they help students learn to use more effective strategies. Therefore, it is important for teachers to be able to teach students more effective strategies so that they can become self-regulated learners.

Let's look at an example of a teacher who focuses on self-regulated learning as a core instructional goal. This teacher is leading a small-group discussion about a text that the students have read. The teacher and the students are discussing the text-comprehension strategies that they can use to be self-regulated learners (** ref **). The transcript of the discussion is on the left; my analysis is on the right.

Teacher:	I'm noticing that, instead of being passive, lots of people are taking control of their learning. Nicole, would you be willing to share what happened when you called me over while you were reading?	The teacher prompts Nicole to discuss her strategy use.
Nicole:	Sure. I couldn't understand this description on page 104. I tried summarizing in my head, but I couldn't figure it out. I read it again and tried to picture it, but it was no use.	Nicole shows that she is aware of the strategies she is using.

Teacher:	The author does tricky things with description. Did anyone else think that? Andy?	
Andy:	He describes things, but doesn't say what they are. It's like a puzzle you have to figure out. Nicole, remember when he described Beanpole's glasses? You had to figure out what they were and label them.	Andy also displays metacognitive knowledge of strategies.
Nicole:	That's what the teacher reminded me. I needed to think about whether the author had done this before and try to access my background knowledge.	
Teacher:	Nicole, that's just what you did. And what did you realize the author was describing?	
Nicole:	A grenade!	
Teacher:	That's it. Nicole, you used a bunch of good strategies here. What did you do?	The teacher asks for a summary of strategies used.
Nicole:	Well, first I knew I was missing important information. Then I asked you for clarification.	
Teacher:	Did I help you?	
Nicole:	No, you helped me think of what I already knew so I could help myself.	Nicole wraps up her summary of her own strategies.
Teacher:	Good! Nicole used lots of strategies here . . . . She was active instead of passive. She took charge of her learning. She did this by using the strategies of summarizing and picturing to monitor her understanding. Did anyone else use similar strategies to take charge of understanding these tricky passages? That's exactly what we all need to do to be independent learners.	The teacher summarizes the strategies that Nicole used. She also emphasizes the importance of students regulating their own learning by applying their knowledge of effective strategies.

In this example, the teacher asks students to talk explicitly about the strategies they are using themselves as well as the strategies that others are using. The teacher is working toward the goal of helping students become self-regulated learners by encouraging them to think and talk about their goals and the strategies they can use to achieve their goals.

We will address self-regulated learning and metacognition in most of the chapters in this book. Chapter 7 discusses effective strategies that self-regulated learners and thinkers use. All of the chapters on designing learning environments address how to promote metacognition and self-regulated learning. Chapter 13 focuses especially on creating learning environments that promote self-regulated learning.

Transfer. The fourth area of research that has transformed educators' thinking about learning goals is research on *transfer*. **Transfer** is the ability of students to take ideas that are learned in one situation and use those ideas in another situation. Here are several examples of transfer.

- A geometry student learns how to calculate the area of a triangle. The student uses that information two weeks later to solve a problem that requires adding the areas of three triangles.
- A fourth grade student learns to construct outlines in reading class. The student applies this to outline her history textbook to prepare for a test the following year.
- A fifth grader is learning about supporting ideas with evidence in social studies class. At dinner with his family the next week, the topic of conversation is nuclear power, which his parents think should be banned. He asks his parents what evidence they have to support their claim.
- A high school student is learning about cell organelles in biology class. The student uses this knowledge to interpret a *Newsweek* magazine report on a study that uses mitochondrial DNA to estimate how closely related different organisms are.

- A high school student learns about advertising in a high school business class. She applies this procedure to design and implement an advertising plan to increase the number of volunteers at a local hospital.
- A married couple who have just had a baby decide to respond quickly to the infant's cries because they learned 10 years ago in a high school psychology class that infants who are soothed quickly when they are in their first months of life cry less as they get older.

Notice that these examples vary in how similar the learning situation is to the transfer situation. In the first example, the learning situation is very close to the transfer situation, both in setting and in time. The learner applies what he learns in a math classroom to a problem encountered just two weeks later in the same math class. But in other examples, the setting is more dissimilar, and the time is longer. In the last example, the transfer setting is very different from the setting in which learning occurred (raising a child in a home vs. sitting in a classroom), and the time gap is very long (ten years later). When there are many differences between the learning situation and the transfer situation, the transfer is called **far transfer**. When there are relatively few differences between the learning situations and the transfer situation, the transfer is called **near transfer**.

Most educators would agree that the goal of schooling is to develop knowledge that can be transferred out of school (e.g., John D. Bransford et al., 1999; Kuhn, 1991; Noddings, 2007; Scardamalia & Bereiter, 2006). Educators want to enable students to participate skillfully in the real world—at their jobs, in their home lives, and in their lives as a member of the community. If knowledge cannot be used out of school, the knowledge is ultimately useless. In the classic words of the educational philosopher Alfred North Whitehead, knowledge that is never used is *inert* (Whitehead, 1929). There is little or no point to having knowledge that cannot be used.

Unfortunately, transfer is extremely difficult to achieve (Barnett & Ceci, 2002, in press; Detterman, 1993). Although most educators do not think that transfer is *impossible*, most agree that achieving it is challenging. Students tend not to transfer information. To give just a few examples (we'll discuss many more in later chapters):

- Students who learn to do one kind of math problem often cannot solve problems that are only slightly different (Reeves & Weisberg, 1994).
- Students who learn strategies such as summarization or note taking in English class do not use these same strategies to help them in math class and social studies class, even though the strategies would be useful in those classes (Pressley & Woloshyn, 1995).
- Students who learn to write essays presenting arguments on several topics are unable to write a persuasive essay on a new topic (Page-Voth & Graham, 1999; Yeh, 1998).

These examples are all fairly *near* transfer. If even *near* transfer is hard, it is not surprising that *far* transfer is even more difficult. Throughout this book, we will be exploring instructional techniques that overcome these difficulties in achieving transfer. In particular, we will be exploring ways of promoting the most challenging kind of far transfer: transfer to the real world. Transfer will be the particular focus of Chapter 14.

Collaboration

Collaboration in schools refers to students working together. Often, the goal of collaboration is to enhance students' learning. When the primary goal of collaboration is to help students learn, we call the collaboration **collaborative learning**. In other cases, the primary goal of collaboration may be to solve a problem or to create something, as when a student council meets to decide how to spend its money or a school newspaper staff meets to plan its next edition.

During the past several decades, educational researchers have argued for the use of collaborative learning in schools. One reason for this is that collaborative learning environments can enhance the learning of individual students. When collaborative learning is designed appropriately, students learn more by working collaboratively than by working individually (Chinn, in press-b; O'Donnell, 2006).

Collaborative learning can enhance the other educational goals we have discussed: engagement (Phyllis C. Blumenfeld et al., 2006), understanding (Webb et al., 2002), self-regulated learning (Chinn, in press-b; A. King, 2002), and transfer (J. S. Krajcik & Blumenfeld, 2006).

Learning to collaborate is also a worthy goal in its own right. Learning to collaborate is valuable because effective collaboration is important in the real world (e.g., Parker, 2008). In almost every organization and profession, knowing how to collaborate effectively in teams is essential to success. A surgical team must work well together, or lives will be lost. Effective teams are vital to corporations: an automobile design team must be able to work effectively in order to build a well-engineered, cost-effective, marketable auto. Teachers, administrators, and parents must work effectively together to improve schools. The ability to work well collaboratively is important in nearly every aspect of real life (Hackman, 1989).

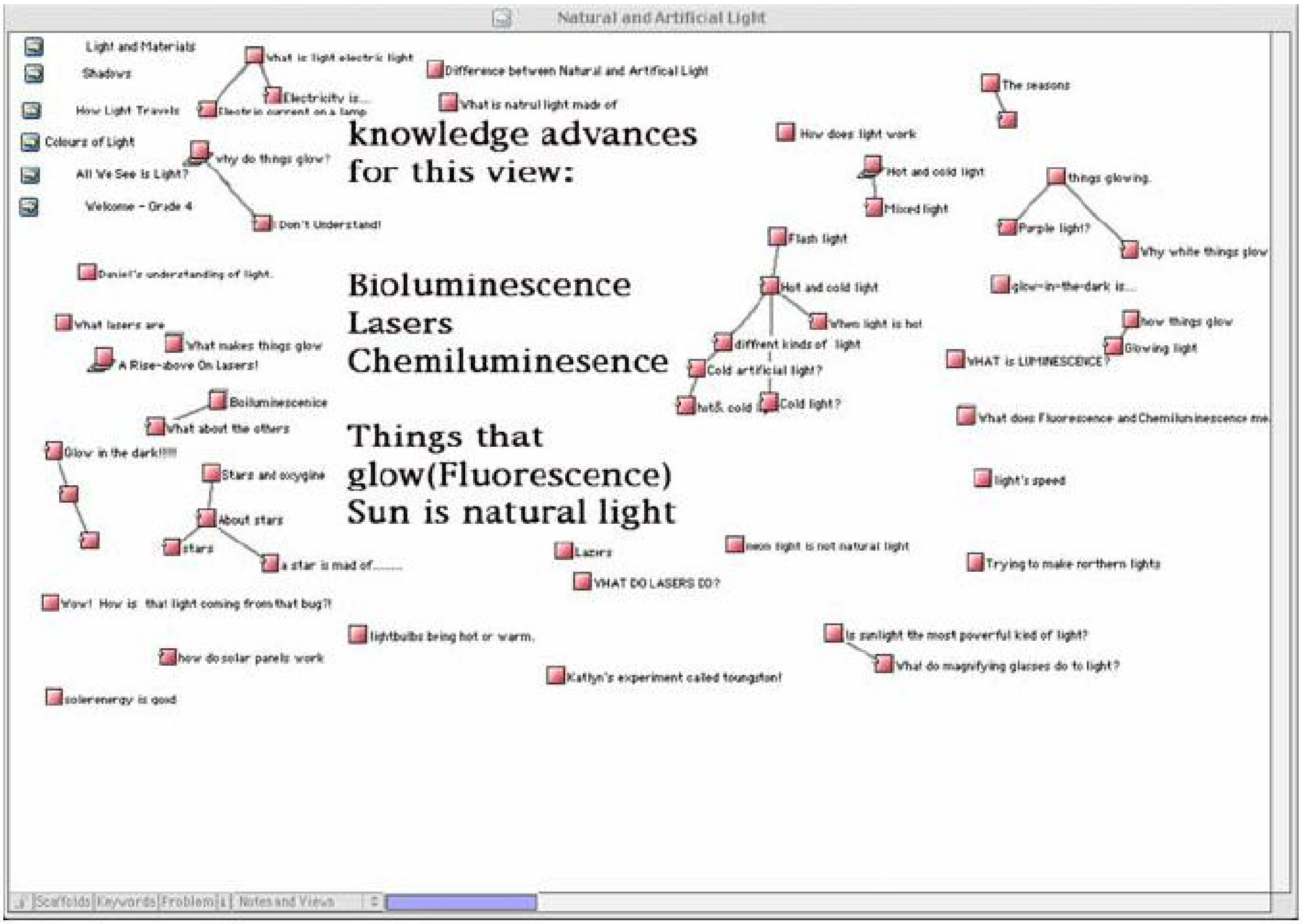
In most organizations, groups are also knowledge creators (Scardamalia & Bereiter, 2006; Senge, 2006). An engineering team learns from its mistakes and shares this knowledge so that others do not make the same mistakes again; in this way, the team has generated knowledge that the entire organization can use. A team of teachers work together to generate and test ideas about how to help children having difficulty learning to read, and then they share these ideas with other teachers and schools in the district. A nursing home team works collaboratively to learn much more about Alzheimer's disease so that they can develop more effective services for their patients; they incorporate their findings in a manual that all future workers will follow. In all of these examples, groups of individuals are generating new knowledge and using their newfound knowledge to help accomplish the goals of their organizations.

Learning scientists Marlene Scardamalia and Carl Bereiter (2006) have emphasized that students in classrooms can work together to create knowledge in much the same way that adults work together to create knowledge. By teaching students to work together to create knowledge, teachers are preparing students for the collaborative work of creating knowledge that they will need to do as adults. Scardamalia and Bereiter do not expect students to create knowledge that is new to the world (such as a brand new scientific discovery) but rather to create knowledge that is new to the students themselves. In their program, called Knowledge Forum, students post ideas on topics the class is studying onto a computer-based network of ideas. For example, one student may post a note on why civilizations fall (Scardamalia & Bereiter, 2006). Other students elaborate on this idea, providing evidence and elaboration, whereas others critique it, pointing out its shortcomings. Some of the students' discussions are online; others are face to face. Gradually, as students explore these ideas more fully, they come to a broad consensus on some of the reasons why civilizations fail. This consensus represents the group's knowledge. The students arrive at this knowledge through a social process of proposing ideas and then collectively evaluating these ideas. This process is very similar to the process followed by social scientists who explore similar issues by writing journals articles, critiquing each others work, and discussing ideas in conferences.

Figure 1.4 presents another example of the use of Knowledge Forum. In this example, 9 and 10-year olds have explicitly identified new knowledge their class has generated on natural and artificial light (Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007). In this way, Scardamalia and Bereiter aim to create communities of students that collectively create knowledge.

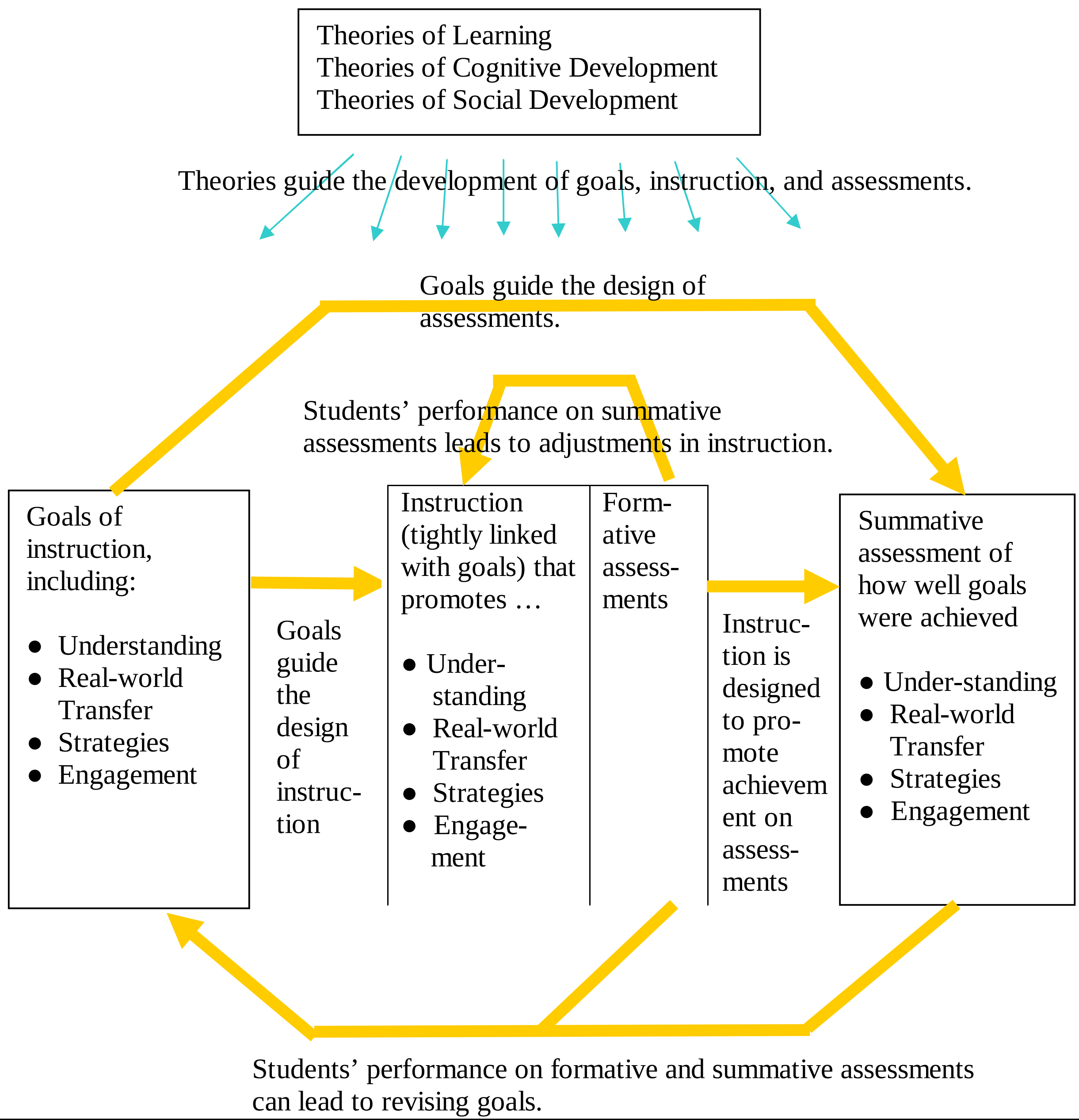
Thus, we have seen that learning to collaborate is valuable for two reasons. First, it is valuable in its own right, because learning to collaborate prepares students to be team members and knowledge creators in the modern world. Second, it is valuable because collaboration can enhance the learning of individual students. We will explore collaboration and collaborative learning in Chapter 15 of this text. In addition, collaborative learning methods will appear in many of the other chapters in this text, as well.

Figure 1.4:
Notes on Knowledge Forum



From Zhang, Scardamalia, Lamon, Messina, & Reeve (2007, pp., p. 125).

Figure 1.5:
The structure of this textbook



SUMMARY: THE STRUCTURE OF THIS TEXTBOOK

The core ideas in this textbook are summarized in Figure 1.5. At the heart of effective learning and teaching is the continuous interplay among instructional goals, instructional methods, and formative and summative assessments. Teachers develop instruction to achieve desired instructional goals; this means that the teacher must design learning environments that are effective in helping students learn. The goals set by the teacher include specific goals related to engagement, understanding, metacognition, transfer, and collaboration. Teachers make sure that formative and summative assessments are tightly aligned with their goals. As teachers gather information from their formative assessments, they revise their instruction; they may even revise their goals to better meet students' needs. At the end of the unit, teachers use summative assessment to provide information about how to modify the unit the next time.

The teacher's decisions about goals, instruction, and assessment are guided and informed by educational theories—theories of learning, theories of development, and theories of individual and group differences. These decisions are also guided by the teacher's knowledge of the student's prior conceptions and strategy use. The summative assessment provides information about students' conceptions and strategies that will feed forward into the next unit.

This textbook is designed to help you begin to master the various components of effective teaching that you see in Figure 1.5. Each of the chapters is designed to help you master one or more processes shown in Figure 1.5. Together, the chapters are intended to help you gain a deep understanding of how all these components of instruction fit together.

THE FEATURES OF THIS TEXT

This text contains several regular features designed to help you master important ideas and skills. We have already discussed one of these features—the links to theory that occur in each of the subsequent theories. In this section, we will discuss four other regular features: multiple examples, revising ideas in different ways, application problems, the Reflections on Students' Thinking that appear at the beginning of each chapter, and the Extensions at the end of each chapter.

Multiple Examples

One of the first things I learned when I began teaching educational psychology was that students clamored for more and more examples. The more, the better. Students reported that when there were many examples, it helped them understand the key concepts and principles better. In addition, when the examples were in varied contexts, they developed an even deeper understanding of the concept, and it made it easier for them to see how they might apply the idea to new contexts in the future.

There is research evidence supporting my students' intuitions about the value of many, varied examples. Psychologist Alan Baddeley (1999) described a study by psychologist K. E. Nitsch that investigated how undergraduates learned new concepts from examples. Nitsch invented concepts and gave them names such as CRINCH and MINGE. He developed two different ways of providing definitions and examples to students. Half of the undergraduates received definitions and a set of examples that were all from the same context, such as examples all from the context of a diner, shown in Table 1.1. The other half of the undergraduates examples received definitions and a set of examples from varied contexts, with each example coming from a different context, as illustrated in the bottom half of

Table 1.1
Definitions and examples of two new concepts

Type 1: Consistent context for new word

CRINCH: To make someone angry by performing an inappropriate act; originally used by waitresses. Usage: when a diner fails to leave a tip; when diners argue about the prices on the menu; when a diner deliberately spills ketchup; when diners complain about slow or inefficient service.

MINGE: To gang up on a person or thing; originally used by cowboys and cowhands. Usage: when three or more riders decide to converge on a single animal; when three or more work together to brand an animal; when three or more encircle a wolf or other marauder to prevent its escape; when three or more join forces against a rustler.

Type 2: Varied context for new word

CRINCH: To make someone angry by performing an inappropriate act; originally used by waitresses. Usage: when a man does not remove his hat on entering a church; when a spectator at a public event blocks the view of those behind; when someone flicks ash over a beautifully polished table; when diners complain about slow or inefficient service.

MINGE: To gang up on a person or thing; originally used by cowboys and cowhands. Usage: when a band of dissatisfied sailors threaten their captain with mutiny; when an audience boos a mediocre act on stage; when someone is helpless to defend himself against attack; when a group of cowboys join forces against a rustler.

From Baddeley (1999, pp., pp. 162)

Nitsch asked students to classify new examples using the words, as in these examples:

- Is this an example of the concept CRINCH? A student says “Hey, dude!” to a teacher.
- Is this an example of the concept MINGE? A group of students talks in the hallway before class.

These examples were from new contexts unlike any of the contexts seen by students in either group.

Consistent with what my students have told me (“lots of varied examples are helpful”), the students who read examples from varied contexts were better at generalizing to new contexts than students who read examples from a single context. In line with these findings, this textbook incorporates as many examples in varied contexts as possible. To keep the length of the textbook manageable, many of the examples appear in the ancillary materials, including the web-based materials. These examples should help you develop a deeper understanding of the key concepts in this book.

Application Problems

A second feature of each chapter is the inclusion of many application problems. My reasons for including numerous application problems stem from my early experiences teaching educational psychology. When I began teaching educational psychology, I quickly discovered that students who could write and talk about concepts at an abstract level frequently found it difficult to apply these same to concrete situations. For example, I found that my students could write fine short essays about **higher-order questions,** which are teacher questions that require students to think rather than to just copy an answer out of the book. My students could define higher-order questions and persuasively justify their importance. But when I presented my students with transcripts of class discussion and asked them to identify instances of higher-order questions, they often experienced considerable difficulty. They counted as higher-order questions many questions that did not require much thinking by the students. Similarly, when they wrote their own higher-order questions, their questions frequently fell short of what a higher-order question should be. In short, they could not apply what they had learned to real teaching. They did not have a *real* understanding of the material. Examples such as these showed me that if I wanted students to really understand key concepts, they needed a great deal of practice actually analyzing real classroom practices.

For this reason, each chapter in this textbook includes many problems—within the main body of the chapter, at the end of the chapter, and in the online materials that accompany each chapter. Many of these problems involve analyzing video on My Education Lab. By working through as many of these problems as you can, you will gain skill at applying powerful ideas about how students learn and how teachers can teach more effectively.

There are three different types of application problems in the body of each chapter. Most problems have a response at the end with a suggested approach to answering the problem. Simple examples of each type of problem are presented on this page; the problems are related to the concept of transfer.

The first type of problem is called *Understanding Students' Thinking*. These problems give you practice at analyzing what students say and write so that you can understand their thinking. Problem 1.1 asks you to analyze the extent to which two students are able to transfer their understanding of one story to another story.

The second type of problem is called *Evaluating Teaching*. In these problems you will evaluate instances of teaching. For example, Problem 1.2 asks you to evaluate a teacher's assessment according to whether it really assesses far transfer. Other problems ask about how well teachers have done at important teaching tasks such as designing learning activities, organizing group work, developing handouts for students, leading discussions, or tutoring individual children.

The third type of problem is called *Designing Instruction*. In these problems, you will develop instructional plans or design instructional materials. For instance, you might design a quiz that you could use for formative assessment, or you might design a handout that would be effective in supporting group work. Or you might outline a lesson that could achieve specified goals such as helping students learn to summarize more effectively.

It is important not just to *read* these problems, but to actually try to solve the problems, even if you are not successful. One of many psychological studies that shows the value of trying to solve problems before learning how to solve them was conducted by psychologists Douglas Needham and Ian Begg (1991). Needham and Begg wanted to determine how to help students learn to solve problems better. They randomly assigned undergraduates to one of two learning conditions. Figure 1.6 shows what students in each of the two learning conditions did. As Figure 1.6 shows, all the students were presented with a problem. Half of them tried to solve the problem before being told the solution and an explanation of the solution. The other half did not try to solve the problem before being given the solution and an explanation of the solution. Later in the session, all the students attempted to solve a new, transfer problem with a solution very similar to the one that they had earlier learned.

Problem 1.1 Introduction: Understanding students' thinking: Transfer

A teacher, Celeste, is having her second graders read a story that is very similar to Aesop's famous fable about the tortoise and the hare, which her students read two months ago. In today's story, a girl (Haylie) and her younger sister (Katrina) are racing to see who can finish their chores first. Haylie is nearly finished but then pauses to talk with her friend on the phone, and before she notices, her younger sister finishes first.

Celeste wonders if her students can transfer their knowledge of the moral of the story of the tortoise and the hare ("slow but steady wins the race") to help them understand this story. Here are her conversations with two students, Jeannie and Andy:

Celeste: Jeannine, what do you think is the lesson of this story?
Jeanine: That you shouldn't talk on the phone when we should be working.
Celeste: Does this story remind you of any other story we've read this year?
Jeannie: No. I can't think of any.
Celeste: How about the tortoise and the hare? Do you remember that story?
Jeannie: Oh, yeah! Haylie is like the hare. She was fast but stopped! And Katrina is like the turtle! She was slower, but she kept going. It's just like that—slow but steady will be the winner.

Celeste: Andy, what do you think is the lesson of this story?
Andy: You have to work hard.
Celeste: Does this story remind you of any other story we've read this year?
Andy: No. We didn't read about two sisters.
Celeste: How about the tortoise and the hare? Do you remember that story?
Andy: Yeah. We learned, like, slow and steady, then you can win the race. The turtle was slow, but it kept going.
Celeste: Does that have anything to do with this story?
Andy: A little, it's like, there's a turtle and a hare, but this story doesn't have any animals like that.

Evaluate the extent to which Jeannie and Andy were able to transfer their knowledge about "The Tortoise and the Hare" to understand the new story about Haylie and Katrina.

Response: Jeannie was not able to spontaneously recall "The Tortoise and the Hare," but once she was prompted by the teacher, she was able both to recall the story and to make the connections very clearly. She understood that Haylie is like the hare, that Katrina is like the tortoise (or, as she says, like the turtle), and that the moral of the stories are the same.

Andy, on the other hand, is not able to transfer knowledge of the Aesop fable even when prompted. He recalls the moral, and he also connects the moral to the turtle's action, so it is clear that he both remembers the story and understands it. However, even after prompting, he is unable to transfer his knowledge to this story. He seems to be looking for similarities at the level of whether the characters are animals, not in terms of the deeper theme or moral of the story.

Problem 1.2 Evaluating teaching: Evaluating teaching: Assessing far transfer

Garrett is an 8th grade history teacher who has recently been learning about transfer in his graduate work at the local university. In this 8th grade classes, he has been teaching students to summarize one-page passages from their history textbook in class. He wants to create a far transfer task to see if students can transfer their skills. He asks them to get a magazine at home and summarize an article that is at least three pages long. Has Garrett succeeded in creating an assessment of far transfer?

Response: This is a fairly good far transfer task. It differs from the in-class training in several respects. They are summarizing a longer text than they were summarizing in class. Magazine writing is a different genre from textbook writing, so there are some new challenges in writing summaries. The topics of the magazine articles will be quite different from the topics in social studies texts. Students are doing the summaries at home rather than at school. Thus, the transfer situation is different on a number of dimensions from the situation in which they were trained. This is a fairly good far transfer task.

Problem 1.3 Evaluating teaching: Designing instruction:

Students have been learning to write persuasive essays in writing class on topics relating to stories they are reading. Create a real-world far transfer task that assesses students' ability to write persuasive essays.

Response: Many answers are possible here. Your transfer task should differ in as many respects as possible from the situation in which students were writing persuasive essays in school.

Figure 1.6:
Example materials from Needham & Begg's study

Step 1. All students read this problem.

An adventurous explorer traveling through the jungles of Africa decided to stop for the night. Since the jungle he was exploring was full of snakes, he decided to sleep in a hammock-like device suspended over a babbling brook. He began unfolding the blanket that would serve as the base for the hammock. When he finished this, the explorer grabbed two vines hanging down and tied them together. This served as support for one end of the blanket. However, the two vines that were to support the other end presented some difficulty. When the explorer grabbed the end of one vine, it was impossible for him to grasp the end of the other vine at the same time. The two vines simply could not be knotted together in this way. The explorer thought he would have to give up and move camp elsewhere because these two vines from above could not be knotted together. Suddenly, an idea struck the explorer and he was able to knot together the two vines.

Step 2

Half of the students tried to answer this question.

How did he do it?

The other half of the students read about how to solve the problem.

He took a rock and attached it to the end of one vine. Next, he grabbed the rock and vigorously swung the vine to which it was attached in the direction of the other vine. He then ran quickly to this other vine, grabbed it, and walked as close as possible to the swinging vine, which was now swinging back and forth. He then waited until the swinging vine came his way and caught it on the upswing. Now, while holding both vines, he removed the rock and knotted the two vines together. He was then able to enjoy a safe night's sleep.

Step 3. All of the students observed an experimenter give this lecture.

In this passage, you are told of a jungle explorer who must tie two vines together to make this sleeping apparatus. However, when he tries to grab the one vine to bring it over to the other one to tie them, he finds that he cannot do it. The two vines are too far apart for him to grab onto at the same time. So, he takes a rock and attaches it to the end of one of the vines. The rock cannot be so heavy that it pulls the vine down and it cannot be so light that it will not allow him to turn the one vine into a pendulum. So, he sets the vine to which he attaches the rock in swinging motion. Then, while it's swinging, he runs over to the stationary vine, grabs it, and walks with it towards the vine that is now swinging. When the swinging vine comes back to him on the upswing, he can grab it, while still holding the other vine, and attach the two of them together. Because of the pendulum motion, this solution works. So, by turning one of the vines into a pendulum, the explorer is able to attach the vines together.

Step 4 continues on the next page.

Step 4. All of the students attempted to solve this transfer problem, which has a solution very similar to the initial problem.

Before the Inaugural Gala, organizers were hurriedly trying to decorate the hall. Everything was nearly ready, and it was about ten minutes before the President-Elect was scheduled to arrive. Mr. Smith was decorating the walls and ceiling with balloons and party streamers made out of ribbon. He had nearly completed a fancy decoration pattern when he noticed two final pieces of ribbon were left dangling from the tiled ceiling above. He had planned to knot these two final pieces of ribbon together in order to attach balloons to them. However, when he grabbed the end of the green ribbon, he was unable to grasp the end of the blue ribbon at the same time. The ribbons could simply not be knotted together in this way. Since everyone had momentarily left the room, Mr. Smith thought that he would have to abandon this bit of decoration altogether. Suddenly, an idea struck him, and he was able to knot together these two ribbons. How?

(Students were not told the solution to this problem, but the solution is analogous to the solution of the problem of the explorer in the jungle. Mr. Smith can tie a weight onto the bottom of one of the ribbons, swing that ribbon, run and grab the other ribbon, and then catch the first ribbon—the one with the weight—when its pendulum motion brings it within reach.)

The students who had tried to solve the initial problem on their own were seldom successful at coming up with a solution to this problem before they were taught the solution. Even so, they were better at solving the later transfer problem. Trying to solve the initial problem on their own helped them recognize that they could use what they had learned in the initial problem later on when they tried to solve the final transfer problem. In short, when students tried to solve problems on their own (even when unsuccessful) before they were taught how to solve the problem, they were better at solving similar new problems on their own.

A central goal of this text is to help you build knowledge that you can apply to address problems you will face as a teacher. I strongly recommend that you spend several minutes trying to solve each problem in each chapter before reading the response. By trying to solve the problem, you are more likely to learn the concepts in a way that will help you apply the concepts to future problems.

Reflecting on Students' Thinking

At the beginning of each chapter except for Chapter 1 is a problem called *Reflecting on Students' Thinking.* This feature is inspired by research conducted by learning scientist Dan Schwartz and his colleagues (D. L. Schwartz & Bransford, 1998; D. L. Schwartz & Martin, 2004). In one of their experiments (D. L. Schwartz & Bransford, 1998), one group of undergraduates in a cognitive psychology course initially learned about human memory and forgetting in a traditional way—by reading textbook passages. Undergraduates in a second group were shown real examples of what people had remembered and forgotten after reading short narratives; the undergraduates tried to analyze the examples and explain why the people remembered some things and forgot other things. They did this before being taught about any psychological principles of memory and forgetting.

After these activities, all of the students listened to a lecture on principles of memory. The researchers found that students who initially tried to explain real examples of what humans remembered and forgot learned much more from the lecture than did students who instead read initial textbook passages on memory. Most importantly, students who had attempted to analyze and explain real examples were much more successful using what they had learned to solve new problems (such as predicting the results of a new memory experiment that they had not seen before).

This pattern of results was found even though most undergraduates who tried to explain the real examples did not in fact discover the principles of remembering and forgetting that they would later learn in the lecture. Just as in the Needham and Begg study described in the last section (Figure 1.4), students benefited from trying to solve a problem even though their initial solution attempts were usually unsuccessful. As the undergraduates tried to analyze and explain real examples, they gained a detailed understanding of real examples of memory and forgetting that they could relate to what they learned later. The experience of trying to explain the examples helped prepare them to understanding the psychological concepts of memory and forgetting.

The results of this study show that a very effective way to promote learning is to ask students to try to explain real examples of learning and teaching before they listen to a lecture or study a textbook chapter. I have therefore incorporated this method into this textbook. At the beginning of each chapter, the *Reflecting on Students' Thinking* feature will ask you to analyze data from studies of learning and teaching. After you have made attempts to analyze and explain the data—even if you are unsuccessful—you will probably be better prepared to learn the new material in the chapter. As with the application problems, it is very important that you take time to try to analyze and explain the data, regardless of how successful you are in your efforts.

Extensions

In the last section of all chapters after Chapter 5, we will examine how the ideas of that chapter apply to (1) students of differing ages (from kindergarten through high school and sometimes beyond), (2) students with learning disabilities, and (3) students of differing cultural and language backgrounds. It is vital for teachers to understand how to apply ideas in each of the chapters 6 through 16 to different students. For instance, when teachers are attempting to create engaging instruction, they need to learn how principles of motivation may be implemented differently with elementary and secondary students. They need to understand how to adapt motivational principles to successfully engage students with learning disabilities. And they need to understand some specific motivational ideas relevant to working with students of different cultural and language backgrounds. The Extensions section of the chapters will provide useful ideas teachers can use to adapt the principles to the diverse range of students in their classes.

RESEARCH ON LEARNING AND TEACHING IS MULTIDISCIPLINARY

Theories of learning and teaching are increasingly **multidisciplinary**. This means that theories of learning and teaching draw on research from many different disciplines (including education, psychology, neuroscience, anthropology, linguistics, and many others). The three general areas of research that are most heavily represented in this textbook are psychology, the learning sciences, and educational research in different subject areas. We briefly discuss each of these areas below.

Psychology is a discipline that, generally, seeks to understand human cognition, emotion, and behavior. Educational psychology is the branch of psychology that focuses specifically on issues related to human learning. Educational psychologists study both learners learning alone and in groups. Educational psychologists conduct research both in classrooms and in more controlled settings including laboratories.

Developmental psychologists study cognitive and social growth in children as they grow older. Social psychologists study processes by which people interact with each other in groups and how people think about the social world (e.g., how and why people stereotype others). Cognitive psychologists study mental processes of thinking and learning. Research in all these areas of psychology can inform our understanding of learning and teaching.

The learning sciences is a relatively new field that has emerged in the past two decades. Learning scientists use methods and concepts from a variety of different scientific disciplines (including psychology, linguistics, and anthropology) to study how learning occurs in real settings (classrooms, museums, homes, and so on) (Sawyer, 2006a, 2006b). Learning scientists emphasize the design of innovative learning environments that they believe will be effective in helping students learn (A. L. Brown, 1992). They frequently incorporate technological tools such as computers in the learning environments they design. For example, a learning scientist might develop a web-based environment for helping students learn to think about primary and secondary historical sources as the students work together to explain the causes of Irish immigration to the United States in the 1800s. The researchers then investigate how students learn within these environments.

The third broad area of research that has strongly influenced this text is research focused on learning and teaching in different subject areas—such areas that include English as a second language, foreign languages, literacy (including reading and writing), mathematics, science, and social studies. Much of the research that has helped us learn about how to teach well in particular subjects has been conducted by these researchers. Like learning scientists and some educational psychologists, these researchers frequently design exemplary instructional interventions and then investigate how students learn using these interventions. These researchers also study what practices are common in classrooms (e.g., how do elementary school teachers typically teach reading?) and how these practices influence student learning.

There is no sharp distinction between the fields discussed above. A number of researchers--including myself--see themselves as belonging to more than one field (for example, I consider myself both a learning scientist and an educational psychologist). As a result, there is increasing convergence among the theories and methods employed by researchers in these fields. Throughout this textbook, we will draw eclectically on research in all of these fields to understand how students learn and how teachers can teach effectively.

CHAPTER 2
Theories of Learning

Chapter Outline

Reflecting on student thinking
Information Processing Theory
- Sensory Register
- Working Memory, or Short-term Memory
- Perception and Rehearsal
- Long-term Memory
- Encoding
- Retrieval
- Forgetting

Constructivism
- Learners
  - Learners actively construct their own understandings of the world
  - Knowledge construction is driven forward by challenges
- Learning Environments
  - Learning environments should center around learners' choices and learning goals
  - Learners engage in authentic tasks relevant to their lives
  - Learning centers around student inquiry and higher-order thinking
  - Learners engage in authentic activities
- Learning from others
  - Students learn from collaborating with other students
  - Teachers are facilitators and orchestrators, not information providers

Summary
Applications

Applied goals

Learning from observation. Social cognitive theory will help you think about how to set up conditions in your classroom so that students can learn by observing other students and yourself. You will also learn how discourage students from learning things from observation that you would rather that they *not* learn.

Promoting memory and understanding. You will apply ideas from information processing theory throughout this text. In this chapter, you will learn initial ideas about how to promote effective methods of remembering information.

- You will learn strategies that your students can use to remember more of what they are learning.
- You will learn about how the limitations of short-term memory are a major bottleneck to learning, and what you can do to try to help your students.

Promoting constructivist learning. You will also apply ideas of constructivism throughout this text. In this chapter, you will learn some initial ideas about how learners construct knowledge, how to set up learning environments, and the role of teachers and peers. Much of what you learn in later chapters will elaborate on these ideas.

You will *also* learn about a theory of learning (the transmissionist theory) that many teachers and students hold, but that is an ineffective way to promote learning. Here you will learn some important ideas about what *not* to do in the classroom.

Reflecting on Student Thinking

You are about to read about four major theories of learning. This Reflection will help you start thinking about one of these theories, information processing theory, which presents a detailed model of human memory. You will recall from Chapter 1 that the purpose of these Reflections at the beginning of each chapter is to prepare you for future learning by doing some initial thinking about real learning phenomena. It is not necessary to come up with a particular answer; the goal is to reflect on the data *presented below so that you can begin to develop ideas about memory phenomena as you read through this chapter.*

Below, you will read about an experiment investigating how memory works and develops. You will then see some typical results from this experiment. As you read, consider your current ideas about how memory develops. You will undoubtedly refine and broaden these ideas as you read about the human memory system later in this chapter.

In a memory experiment, psychologists were studying how students of different ages (6 year olds and 18 year olds) remember lists of items. They were interested in how memory works as students try to remember lists of numbers and lists of words.

An experimenter interviewed each student individually. The experimenter read aloud a list of 20 words to each student at the rate of one word per second. After reading all of the words, the experimenter directed the student, "Tell me all the words (or numbers) you can remember from the list."

The list of words was: orange apple strawberry banana desk sofa table bed pig cow dog horse necktie skirt shirt shoes car train bus airplane

Here are the results. Ellipses show where the students paused.

Student	
GIRL, age 6	airplane…. cow orange … car … dog … apple
GIRL, age 6	… orange … pig … table shoes … bed
BOY, age 6	banana desk … cow strawberries … shoes … cat
BOY, age 6	airplane … orange apple…. shirt … airplane
GIRL, age 18	orange apple peach … … necktie skirt shirt … … horse cow … cat dog … … car truck airplane
BOY, age 18	orange banana apple peach cherry… sofa chair table … … horse cow sheep cat dog
GIRL, age 18	airplane bus train car … orange apple … desk sofa …. bed
BOY, age 18	car bus truck airplane …. orange apple … shirt skirt shoes …

Explain these results. Classify the responses in a way that can highlight important differences between different groups of students, between different words, or anything else you can think of. Present a graphical analysis of your results.

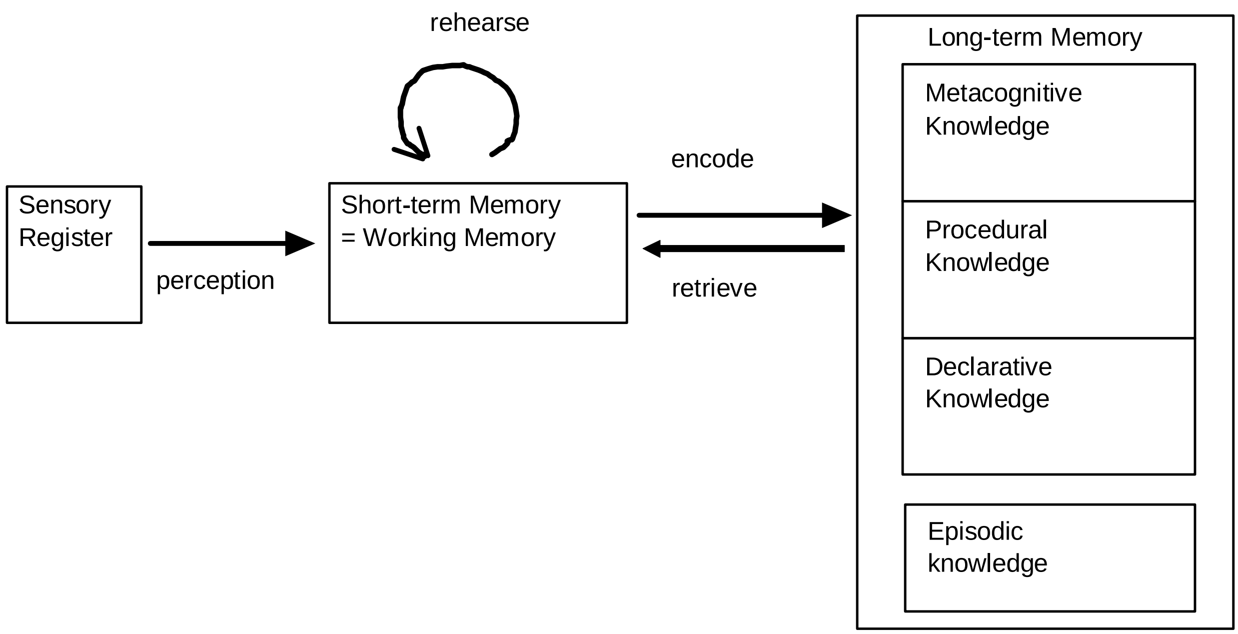
Theoretical models of learning are powerful tools that will help you understand your students and how they learn; this understanding, in turn, will allow you to design effective instruction. This chapter presents an overview of two theories of learning: *information processing theory* and *constructivism.*

INFORMATION PROCESSING THEORY

Information processing theory (also called **cognitive learning theory**) is a theory of human learning based on the idea that learning involves moving information in and out of different *memory stores*. Information processing theory has been developed by numerous psychologists; two of the seminal thinkers were Herbert Simon and Allen Newell (Newell, Shaw, & Simon, 1958; A. Newell & H. A. Simon, 1972). In information processing theory, learning occurs when learners store information in a *long-term memory* store. Learners can then retrieve that information and use it to solve problems, to reason, or to learn new information. The processing of information occurs within another memory store, called *working memory* or *short-term memory*. In direct opposition to radical behaviorism's rejection of all speculation about mental processes, information processing theory explains learning by examining what is happening inside the mind during the learning process. As we have discussed earlier, social cognitive theory emphasizes the importance of mental or cognitive processes. Information processing theory presents a more specific account of the cognitive processes that occur during learning. In contrast to these behaviorism and social cognitive theories, information processing theory has little to say about rewards and punishments.

According to the information processing theory, information moves through various memory stores until it can be stored in a long-term or permanent memory store; cognitive processes operate on this information as it moves from one memory store to another (A. D. Baddeley, 1996; Miller, 1956; A. Newell & H. Simon, 1972). Figure 2.1 displays the main memory stores of the information processing system (the boxes in the diagram), together with the processes (the labeled arrows) that operate on the information. The memory stores include the *sensory register, short-term memory (also called working memory),* and *long-term memory*. Some of the key processes that operate on this information in these three memory stores are *perception, rehearsal, encoding,* and *retrieval.*

Figure 2.1 The main memory stories and main processes of the information processing system.



In the following sections, we will illustrate the key concepts of information processing theory by following the learning process of a fourth grader, Rachel, who is reading a text about aquatic animals. We will focus on what happens when she reads a sentence that surprises her, "Lobsters taste food with hairs on their legs."

Sensory Register

The first step in processing the sentence about lobsters is that the information is very briefly stored in the first memory store, the **sensory register**, which stores visual information for a short time. Visual information, such as a word read in a book, remains in the sensory register for only about 500 milliseconds (Sperling, 1960). If the information does not move into the next memory store, short-term memory, it is completely lost from the system within about half a second.

The **auditory sensory register** is the sensory register that briefly stores sounds. Information in the auditory sensory register lasts up to perhaps two seconds before the sounds are lost from memory (Darwin, Turvey, & Crowder, 1972; Moray, Bates, & Barnett, 1965). The auditory sensory register sometimes helps you figure out what someone said to you, even if you weren't paying attention. For example, have you ever had an experience like this: Some speaks to you to you while you were occupied with something else, and you did not attend to what they said right away. You had no idea at this moment what was said. Yet when you turned your attention to what was said a second or two later, you were able to piece together at least some of the words. This occurs because of the auditory sensory register, which gives you access to what you hear for up to several seconds, even if you were not attending to it.

Information in the sensory register is stored in a form that has not yet been classified or interpreted. For example, let's return to Rachel as she is processing the word *lobster*. How is the first letter, L, stored in her visual sensory register? The visual sensory register stores the "L" not as the letter L but as shape (just two lines that are connected). The lines have not yet been classified as an "L," or as the first letter in *lobster*. Similarly, the auditory register records sounds that have not yet been interpreted. If Rachel hears the word *lobster*, the auditory sensory register contains an impression of the sounds heard, but these sounds would not yet be recognized as the word *lobster*.

Working Memory, or Short-term Memory

Working memory, also called **short-term memory,** is the memory store that holds information and processes that are currently active. This memory store holds the information of which we are currently aware.

The size of working memory is extremely limited. Although it is difficult to pin down the exact size, a widely-cited conclusion by the psychologist George Miller (1956) is that people can hold only 7 ± 2 pieces of information in working memory at one time. For instance, one can remember seven numbers or seven items in a list. The limited size of working or short-term memory plays an important role in many current models of how humans learn. As we will see in later chapters, the limited size of working memory will help us understand why some instructional methods work better than others.

To test the limited size of your own working memory, listen or read a series of single-digit numbers, and then try to recall the numbers you have heard. Try it with the list of numbers below. View these numbers long enough to say each to yourself. Next, cover the numbers and try to write down as many as you can on a piece of paper.

5 8 1 9 6 7 2

Most adults can recall these 7 numbers, or at least 6 of them. Now try it with these numbers.

9 7 2 0 8 4 7 3 2 5

Few people can remember 10 digits, and those who do use special memory strategies of the sort that we will discuss shortly.

As new information in stored into working memory, old information fades. If you have ever had the experience of trying to remember a phone number long enough to dial it, only to have someone in the room say something to you, you have experienced this phenomenon. The information you had retained in your working memory was simply replaced as you tried to take in the new information that was being communicated to you. Below we will discuss some strategies for increasing the amount of information that can be stored in the working memory.

Chunking. **Chunking** is a key method of placing larger amounts of information into working memory (Gobet & Clarkson, 2004; Miller, 1956). Let's try recalling another series of digits. But this time, before you begin, be aware that the digits are dates of U.S. holidays. Keeping this in mind, how many of the digits can you recall after you read and say them to yourself.

3 / 17   2 / 14   4 / 1   10 / 31   7 / 4   12 / 31

If you know what all these dates represent (Saint Patrick's Day, Valentine's Day, April Fool's Day, Halloween, Independence Day, and New Year's Eve), you probably were able to recall most or even all of these dates. Information processing theorists have shown that when we **chunk** the numbers into larger meaningful units, we are more likely to retain more information. In this case, the numbers are chunked into meaningful dates, allowing you to recall up to 18 digits. However, what if you try to recall 7 dates with 18 digits when the dates are less meaningful to you, such as

5 / 3   4 / 29   2 / 11   3 / 14   11 / 3   11 / 15

These dates are Japanese holidays. If you are very familiar with Japanese holidays, you may do very well with this list. If some of these dates have a personal meaning for you, you will be able to chunk them in this way. Otherwise, you will probably be unable to chunk the numbers, and you will probably remember fewer of the numbers in these dates.

Consider another example of chunking (Bower, 1970, 1972). Read this series of letters to yourself, one letter at a time, and then try to remember as many as you can.

F   BIE   SP   NMT   VNB   CDN   AU   SAF   AQ

Now consider how much easier it is to remember the same 22 letters, in the same order, when they are organized like this:

FBI   ESPN   MTV   NBC   DNA   USA   FAQ

How did you do? In the first case, the unit of information is likely to be the individual letter. Perhaps you can make some small chunks—some might store "SAF" by thinking of the word *safe*. But for the most part, chunking is difficult in the first list. On the other hand, chunking is easy in the second list, as you are not storing individual letters in working memory; rather, you are storing meaningful acronyms such as "FBI" as single units.

Automaticity. Chunking is the way in which people are able to place units in working memory that are large enough to understand whole sentences and more. **Automaticity** occurs when a process is can be performed with very little use of working memory. As an example, let's return to Rachel and the sentence about lobsters. There are eight words and 37 letters in the first sentence, "Lobsters taste food with hairs on their legs." If Rachel is a good reader who can decode (decoding refers to determining what a word is based on the letters in the word), she will not store individual letters in working memory. She will store larger units of meaning in working memory, such as words or even larger units. There is no definitive way to determine exactly the size or content of the chunks that individuals form. Perhaps Rachel stores *lobster* as one chunk, *taste food* as a second chunk, *hairs on their legs* as a third chunk, and *with* as a fourth chunk that indicates that tasting food occurs by means of the hairs on the legs. This means that she still has working memory capacity left over. This possibility is shown in Figure 2.2. Rachel is able to store all this information in working memory because her ability to translate the written letters into words is **automatic**, which means that the decoding process occupies little if any working memory space. Thus, she does not need to place individual letters in working memory as she is reading, and she has more space to store larger chunks of information in the sentence.

Figure 2.2. The possible chunked contents of Rachel's working memory when she has she read the sentence. Notice she has excess working memory capacity.

lobsters	taste food	with	hairs on their legs			

On the other hand, let's consider a classmate of Rachel's, Tamra, who is a very poor decoder. Unlike Rachel, Tamra must work out the letters one by one, so that each letter or its corresponding sound may need to be stored as separate units in working memory. Figure 2.3 shows a possible process by which Tamra tries to read the sentence. As she begins by reading the word *lobster*, she may have to sound out the word, letter by letter. The letters and sounds occupy parts of her working memory. Then, once she realizes that the first word spells *lobster* and so stores the concept *lobster* into working memory, she must work out the next word, *taste*, letter by letter. Then she tackles the word *food*, and then the word *with*. By the time she gets to the word *with*, there is no room in working memory to store the first three concepts in the sentence while she sounds out the word *with*. Too much of her working memory is occupied by the letters and other information needed to decode the words bit by bit. As she decodes *with*, the concept *lobster* might thus drop out of working memory because there is not enough room for it (see Figure 2.3). Because Tamra has difficulty storing all of the concepts in the sentence in working memory at the same time that she works out what the letters spell, she will have a very difficult time understanding the sentence (Savage & Frederickson, 2005; Savage et al., 2005; Strayer & Kramer, 1990; Tronsky, 2005).

Figure 2.3 This figure shows the chunked contents of Tamra's working memory at two points in time, as indicated in the text.

First, Tamra reads the word *lobster*, first encoding LOB, then working out the rest of the word.

LOB	S	T	E	R	S	lobsters

Second, Tamra keeps *lobsters* in working memory as she reads the word *taste*, letter by letter.

lobsters	T	A	S	T	E	taste

Third, Tamra keeps *lobsters taste* in memory as she works out the word *food*.

lobsters	taste	F	O	O	D	Food

Fourth, As Tamra reads the word *with*, there is no space for any information beyond the W-I-T-H spelling, so the concept *lobsters* drops out of working memory.

taste	food	W	I	T	H	with

lobsters

Most information processing theorists emphasize the role of extensive practice in gaining automaticity (K. A. Ericsson, Krampe, & Clemens, 1993). For instance, students who gain proficiency in reading have spent a substantial amount of time reading, thereby enhancing their skill at decoding words as well as their skill at interpreting sentences. Little by little, with increased practice, these reading skills become more and more automatic (Archer, Gleason, & Vachon, 2003). The challenge to teachers, in light of this knowledge, is how to help students engage in lots of practice so that skills become automatic, but to make this practice both interesting and engaging. We revisit this topic in Chapter 12 (Creating Motivating Instruction). In addition, when encouraging students to practice their skills, teachers also must ensure that students' practice is thoughtful and purposeful in order for it to be effective. Five hours of half-hearted, mindless practice on math problems may have much less value than two hours of thoughtful practice using effective learning strategies. We will revisit this topic in Chapter 7 (Complex Cognitive Strategies and Self-Regulated Learning).

As we have seen in this section, there are two central ways to increase the amount of information that can be placed in working memory at the same time: chunking information and making processes automatic. We will encounter a number of the instructional methods in later chapters that will help students chunk more effectively and make processes automatic.

Problem 2.1 Understanding Students' Thinking: Expanding Memory

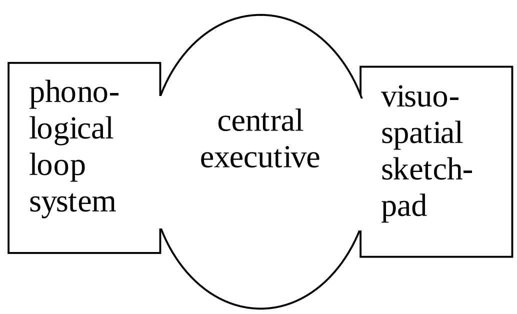
Capacity

Chase and Ericsson (1981) studied a college student who was able to expand his digit span from 7 digits to over 80 digits after about 250 hours of practice in the laboratory over two years. How did he accomplish this?

Response: *The student was a runner who had a very rich knowledge base of running times (his own and those of famous runners) that he used to chunk the digits. For instance, he might chunk 3-4-7 as a record mile time by Sebastian Coe and 3-4-9 as a record mile time by John Walker. A series of 3-4-7-3-4-9 could then be combined into a higher chunk (Recent World Records in the mile). So the memory feat was accomplished by chunking.*

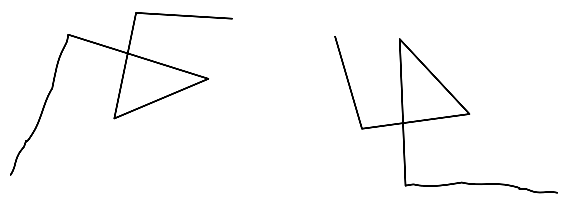
Components of working memory. Cognitive psychologists have found evidence that working memory contains at least three different subcomponents: the *phonological loop system*, the *visuospatial sketchpad*, and the *central executive* (see Figure 2.4) (A. Baddeley, 2003; A. D. Baddeley, 1996; Holmes & Adams, 2006). The **phonological loop system** is a system for retaining auditory information. For example, when you say a phone number to yourself over and over, you are using the phonological loop system, because the numbers you are saying are in an auditory format. Evidence suggests that when people are asked to remember lists of words, they often subvocalize (i.e., they say the word silently to oneself), so that they are using their phonological loop system.

Figure 2.4 The working memory system includes a phonological loop system, a visuospatial sketchpad, and the central executive.



The **visuospatial sketchpad** is the working memory system for storing visual information and for carrying out operations that involve visual imagery. For instance, if you mentally rotate the figure shown at the left of Figure 2.5 to determine whether it matches the figure at the right, you will use your visuospatial sketchpad. Similarly, when you examine a diagram in a textbook, such as a diagram showing how hydraulic brakes work or how a curveball spins, you employ your visuospatial sketchpad.

Figure 2.5. When you mentally rotate the object on the left, will it match the object on the right? When you carry out the mental rotation, you use your visuospatial sketchpad.



There is evidence that the phonological loop system and the visuospatial sketchpad are partly independent. People can process more information in the two systems together than they can in either system alone.

The **central executive** is the system that manages all the work that occurs within working memory. It is the least understood of the working memory systems because it is the hardest to investigate. The central executive controls operations within the phonological loop system and the visuospatial sketchpad. It also plays a role in comprehension, reasoning, and problem solving. People with high central executive memory capacity can remember a greater amount of meaningful material (Daneman & Carpenter, 1980). This ability is crucial to understand complex ideas. For instance, read the following passage and see if you can spot a contradiction.

> Erin loved to read in her house on winter evenings, although this particular evening was rather warm. She cuddled up in front of the fire and took out her philosophy textbook. As she read, she thought she heard an odd noise outside. It sounded alarmingly like a footstep outside her window. She set aside John Locke and his ideas about the mind as a blank slate and got up out of her chair. She heard the sound again, but this time she was less sure what it was. Some might have called her foolhardy, but she grabbed a baseball bat and headed out the door. An icy wind greeted her as she stepped outside.

To notice the contradiction (there would not be an icy wind on a warm evening), you have to be able to retain some information from the first part of the paragraph until you reach the end. The ability to retain large amounts of meaningful information of this sort in memory is a hallmark of people with large executive processing capacity. People with smaller executive processing capacity are less likely to be able to notice the contradiction (cf. A. D. Baddeley, 1999, pp. 67-68).

The central executive is involved in storing information such as the information that Rachel read about lobsters. Yet the central executive can extend the overall capacity of working memory by sending some information to the phonological loop or the visuospatial sketchpad. For instance, if Rachel stores part of the information about the lobsters as a visual image in the visuospatial sketchpad, she may be able to retain more information at once in working memory.

Problem 2.2 Understanding Students' Thinking: Assessing Executive Processing Capacities

You are curious about one of your twelfth grade history students' executive processing capacities. You learned about a test developed by Daneman and Carpenter (1980) to assess working memory. You give the student the following 4 statements. You cover up each one after she has read it. Then, after she has read the last sentence, she is asked to recall the last word in each sentence. You also tell her that you may stop at any time to ask her to paraphrase the current sentence. (Try it yourself first.)

> The greengrocer sold many apples and oranges.
> The sailor had been round the world several times.
> The house had large windows and a massive mahogany door.
> The bookseller crossed the room, scowled and threw the manuscript on the chair.
> The banker counted up the money at the end of the day.

The student produced four words: oranges, door, chair, day

How would you evaluate her executive processing capacity?

Response: *Four words is a good performance on this task. (I got just 3 the first time I tried it.) Her executive processing capacity is good. Consider how difficult it is to recall four words on this task. The student must retain three words in working memory while understanding a fourth sentence and then the fourth end-of-sentence word to working memory. This requires both that the student has a large executive processing capacity and that she is very efficient at processing these sentence in relatively large chunks. For instance, in the last sentence she might be able to store "the banker" as one chunk, "counted up" as a second chunk, "the money" as a third chunk and "at the end of the day" as a fourth chunk. Because she hasn't stored individual words, she would not be able to recall the exact words (she might recall that "the banker was checking how much money there was" rather than that "the banker counted up the money"). But she is able to retain the overall meaning. Even so, she would also need a large executive processing capacity to retain all these chunks as well as the individual words from the end of the sentences.*

Perception and Rehearsal

So far, we have examined two of the memory stores in the information processing system: the sensory register and working memory. **Perception** is a process by which information moves from the sensory register to working memory.

Perception is a complex process, involving many subprocesses. Two of these subprocesses are *classification* and *attention*. **Classification** refers to how information is categorized in the sensory register. As we discussed when we examined the sensory register, information in the sensory register has not yet been classified or interpreted. Thus, an "H" is not an "H" but three lines that have not yet been classified as an H. In the sensory register, the word "HAT" is not the word *hat* or the letters H-A-T but rather a series of lines and curves that have not yet been interpreted. As information moves to working memory, it is classified, so that the H is now recognized as an H, and H-A-T is now the word *hat*. **Attention** refers to focusing working memory on particular information. When people attend to some information, they do so at the expense of other information. Attention is limited. Although there is debate on this issue, recent evidence suggests that information that is not attended to does not enter working memory (Lachter, Forster, & Ruthruff, 2004).

Classification involves two interacting forms of processing, called **bottom-up processing** and **top-down processing** (Brewer & Lambert, 2001; Chinn & Malhotra, 2002a; Rock, 1985a, 1985b). When you classify a stimulus that you observe, you use both the information in the stimulus (bottom-up processing) and your own prior knowledge (top-down processing) to classify what you are observing. Bottom-up processing is driven by the features of what you are observing. As an example, consider the word HAT. You do not misperceive the word as CAT or BAT. The pattern of three intersecting lines in the H cannot be mistaken for a C or a B. You respond to the pattern that you see. The information from the stimulus (at the "*bottom*" of the system) is passed *up* through the system until you inevitably classify the three lines as an H and as the first letter in the word HAT.

In top-down processing, prior knowledge plays a central role in influencing what is perceived. To use an example similar to the previous one, read this word: . You no doubt read the first letter as an H and read the word as HAT. Now read this word:  . You probably read this as CAT. But notice that the H in HAT and the A in CAT are exactly the same configuration of lines:  . Whether you interpret these lines as an A or as an H depends on the context. In the first case, you use your prior knowledge about words (your knowledge is the "top" of the perceptual system) to form expectations that the word is HAT, and so you interpret the  as an H. In the second case, you form expectations that the word is CAT, which induces you to interpret the  as an A. This is top-down processing because your expectations move from your prior knowledge (the "top" of the system) about words to influence how you interpret the lines on the page (these stimuli are at the "bottom" of the system).

In this instance, the stimulus is ambiguous, but top-down processing also influences perception even when the stimulus is not ambiguous. For one thing, top-down processing expedites the perception process. For instance, if you know you are going to be looking at pictures of farm scenes, you will probably identify a cow as a cow faster than if you mistakenly expect that you will be looking at urban scenes but are instead shown a picture of a cow (cf. Delorme & Rousselet, 2004). We will discuss perceptual processing, including top-down and bottom-up processing, in more detail in Chapter 5 (Prior Conceptions).

Whereas perception is a process by which information moves into working memory, **rehearsal** is the active repetition of information so that it stays in working memory. Rehearsal is simply saying information over and over to keep it from dropping out of working memory, as when you repeat a phone number to yourself to keep from forgetting it until you have dialed the number. Rehearsal by itself does not move information into long-term memory; is simply keeps information cycling within working memory so that it does not drop out of working memory.

Long-term Memory

Long-term memory (LTM) is the memory store where information is stored for very long periods of time. But active processing does not occur in LTM. Information must be moved from LTM to working memory to be used in active cognitive processes. Unlike working memory, which has a limited capacity, the size of LTM has no known limits. People can store as much information in LTM as you can process through working memory. What makes learning difficult is the limited size of working memory through which information must pass on the way to long-term storage in LTM.

Psychologists have distinguished several kinds of knowledge in long-term memory: *declarative knowledge, procedural knowledge, metacognitive knowledge,* and *episodic knowledge* (J. R. Anderson, 1995). **Declarative knowledge** is knowledge that you can express in sentence form, such as the knowledge that rain makes things wet. You can use declarative knowledge to guide your actions and decisions. For example, because you know that rain makes you wet, you may decide to take an umbrella with you when it is supposed to rain.

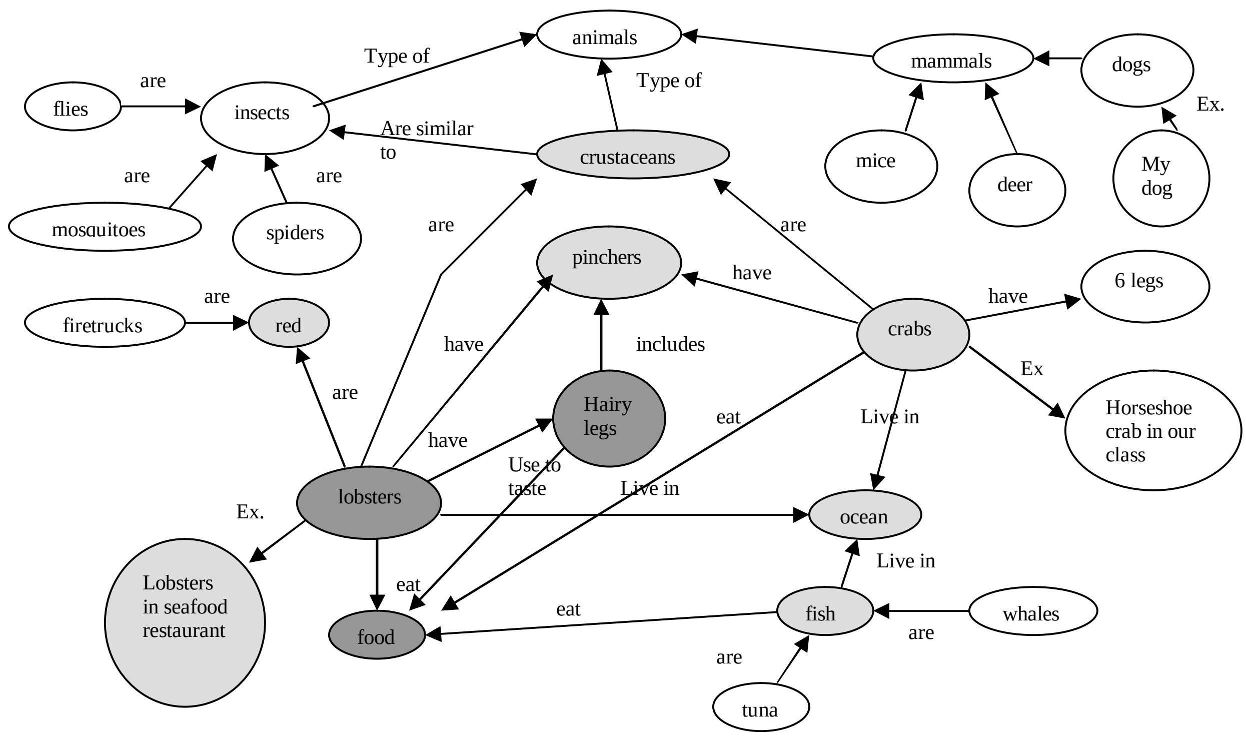
Procedural knowledge is knowledge that specifies actions that people take. The actions can be physical actions (the actions needed to kick a soccer ball) or mental (the mental actions needed to add two numbers). You may or may not be able to express procedural knowledge in words. For example, if you can ride a bicycle, you probably cannot explain all the things you do to keep your balance smoothly as you ride, yet you carry out all these actions smoothly. Procedural knowledge is often viewed as having this form: “If your GOAL is X, then DO y.” For instance, if your goal is to save money, then don’t go out on weekends as often.

Metacognitive knowledge is a type of procedural knowledge that focuses on cognitive processes. Your metacognitive knowledge is your knowledge about how to learn new information, how to solve problems, and so on. For instance, if your goal is to get an A on a paper, you may know that you should spend ample time writing several drafts of your paper. If your goal is to remember a long list of words, then you should try to chunk the words in some way. We will discuss metacognitive knowledge in many later chapters; metacognitive knowledge is the main topic of Chapter 7.

Episodic knowledge consists of memories of your own personal experiences. Your memories of what you did with your friends in high school are an example, as are your memories of the class activities in your educational psychology class this year.

How is information stored in LTM? One of several proposals is that information in LTM is organized in **associative networks** of nodes and links between the nodes (J. R. Anderson, 1976; A. M. Collins & Loftus, 1975). (We’ll discuss other proposals in later chapters.) Let’s return to Rachel and consider how the information she learns about lobsters might be stored in long-term memory as an associative network. Figure 2.6 provides an illustration. The network consists of concepts that appear in nodes (the circles) that are connected by links (the labeled lines between the circles). Some of the concepts and links are new ideas that Rachel learned when she read the two new sentences. Others are ideas that she knew previously. Some of the ideas in the network are incorrect, such as Rachel’s mistaken idea that crabs have six legs.

Figure 2.6 Rachel's associative network of concepts related to the sentence "Lobsters taste food with hairs on their legs." The shaded nodes show concepts that have been activated after reading the sentence. The darker the node, the greater the activation.



If information in LTM is in fact stored in associative networks, this explains a number of interesting memory phenomena. For instance, after reading the sentence about lobsters, Rachel is likely to be able to answer questions about crabs faster than she would be able to if she had not read the lobster passage. Information processing theorists explain this by hypothesizing that when Rachel reads the sentences about lobsters, the nodes related to the concepts in these sentences are *activated*. That is, they attain a higher level of energy or intensity. This activation spreads to other nodes that are connected to the activated nodes. Thus, through **spreading activation**, concepts such as crab, sea, and seafood that are connected to lobster directly or indirectly rise to a higher level of activation. When Rachel is asked a question about crabs, she can answer it more quickly because the concept crab is already at a heightened level of activation.

Encoding

Encoding is the process of moving information from working memory to LTM. **Encoding strategies** are mental actions that learners can take to make information more memorable as it is encoded. Encoding strategies can be broadly divided into three groups: *selection strategies, organization strategies,* and *integration strategies* (Mayer, 1989).

Selection strategies. As we have discussed, not all information that goes through working memory makes it into long-term memory. Learners select which information they want to process further. The act of selecting important information facilitates memory for the information (Pressley, Goodchild, Fleet, Zajchowski, & Evans, 1989). Two prominent ways of selecting information are **summarizing** and **taking notes**. When a person summarizes a text, memory improves in part because the learner is focusing on what is most important from all the available information. Similarly, a good note taker selects important information while taking notes instead of writing down everything. Students who take notes learn more than students who do not take notes, even if they do not study their notes (Kobayashi, 2005). The very act of selecting what is important helps facilitate memory.

Organization strategies. As shown in Table 2.1, there are a number of **organization strategies** that learners use to move information from working memory to LTM (Gaskill & Murphy, 2004; Schlagmüller & Schneider, 2002). Each of these strategies require learners to rearrange the information in new ways. By rearranging information in new ways, learners make the new information more memorable. Learners can use each of these organizing strategies to help them arrange information in different ways so as to make it easier to remember.

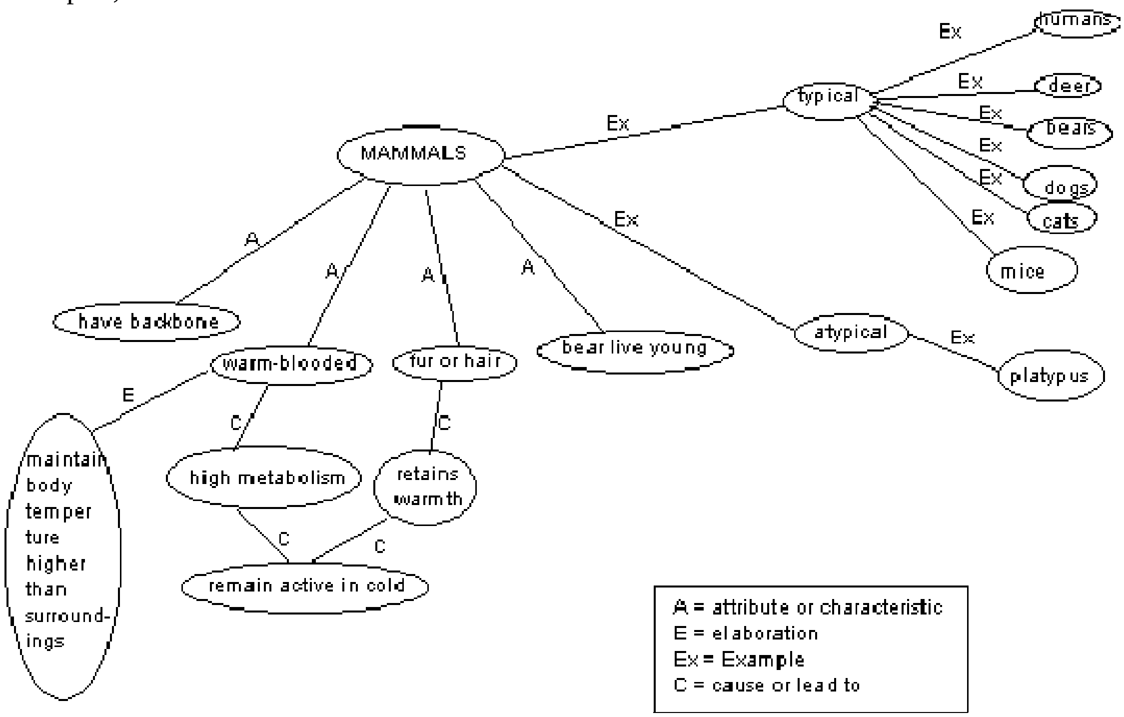
Table 2.1 Organization strategies.

Organizing strategy	Explanation and examples
Classification	Classification involves reorganizing ideas according to categories that the learner selects. For instance, when asked to learn a list of words (orange goat sun moon mouse apple broccoli mango star horse lettuce radish), the learner remembers more of them a day later because she has organized them into categories: FRUITS: orange apple mango MAMMALS: goat mouse horse VEGETABLES: broccoli lettuce radish HEAVENLY BODIES: sun star moon
Acrostics	An acrostic is a sentence in which the first letter of each sentence stands for something that you want to learn. Examples: 1. Every Good Boy Does Fine. These are the names of the musical notes on the lines in treble clef: EGBDF. 2. My very educated mother just served us nine pizzas. The first letter of each word stands for the order of the nine planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.
Acronyms	An acronym is a word (or pseudoword), each letter of which stands for something that you want to learn. Examples: 1. HOMES. The letters are the first letters of the names of the Great Lakes: Huron, Ontario, Michigan, Erie, Superior) 2. Roy G. Biv. These letters are the first letters of the colors of the rainbow, in order: red, orange, yellow, green, blue, indigo, and violet. 3. PEMDAS. These are the first letters of the words that show the order in which math operations should be carried out: parentheses, exponents, multiplication, division, addition, subtraction.
Rhymes	Rhymes are readily remembered organizing tools. Examples: 1. I before E except after C. 2. In 1492 Columbus sailed the ocean blue…
Songs	Songs are another powerful way to organize information. The ABC song, for instance, is a powerful way to help children learn the letters in the English alphabet.
Outlining or summarizing	Outlining and summarizing involve selection, but they also involve organization. If you summarize a long passage, you are likely to be doing more than just selecting what is important. Similarly, when you outline, you not only select what to put in the outline; you also classify ideas within headings at different levels of your overall organization.

Integration strategies. Integration strategies explicitly connect information in working memory with information from long-term memory (Mayer, 1989). Integration strategies are powerful ways of encoding information effectively into LTM. Table 2.2 shows a broad array of specific integration strategies.

Table 2.2 Integration strategies

Integration strategy	Explanation and examples
Imagery	Imagery is the strategy of creating visual mental images in your mind's eye. Imagery is a very potent memory strategy (refs xx). Imagery allows you to link new information to visual information stored in LTM. For example, when trying to remember details about the Boston Tea Party, a learner can generate a vivid "movie" in his mind that includes all the details he wants to remember.
Keyword method	When using the keyword method, the learner links the words being learned to other words already known. The linked word or words become the keyword. The keyword method is a strategy that has been found to be very effective for learning words, both words in foreign languages and words in one's native language (refs xx). For example, when trying to learn that the German word <u>frau</u> means woman, a learner might generate a mental image of a woman frowning severely. Because the word <u>frown</u> sounds similar to the German word <u>frau</u>, the image helps you remember better. In this case, <u>frown</u> is the keyword that helps you remember the word <u>frau</u>, via the mental image you create. As another example, a student studying the SAT word *dormant* might remember that one meaning is asleep or acting as if one is asleep by imagining a *door* that is sleeping for a time. The word *door* is the key that helps the learner recall *dormant* via the mental image.

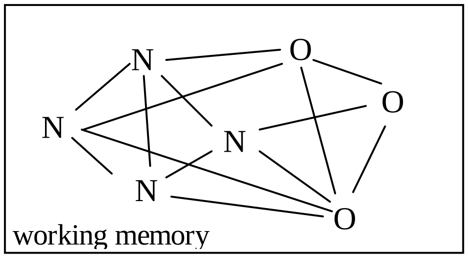
Concept maps	One way to improve memory and understanding that has been studied extensively by researchers is concept maps (refs xx). A concept map consists of nodes and links that capture key aspects of what one has read or what one knows. Concept maps are like the semantic networks that you have already learned about. Constructing concept maps facilitates students' learning. For example, if students construct concept maps that capture the main ideas in textbook chapters, they learn more than if they just read the chapter. Here is an example of a concept map that an upper elementary school student might make after reading a section of a science textbook about mammals. In this example, the student has used four different kinds of links to connect concepts: attributes, elaborations, examples, and causes. 
Comparing and contrasting	Comparing and contrasting is a way of connecting new material with old material. The learner focuses on similarities and differences between new and old information. For instance, when trying to learn about the French Revolution, compare events point by point with the more familiar events of the American Revolution.
Analogies	Analogies are connections between concepts or structures that are superficially dissimilar but similar at a deeper level. For instance, a student learning about heat flow might notice some points of analogy between heat flow and water flow. A student learning about cells might notice that mitochondria in a cell are analogous to power plants in a town. Because analogies are rarely perfect, it is often important for learners to notice dissimilarities as well as similarities (for instance, water is a substance with mass and volume, but heat is not energy, not a material substance). Of course, teachers often point out analogies to students, but students can also productively generate analogies on their own.

Examples and nonexamples	Generating examples of new ideas, and thinking about what is *not* an example of the idea, is a good way to integrate new ideas with what you already know. When given a definition of *propaganda*, a learner might think of currently popular ads on TV and decide which ones are examples of propaganda and which are not. Note that thinking about nonexamples can be very useful for learning. Realizing that a whale is *not* an example of a fish can be even more helpful to understanding what a fish is, and what it is not, than is noting that a guppy *is* an example of a fish.
Arguments for or against	Thinking of arguments for and against an idea is another way to connect new ideas to what you already know. When reading about a textbook's description of the causes of the Industrial Revolution, a student might try to think of arguments that would support the textbook's claims and also of arguments that militate against the textbook's claims.
Applications to the real world	Thinking of how to apply information to solve real-world problems is a way to connect new information to a student's current real-world knowledge. For instance, when learning how to solve a differential equation in calculus, you could think of situations in which you could use this knowledge in the real world.
Explanation	Explanation is a very powerful and effective way of connecting new information to knowledge already stored in LTM. For instance, when trying to remember that animals' temperatures decrease during hibernation, learners may explain to themselves that maintaining a high body temperature takes a great deal of energy, and because animals cannot eat while hibernating, their metabolism needs to shift to a low temperature that does not consume much energy. In this example, the learners connect the new information about hibernation to other known explanations about body temperature and metabolism.
Elaboration	Elaboration is a strategy that requires connecting new information to old information. When learners think about what they already know in relation to what they are learning, they are elaborating. For instance, when reading about Jackson's presidency, learners might think about everything else they knows about politics in the early 1800s. All of the strategies listed above in this table can be viewed as specific ways to elaborate material. For instance, thinking about applications to the real world are one way of connecting new information to old information.

By combining two core principles from information processing theory, teachers can gain important insights into how students learn. These two principles are the ideas (1) that the size of working memory is very limited and (2) that an effective means of learning is to connect new information with information already stored in LTM (cf. van Merriënboer & Sweller, 2005). To see how these two principles work together to explain learning, let's look again at Rachel learning about lobsters tasting food with hairs on their legs. To integrate these new ideas with old information that she already knows, Rachel needs to bring the new information and the old information from LTM into working memory at the same time. We can diagram this symbolically as shown in Figure 2.7a.

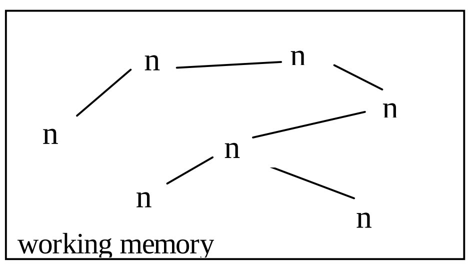
In the diagram, the N's represent new information, and the O's represent old information that has been retrieved from long-term memory. Rachel is connecting the new ideas about lobsters to old information (e.g., lobsters have eight legs, with large pincers on two of the legs, lobsters live in the ocean, and so on). For learning to take place, Rachel needs to retain open space in working memory for this old information to be brought in from long-term memory (represented schematically by the three O's) to connect to chunks of new information (the four N's).

2.7a In this diagram, working memory contains both new information and old information. Encoding is therefore successful.



When you understand that learning typically involves integrating new information with old information, then you can readily understand why learning is difficult in some situations. As we noted earlier, when learners use up most of their working memory space for decoding or comprehending individual sentences, there is not any space left in working memory to bring in old knowledge to connect to the new information. This situation is illustrated in Figure 2.7b. Here, the small n's symbolize that the student has only small chunks in memory at one time, perhaps individual words or even individual sounds rather than larger unit. There is no space left to bring in old information, so in this case, little learning occurs.

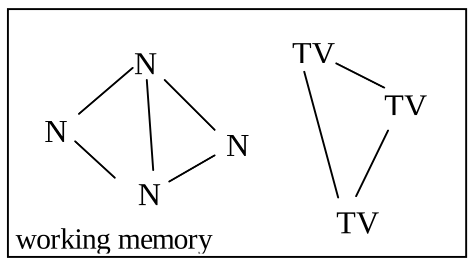
2.7b. Working memory is filled with lower-level, unchunked information. Therefore, successful encoding does not occur.



Now suppose that Rachel is watching television while she is reading the text about lobsters. Even if she can read the words and sentences fluently, her learning may be impeded by watching television. If she is paying attention to the television, it means that some information from the television is entering working memory. Then her working memory at any given moment might be diagrammed as in Figure 2.7c.

This is consistent with research that indicates that watching television while studying impedes learning (e.g., Pool, Koolstra, & van der Voort, 2003a, 2003b). The effects of listening to the radio are less clear, though some studies suggest that learning can be impeded. Instrumental music has the smallest impact, perhaps due to the fact that there is less interference with meaningful units stored in working memory (e.g., Pool et al., 2003a; Pool et al., 2003b).

2.7c. Working memory is filled with new information plus information from watching TV. There is no space to bring in old information to connect with new information.



Consider one more television example. Now imagine Rachel doing her mathematics homework in front of the television. Suppose that Rachel needs, on average, three or four chunks of space in working memory to solve the homework problems, which leaves several chunks of working memory to process what is going on in the television show. It is very possible that Rachel will successfully complete the math problems and even get an A on this homework assignment. Four or five chunks of working memory may be enough for her to be successful (if the problems are not too difficult). However, the long-term effect of Rachel watching television as she is doing her homework is that Rachel is unlikely to create strong long-term memories because she has no space in working memory left over to make connections between the new math problems and other mathematics information stored in LTM. There is no space in working memory into which the old knowledge can be retrieved.

As a result, Rachel may not become a successful problem solver as successful problem solvers make many connections among problems (Anzai & Simon, 1979; Catrambone & Holyoak, 1989). For example, they may notice similarities and differences between two problems in the current assignment or similarities and differences between the current problem and problems in earlier homework assignments. They may also notice how a particular rule applies or does not apply to a particular problem. All of these activities require successful students to make room in working memory for both the current problem and other information (other problems from the current assignment, problems from earlier assignments, rules from the chapter or earlier chapters, and so on).

Active, meaningful encoding. Encoding is most effective when it is active and meaningful (Craik & Lockhart, 1972; Craik & Tulving, 1975; McNamara & Healy, 1995). Students tend to learn more if they actively carry out key encoding processes themselves, instead of having teachers do the cognitive work for them. For example, students are likely to learn more if they come up with their own explanations or elaborations than if teachers provide all the explanations and elaborations for them (Willoughby et al., 2000). Similarly, students are likely to learn more if they imagine visual images themselves than if teachers provide pictures of visual images (cf. Kinjo & Snodgrass, 2000).

There may be times, however, when students need teachers' help because they cannot carry out a strategy on their own. For example, a student may try to use the keyword method but find himself unable to come up with a good keyword for a particular vocabulary word. In this case, the teacher can certainly help the student by providing a good keyword. But the teacher should nonetheless encourage the student to invent his own keyword whenever possible. In general, teachers should teach students to execute strategies on their own and allow them to do so whenever they can.

In **meaningful encoding**, students focus on what the new information means, and they try to understand the information. Students remember more when they focus on meaning and when they understand what they are learning. For example, people learn word lists better if they focus on meaning than if they focus on unmeaningful information such as the number of vowels or consonants in the word (Craik & Tulving, 1975).

Meaningful learning also facilitates the ability to use the knowledge to apply knowledge to solve problems or answer new questions. Consider how Rachel might try to learn the fact about lobsters. Rachel could opt for a relatively nonmeaningful way to remember the new fact about lobsters: She could say that *lobster* starts with an *L*, and they lobsters taste foods with hairs on their *legs*, which also starts with *L*. She could try to remember that *lobsters* taste with hairs on their *legs* by remembering "LL" together. This might indeed help Rachel remember this fact.

But suppose Rachel is asked, "What would happen to lobsters if the water where they lived became polluted?" She would have difficulty applying her knowledge to answer this question, because she does not understand *why* lobsters taste food with their hair (J. D. Bransford, Stein, Shelton, & Owings, 1981) To make the information she has more meaningful, Rachel needs to read further and learn more about lobsters. By reading further and then attempting to explain the information, she will generate more meaningful connections. She will learn that lobsters decide which food to pass into their mouths based on the taste registered by the hairs on their legs. Rachel will also learn that this is analogous to smell in humans; people will reject eating something if they don't like the smell of it. She might then be able to provide a plausible answer to the question: If pollution in the water interferes with lobsters' ability to taste food with their legs, they might be more likely to eat food that is harmful to them, and this might cause some lobsters to die or to get sick. Thus, by generating meaningful explanations, Rachel creates knowledge that can be used to answer practical questions. Less meaningful learning may help Rachel remember facts, but she won't understand how to use the facts to answer new kinds of questions.

Problem 2.3 Understanding Students' Thinking. Identifying students' memory strategies. An important skill for teachers to gain is the skill to rapidly and even automatically identify which strategies your students are using. As teachers become aware of the strategies that their students are using, they are better prepared to develop plans to help students learn new strategies that they are not currently using.

Consider the following examples. Which strategies do you see students using in each scenario?

A. Jessica, a ninth grader studying cell organelles in a biology text says to herself, "I guess mitochondria are kind of like car engines."

B. Alden, a fifth grader studying social studies writes: "There are several pretty important ideas, but I'd say the most important is that the print press started to change society, because the printing press changed everything."

C. Isabel, an eleventh grader studying English history explains: "So Henry VIII brought peace to England. I'll remember that by imagining about a nation full of peaceful hens, made peaceful by King HENry."

D. Shauna, a third grader remembering a list of what to get at the office supplies store says: "Writing stuff--pens, pencils, paper. Art stuff—construction paper, glue, tape."

E. Eli, a seventh grader is trying to learn the order of steps in meiosis: "Interphase, prophase, metaphase, anaphase, telophase, interphase, prophase, metaphase, anaphase, telophase, interphase, prophase, metaphase, anaphase, telophase, interphase, prophase, metaphase, anaphase, telophase."

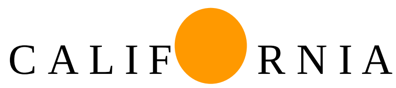
Response:
A. Analogy, an integration strategy, noticing the similarity between engines and mitochondria. You can also view this as elaboration, as it involves making connections with prior knowledge. Many integration strategies can be viewed as elaboration in addition to a more specific strategy such as analogy.
B. Selection—summarizing or choosing a single main idea. Also explanation, as the student explains why the printing press was the most important invention.
C. Keyword method (peaceful HENS and HENry). Imagery plays a role, too, if the student tries to vividly imagine the hens.
D. Categorization into two groups—writing material and art materials.
E. Rehearsal (a miserable choice as a memory strategy!)

Retrieval

The last process in the information processing model is retrieval. As you have just seen, learners move information from working memory to LTM by encoding the information. **Retrieval** is the process of moving information from LTM back to working memory.

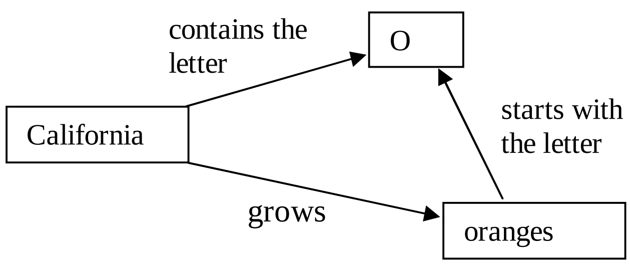
Retrieval is facilitated when students encode information using the encoding strategies presented in the previous section. One reason for this is that effective encoding creates many connections between old information and new information, and it is easier to retrieve information when there are multiple connections to it (Nelson & Hill, 1974; Radvansky, 2005).

As an illustration of why meaningful encoding with multiple connections is an effective encoding strategy, consider two alternative ways of learning the fact that oranges are grown in California. One student remembers it by imagining the O in "California" as a large orange.



Essentially, this student has attempted to create a long-term memory structure with the connections shown in Figure 2.8a. This provides two different paths along which the crucial information (California grows oranges) can be retrieved. The learner can either directly recall that California grows oranges or can recall that the O in California provides a clue that oranges are one important crop.

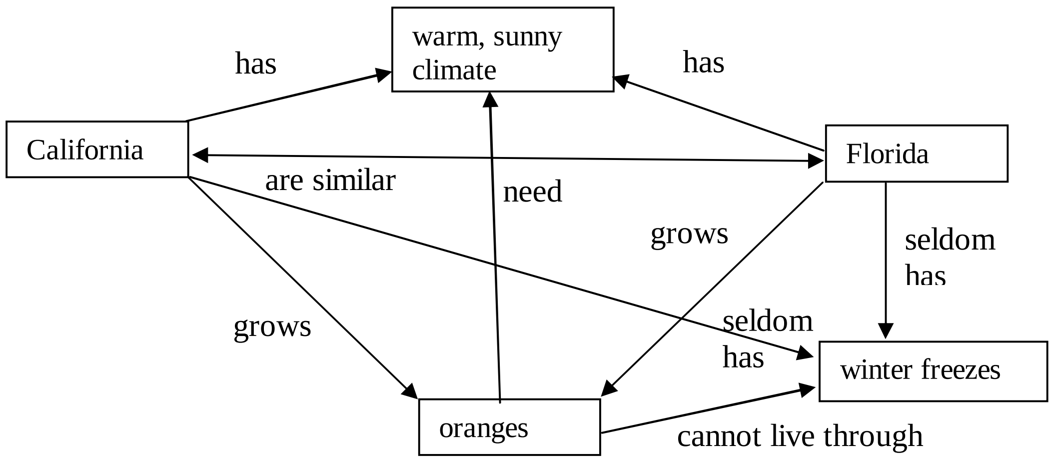
Figure 2.8a An associative network in which the O in California is envisioned as an orange



Contrast this with a student who uses meaningful explanations with many connections to encode the information (Figure 2.8b). This student thinks to herself that oranges are grown in California because oranges require a warm, sunny climate. Oranges are grown in Florida for the same reason; the two states are similar in climate and in crops. In both states, freezes are rare, and this is important because oranges are damaged by freezing. Other crops that require a warm sunny climate, such as peanuts and peaches, are also grown in these states. By making all these connections, this student has a generated a much more interconnected explanatory network of ideas, as shown in this diagram.

The student who constructs this highly interconnected associative network has many more interconnections to help her recall that California grows oranges. If this student can recall any of the other ideas that are connected within this memory structure (for instance, the climate in Florida is like California, oranges are grown in both because of similar warm, sunny climates, and so on), the student will probably be able to retrieve the information that California grows oranges. Multiple interlocking connections created during encoding provide more memory paths to help the learner retrieve target information (see Mishra & Brewer, 2003; Radvansky, 2005).

2.8b. An associative network with multiple, meaningful connections for remembering that oranges are grown in California.



Another way to promote retrieval is to use **retrieval frames**. A retrieval frame is a general set of categories that a student can use to help remember key ideas. Suppose a student is studying a sixth-grade social studies text in which each chapter describes a different nation. The student could facilitate the retrieval of the information in the chapters by using this set of categories to help her remember:

people: _______________
language: _______________
geography: _______________
religion: _______________
customs: _______________
economy: _______________

By applying this frame to the retrieval task, the learner makes it less likely that she will omit crucial information. Studies with sixth-graders (Ohlhausen & Roller, 1987) have shown that students who use this type of frame when they study learn more information.

Rachel could help herself remember facts about lobsters and other animals by using a retrieval frame such as this one:

animal name: ________________
where it lives: ________________
what it eats: ________________
how it eats: ________________
how it protects itself: ________________
surprising facts: ________________

Why do frames such as these help students learn more? The are at least two reasons: one focuses on encoding and one on retrieval. First, the frames help students select which information to encode as they are learning. For example, Rachel will remember to encode facts about how lobsters eat if she uses the frame to help her decide what is important to remember. Second, the frames aid retrieval. For example, when trying to remember information about lobsters, Rachel can use the frame to make sure that she does not forget important categories of information as she tries to recall what she knows. Accordingly, frames help with both encoding and retrieval. Figure 2.9 presents examples of other frames that students use for encoding and retrieving information at different age levels.

Problem 2.4 Designing instruction: Remembering Learning Theories

Develop a retrieval frame that *you* can use to remember the key features of the three learning theories you have learned about so far in this chapter. This activity is typical of what you will often do as a teacher. You should be able to develop retrieval frames for many of the topics that you will be teaching.

Response: There are many ways to develop your retrieval framework, but you might start by contrasting the three different theories you've learned about so far to identify general categories along which the three theories differ. For instance, all of the theories identify learning processes (operant and classical conditioning for behaviorism; attention, retention, reproduction, and motivation for social cognitive theory; encoding and retrieval for information processing theory). Thus, learning processes is a general category for learning theories; all learning theories identify learning processes. Try to think of other categories along which the theories differ. Table 2.6 at the end of the chapter shows one possible set of categories, but you should try to identify your own first.

Figure 2.9 Examples of frames

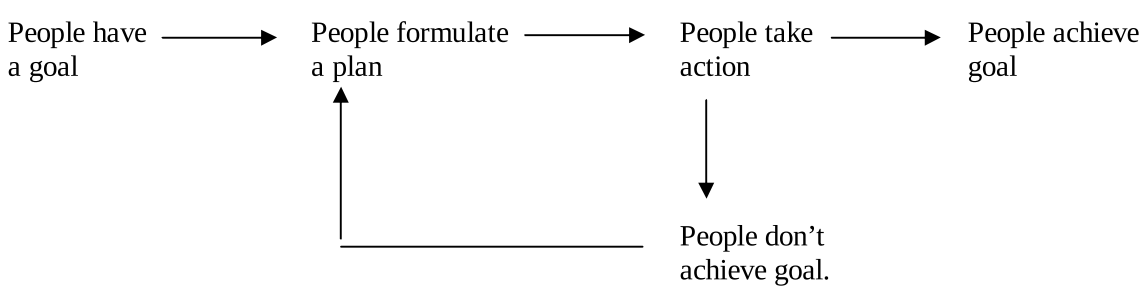
Elementary. Teaching students the main parts of a story helps students understand and remember stories. Here is one story frame. Frames of this sort are often called **story grammars**.

Characters: ______________
Place: ______________
Time: ______________
Problem: ______________
Solution: ______________

Elementary/Middle. Gallagher and Pearson (1989) found that this frame was effective in helping students learn about different insect societies such as bees, termites, and ants.

Insect societies
  Getting started
    Mating ______________
    Caring for young ______________
  Keeping going
    Food gathering ______________
    Nest building ______________

Middle. Studies of social studies students have found that students learn more from social studies text when they are taught to use this general frame for understanding historical events (Armbruster, Anderson, & Meyer, 1991).



Secondary/Undergraduates. Studies of undergraduates have found that undergraduates understand and remember research reports better when they learn a general schema such as the following (Dansereau, 1985):

Purpose of study: ________________
Hypothesis: ________________
Method: ________________
Results: ________________
Interpretation: ________________

Forgetting

We have discussed the many ways in which the mind remembers, stores and retrieves information. However, people do not only remember information. They also forget. **Forgetting** is universal. In a series of famous experiments, Hermann Ebbinghaus (1885/1987) tested how well he could recall numerous lists of nonsense syllables. He found that after just 31 days, he could recall fewer than 30% of the nonsense syllabus in lists he had memorized. Forgetting was rapid in the first 24 hours and then decreased only very slowly after that. This is a general finding: People forget some of what they learn, and they tend to forget most rapidly soon after the learning period is over (A. D. Baddeley, 1999).

However, according to researchers, people forget less than they think they do. I have heard students say that they have forgotten everything in courses they have taken within a month of two of their final exams. However, researchers have found that people in fact, they remember a great deal of what they learn in college courses (Conway, Cohen, & Stanhope, 1991; Semb & Ellis, 1994). In one study, biochemistry students could recall more than 80% of what they had learned 24 weeks after the course ended (P. L. Schwartz, 1981). Likewise, George Semb and his colleagues (1993) found that although students recalled less than 50% of what they had learned in a child psychology course 44 weeks later, their performance on recognition tests was 75%, as was their performance on assessments of cognitive skills (such as the ability to apply concepts). In a longitudinal study, Harry Bahrick and Elizabeth Phelps (1987) tracked students who had taken a Spanish course 50 years earlier and tracked how much they had retained after 50 years. Forgetting was most rapid over the first year, and there was relatively little additional forgetting from years 10 to 50. In some areas, such as Spanish grammar, there is relatively little forgetting over many years (Bahrick, 1984). Students who did well in the class maintained their initial advantage for 50 years. And given that initial recall was 37% for students who did well right at the end of class and 22% after 50 years, these students recalled more than half of what they knew at the end of the course 50 years later. Not all studies show such high levels of recall (e.g., Ellis, Semb, & Cole, 1998), but overall performance has typically been fairly good in these studies.

Several factors mediate how slowly or rapidly forgetting proceeds (Semb & Ellis, 1994):

- *Initial learning*. Initial learning is an important factor in retaining information over time. The more you learn initially while you are taking the course, the more you will remember years later.
- *Repeated use of ideas*. Even occasional use of ideas dramatically improves very-long-term memory. If you take just one test of how much you remember, you dramatically decrease long-term forgetting on other tests months or years later. If you continue to use ideas in later coursework or in life, retention is high.
- *Spaced study*. Information, such as Spanish vocabulary, that is learned over study periods that are spread out over time (rather than being crammed into one or two study periods) is much better retained (Bahrick & Phelps, 1987). For example, it is more effective to study 1 hour a day for 7 days than to study 7 hours in a single day.

There are two main theories of why forgetting occurs: the fading theory and the interference theory (see A. D. Baddeley, 1999). According to the **fading theory**, memory traces fade away over time. According to the **interference theory**, forgetting occurs because people lose the ability to retrieve memories as new memories are added to LTM, making it harder to locate information. As a result, they lose retrieval pathways that can succeed at getting at the information. It is difficult to definitively distinguish between these two theories because as time passes, people accumulate more interfering memories. Most theorists would agree, however, that at least some forgetting results from interference (see A. D. Baddeley, 1999).

Problem 2.5 Designing instruction: Helping students remember important ideas.
Using everything you have learned about memory, what instructional methods would you use to help students learn and remember facts such as these:

A. The steel industry is concentrated in the Great Lakes States.
B. Light is needed for photosynthesis to occur.

Response: As you develop an answer, consider these questions:
1. Have you enabled the students to be as active as possible? If you have provided them information to help them remember (such as an explanation), could you step back and have them generate that information themselves?
2. Have you included integration strategies of some kind that link this information to long-term memory?
3. Have you used meaningful strategies that will form multiple retrieval paths?

CONSTRUCTIVISM

Constructivism is probably the single most influential theory of learning in contemporary education. **Constructivism** asserts that students learn by actively building up ideas on their own. In other words, students learn by actively thinking about ideas, developing their own interpretations of ideas, and inventing their own ways of understanding what they are learning. Because each student is unique, students will construct unique interpretations of what they are studying.

For example, when the teacher tells the students in Rachel's class about lobsters, the students will all interpret what she says somewhat differently. Each student will construct a somewhat different understanding of lobsters and how lobsters eat, because they all have different prior ideas about lobsters. One student who hears that "lobsters smell food with hairs on their legs" imagines hairy legs as on a dog, because this student does not have a good understanding of lobster anatomy. Another envisions a creature with six legs (rather than 10). Still another, who has read extensively about crustaceans, may develop ideas about how lobsters taste food and eat that are even more complex and sophisticated than the teachers ideas. Constructivists thus emphasize that each learner will understand new ideas in a unique way, and that teachers can never expect all students to end up with the same ideas.

Constructivism stands in stark contrast to a discredited model of learning that nonetheless appears to be held by many people: the **transmissionist** or **banking** model of learning (Freire, 1970; Maor & Taylor, 1995). According to the transmissionist model, students are receptacles, and teachers pour information into them. Students meekly receive the information and memorize it. Students are like banks, passively storing the deposits made by the teacher. How does this work with our example of Rachel and lobsters? The teacher has an understanding of how lobsters taste food in her own mind. She tells the students what she knows. This information is neatly transported into her students, who then have an exact copy of the teacher's knowledge in their own minds. Constructivists say that such an outcome is impossible.

Types of Constructivism

There is a vast array of different versions of constructivism (Archer et al., 2003; Matthews, 2000; Phillips, 1995, October) and there is no one set of principles that all constructivists agree upon without qualification. Nonetheless, constructivists can be divided into two broad camps depending on how much they emphasize the role of social interaction in learning (Windschitl, 2002). **Cognitive constructivists** focus predominantly on the individual learner's cognitive processes (Steffe, 1992; Ernst von Glasersfeld, 1993). Although most constructivists in this camp certainly acknowledge that social interactions are very important, their explanatory accounts of learning focus primarily on knowledge construction of the individual. The developmental psychologist, Jean Piaget, whom you will read about in Chapter 3 (Cognitive Development), belongs to this camp. **Social constructivists** emphasize that learning occurs during social interactions (J. S. Brown, Collins, & Duguid, 1989). Learning occurs best (or only) when learners are constructing ideas collaboratively in group or class discussions. Lev Vygotsky, another developmental psychologist that you will read about in Chapter 3, is a key theorist in this broad camp. You will encounter many instructional methods based on social constructivist ideas throughout this text.

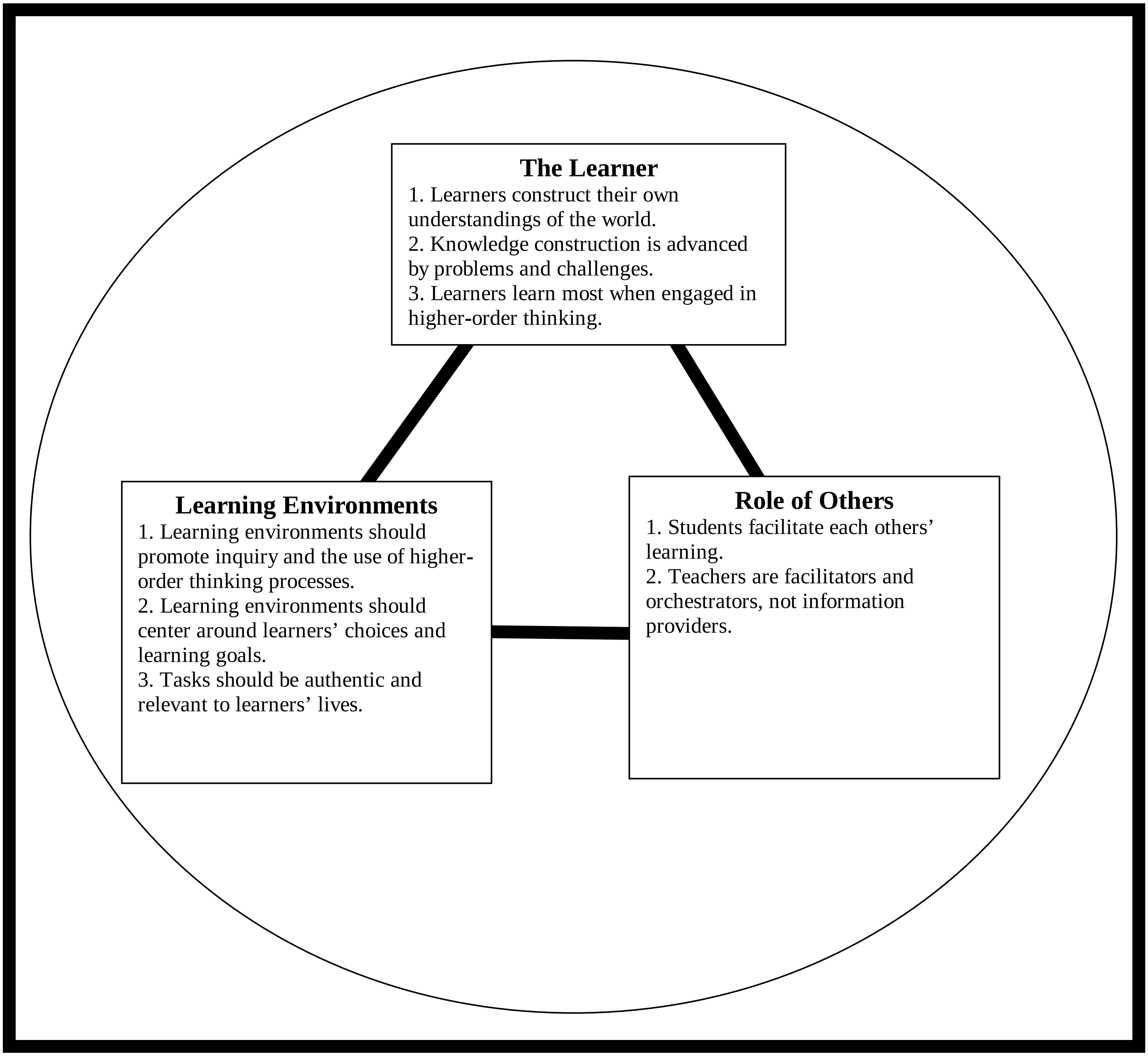
Many constructivists explicitly adopt a **pragmatist philosophy** (see van Fraassen, 1980, 2003; E. von Glasersfeld, 1989; Ernst von Glasersfeld, 1993). According to this philosophy, there is no reason to expect that our ideas correspond to the world around us. For example, although scientists have developed a theory that matter is composed of molecules and atoms, pragmatists insist that there is no reason to think that this theory corresponds to the world at large. They would never say that the world is made of molecules; rather, pragmatists would say that molecular theory enables us to make accurate predictions. They would view molecules as a useful conceptual tool invented by humans to try to make sense of the world. Thus, according to pragmatists, knowledge really is *invented* or *constructed* by humans. According to constructivists, all learners are like scientists. Learners of all ages construct knowledge that is useful to them in explaining events in the world and making predictions. According to constructivists, learners' ideas are creative inventions built by learners to explain and predict events.

Core Principles of Constructivism

In this section, we will introduce you to eight core principles of constructivism with which most constructivists would agree. Although this is only an initial introduction to this theory, constructivism will recur as a major theme in most subsequent chapters throughout this text.

These eight principles fall into three general categories (see Figure 2.10). Constructivists make claims about (1) how learners learn, (2) how learning environments should be designed to promote learning, and (3) the role of others in learning. To illustrate these constructivist principles, we will expand on our example of Rachel learning about lobsters. Let us now imagine that Rachel and her class are learning not just about lobsters, but more generally about ecosystems, including lobsters and other crustaceans as well as other components of the ecosystem.

Figure 2.10 Constructivist principles of the learner, learning environments, and the role of others.



Learners As Figure 2.10 illustrates, the first three principles focus on the learning processes. These principles focus on how learners construct their own understandings.

Learners actively construct their own understandings of the world. The first and most central principle of constructivism is that learners are actively engaged in constructing their own understandings of the world (e.g., Piaget, 1970/1983; Wittrock, 1992). This understanding is based on their past experiences and knowledge. Their unique perceptions, therefore, influence how all students construct their own individualized ideas. It is important that teachers recognize and acknowledge these differences among students in their teaching. In recognition of student differences, most constructivists emphasize that teachers cannot transmit knowledge just by presenting it; they urge teachers to deemphasize methods of instruction such as lectures (e.g., Gonzales, 2004). Instead, constructivists believe that teachers should encourage students to construct knowledge by actively seeking it out, sifting through it, and reorganizing it rather than passively receiving new information.

Instead of revisiting Rachel and the single sentence she was learning, we are going to venture into her fourth-grade class where the teacher's is practicing constructivist instruction. To learn more about lobsters, Rachel's teacher encourages the class to find out as much as they can about coastal ecosystems. To do this, the class goes on a field trip to a beach so that the students can investigate lobsters' environment and resources. This allows Rachel and her classmates to processes and integrate many sources of information. After the field trip, the teacher suggests that Rachel and her classmates work in groups to develop presentations for class that will require her to integrate ideas based on what she has read, what she learned on her field trip, and what she has learned from pooling ideas with her classmates. This vast array of resources allows Rachel to develop a more complex understanding of coast ecosystems and of lobsters' environments.

Knowledge construction is driven forward by problems and challenges. Many constructivist learning environments are designed to encourage learning through different sorts of challenges (e.g., Taber, 2000). One kind of challenge is information that contradicts students' current conceptions (Chinn & Brewer, 1993). For instance, students trying to construct an understanding of how electrical circuits work will be impelled to change their ideas when they find that their predictions about how bright a light bulb in a circuit will be are mistaken. Students' stereotypes about an ethnic group can be challenged by participation in a discussion in which students of different ethnic groups share their experiences. Students' interpretation of a poem can be challenged by an alternative interpretation.

In all of these examples, challenges motivate students to construct new ideas. To encourage students to exchange and challenge ideas, constructivist teachers often place students in groups to investigate meaningful problems (Chin & Chia, 2004; T. Wood & Sellers, 1996). As students discuss their ideas and perspectives, they may encounter new ideas, and as a result, evaluate their own.

In addition, when solving problems, students identify **knowledge gaps** that they must address in order to reach a solution (Hmelo-Silver, 2004). Students identify knowledge gaps when they realize that they lack knowledge that they need to address a problem. Knowledge gaps present another kind of challenge—a challenge that arises when students realize that they need to build up their own knowledge base in order to solve the problem.

If Rachel's teacher asks students to tackle a complex problem such as why the lobster population in Chesapeake Bay is decreasing, it is likely that different students will have some different ideas. Rachel will construct new ideas about ecosystems as she finds that she should refine some of the ideas in light of her peers' ideas. Similarly, if the unit involves examining evidence related to the decline of populations in coastal ecosystems, this data may challenge Rachel's ideas about how humans can affect ecosystems.

*Students learn most when engaged in inquiry***.** Many constructivists emphasize **learning through inquiry** (Barton, McCully, & Marks, 2004; Hammer, 1997; L. M. Taylor, Casto, & Walls, 2004; Wu & Krajcik, 2006). With instructional methods that emphasize *inquiry*, students typically analyze and evaluate an array of information in order to reach decisions or conclusions; students typically gather or locate some of the information on their own. For instance, students in science class might engage in inquiry to find out why algae is growing in a pond on the school grounds. This might involve students' performing simple chemical tests of the water as well as looking for relevant research on the Internet or in the library. Likewise, history students might do an extensive internet search in order to find research that will help them prepare a presentation on how people lived during the Revolutionary War, or they might analyze original source data to determine the role of the U.S. in promoting the Panamanian Revolution that paved the way for the building of the Panama Canal (Britt & Aglinskas, 2002). During inquiry projects of this sort, students have the opportunity to construct rich knowledge bases relevant to the topics they are studying.

In contrast to the transmission model of learning, in which students learn by rote memory, students in constructivist learning environments are engaged in **higher-order thinking** processes, which are characterized by the quest for alternative explanations or solutions to problems. This type of learning involves deciding what information is needed, evaluating evidence, thinking critically, formulating arguments, integrating disparate ideas, and so on (Zohar, 2004). These processes are necessary in order to carry out inquiry and construct new knowledge.

Rachel's constructivist teacher believes that Rachel needs to be engaged in meaningful inquiry as she learners about lobsters and coastal ecosystems. If Rachel simply reads a textbook chapter on wetlands to acquire knowledge, she is unlikely to integrate other information or remember much of what she read if she is not applying this knowledge in some way. Conversely, she is more likely to understand and remember what she reads if she is trying to figure out the answer to a question that interests her, such as deciding whether she will advocate for or against a new local mall that critics say would cause damage to wetlands.

Learning Environments. According to the constructivist approach, the teacher's job is to design environments in which students can construct knowledge effectively. The principles of learning described above about how learners learn have clear implications for designing learning environments.

Learning environments should facilitate inquiry and the use of higher-order thinking processes. If students learn best via inquiry, learning environments should foster inquiry. Two implications are that (1) much of the curriculum should be organized around problems that afford inquiry and (2) students should have access to many sources of information that are needed to address the problems.

Constructivists design learning environments that are centered around problems that students attempt to solve. For instance, a constructivist teacher who teaches high school business classes would organize the curriculum not around a textbook but around realistic cases that pose business problems for students to solve (see DaCosta & Chinn, 2006). Students would be provided a broad array of resources to address this problem, including information on the Internet, information from newspapers, from business magazines, and so on. A middle school health teacher with a constructivist orientation might organize her course around health related problems such as how to reduce obesity in the U.S. or how to reduce tobacco, drug, and alcohol use among teens. Each problem becomes the center of a three- to five-week unit. Students would seek information from a variety of sources to try to develop the best way to solve the problem posed. They would learn to discriminate between more trustworthy and less trustworthy sources (Brem, Russell, & Weems, 2001). Constructivists hold that students learn by gathering and mastering whatever information is needed to solve these problems, rather than by studying ideas in thematically organized topics.

For students to gather the information needed to solve problems, teachers must create learning environments that provide many resources for students to use. In setting up a unit organized around why the lobster population in Chesapeake Bay is decreasing, Rachel's teacher could provide trade books, magazine articles, simple summaries of scientific research reports, access to internet resources, and equipment for a variety of hands-on investigations that students might decide to undertake. Setting up inquiry-oriented learning environments is very challenging, as it takes a great deal of thought and planning to gather age-appropriate resources, especially for students at younger ages.

Learning environments should center around learners' choices and learning goals. Most constructivists emphasize that learners should have a great deal of choice over what they are learning. Students are unlikely to be engaged in inquiry if they are not interested in the inquiry tasks. Choice enhances interest and learning, as we will explore further in Chapter 8 (Motivation and Core Beliefs) (Chin & Chia, 2006; Deci & Ryan, 1985; Rosebery, Warren, & Conant, 1992).

The most extreme constructivists would say that learners should always choose on their own what they want to learn (Neill, 1964). In this view, a teacher should never give students a topic to study. Students who choose to study ecosystems can do so; students who would rather study Asian history can do that. But because states have recently specified instructional goals that schools must meet, most teachers would not be able to give Rachel and her classmates the choice of whether to study ecosystems, because ecosystems are a required curriculum topic. Many constructivists would even agree that specifying instructional goals is useful (Appleton & Asoko, 1996). But even if teachers make some of the choices, they can still leave some other choices up to the students.

Even if Rachel's class is not given the choice of *whether* to study ecosystem, they can be given many other choices about what to study about ecosystems. For example, Rachel's teacher might allow students to select which of several ecosystems (coastal, forest, etc.) they want to learn about and have students who made the same choice work together. Students can decide what it is they want to learn about ecosystems. Rachel's group might decide that they want to focus on how different coastal animals such as lobsters adapt to their environmental niches. Another group might want to study how humans affect forest ecosystems.

Learners should engage in authentic, relevant tasks. Constructivists emphasize that learners should engage in activities that are as similar to real-world activities as possible. They believe that such preparation provides learners the experience they need to handle with real-world tasks (J. S. Brown et al., 1989). For example, if learners always engage in oversimplified mathematical tasks (such as two-sentence word problems in the back of the book), they will be unprepared for complex, real-life mathematical problems (such as completing taxes or projecting future profits for a multi-pronged business plan for a new product) (cf. Hickey, Moore, & Pellegrino, 2001; J. Taylor & Cox, 1997). Conversely, when they engage in authentic, real-world tasks, such as making recommendations about how to clean up a polluted river that they have actually studied, they will find science motivating and relevant (cf. Rivet & Krajcik, 2004).

While constructivists stress that students should engage in activities that are similar to real-world activities, in reality, it is usually necessary to simplify learning environments in some ways. Schools usually cannot recreate the full complexity of real life, and tasks that are too complex may overwhelm students (Windschitl, 2002). Yet, teachers who practice the constructivist approach find a balance by engaging students in tasks that are as authentic as possible and given them appropriate assistance so that they can carry out the tasks successfully.

Rachel's teacher can engage students in learning about ecosystems by engaging them in real research on school grounds. Students can investigate their local ecosystem with real scientific tools such as thermometers and light meters (cf. Roth & Bowen, 1993). Alternatively, students might investigate how to use ecosystem concepts to improve the ecosystem of a small wood and stream on the school grounds (Malhotra, 2006), or they could study the small-scale system of a tropical fish aquarium in the classroom (cf. Hmelo-Silver, 2004). Such activities are more likely to promote the complex reasoning skills needed for authentic research than simple lab experiments where students follow "recipes" for experiments (Chinn & Malhotra, 2001, 2002b).

Learning from Others Constructivists—and especially social constructivists—envision a different role for students and teachers than in the traditional transmission model of teachers lecturing to students. The role of teachers is to help students learn on their own and in groups rather than to be the main provider of information.

Students facilitate each others' learning. A core idea of social constructivism is that students learn a great deal from engaging in interactions with peers (A. S. Palincsar, 1998). Likewise, because humans are immersed in the practices of their cultures, students learn through interactions with other members of their culture as well as with members of other cultures (Rogoff & Angelillo, 2002). Social constructivists point to the importance of interactions both with those who are more experienced as well as one's peers. Those who are more experienced (parents, other adults, older students) can provide assistance based on their expertise. Peers can also challenge each others' ideas, which in turn, allows students to consider and create new ideas.

Rachel may profit from working with peers on a project in many different ways. One group member's enthusiasm for the crabs may engage her own interest in crabs. Different students learn about different ideas and share these ideas with each other. One classmate helps Rachel learn more about plant life in the ocean. Another helps Rachel learn about fishing. Rachel helps her classmates learn about sea birds, which she has become interested in. In this way, Rachel learns a great deal beyond what she can read about by herself. Rachel also learns from occasions when her classmates disagree with her. When Rachel states her position that there will always be lots of fish because fish lay lots of eggs, her classmate Saari argues, based on her research that most of the eggs get eaten by other animals. Rachel revises her own ideas in response to this challenge.

Teachers facilitators and orchestrate student learning. In the transmissionist model of learning, teachers are information providers. In constructivist environments, the teacher's primary role is that of a facilitator or an orchestrator (Windschitl, 2002). Teachers carefully plan activities that can drive students' thinking forward. They organize needed resources and help students learn to work effectively with these resources. They help students as needed, but they do not provide answers.

As Rachel's teacher works with Rachel's group, which is investigating population changes in Chesapeake Bay, much of her work consists of organizing a broad range of materials for students to use. She provides brief mini-lectures to help students with key points, but her input is usually in response to needs expressed by groups. When she works with groups, she may provide hints, but she does not tell the students how to think about the problem.

Problem 2.6 Evaluating Teaching: Using Constructivist Methods

Janice Craig is a fifth grade teacher. She is a self-proclaimed constructivist. Her principal even asks her to mentor other teachers on constructivist methods. Here is the beginning of one of her inquiry lessons in history.

Teacher	Today you are going to investigate how Lewis and Clark felt as they traveled through Montana. Look at the handout I gave you. Lena, could you read what it says for us?
Lena	Read the five diary entries you see below. Next to each one, write the main emotion that you think that the writer felt.
Teacher	Very good. Now, you can work in pairs on this. Read each one, and then write the *one* emotion that you think is most clearly indicated by the diary entry. That will tell you about the emotions that Lewis and Clark experienced during their travels. When you're finished, we'll see whether you got the right answers.

Would you evaluate this as a constructivist task? Why or why not?

Response: *Examination of diary entries is certainly something that constructivists teachers would do, but this task is not designed as a constructivist task. There is no problem that students are trying to solve. There is nothing authentic about this task. (Who in the real world ever writes down the main emotion experienced next to a diary entry?) The students have been given little choice in how to tackle the diary entries, and the teacher implies in her last line that there may be a right answer that students are supposed to arrive at. Constructivists would say that on anything as* *complex as judging emotions from diary entries, there should be ample room for some alternate interpretations. At the end of this chapters, there are other lessons that aim to be constructivist for you to evaluate.*

Applying Constructivist Theory to Teaching Vocabulary

Constructivists do not write much about vocabulary instruction because in general, directed vocabulary instruction is inconsistent with the seven principles laid out above. Studying vocabulary as a separate, isolated activity is not an authentic task. Architects, engineers, and doctors do not spend part of their working days studying lists of vocabulary words. All of them no doubt continue to learn words, but they do so in the context of other activities. For instance, doctors continue to learn new words as they read journal articles to keep up to date with the latest practices in their field, which they do to treat their patients more effectively.

Constructivists would quickly point out that people learn the vast majority of the words they know through incidental learning—learning by picking up the meaning from context. Given that this is the natural way that humans learn words, most constructivists would avoid directed vocabulary instruction and instead have students learn meanings of words by engaging in other, more authentic activities, just as professionals do in their work. For example, students learn vocabulary through engaging in authentic problems that require the use of new words.

CHAPTER 2 SUMMARY

INFORMATION PROCESSING THEORY

Information processing theory is a theory of human learning that postulates that information is moved to and from different memory stores.

The memory stores are the sensory register, short-term memory, and long-term memory

Information is stored in a long-term memory store, after which they can retrieve the information to solve problems, reason, or learn new information.

Some of the key processes that operate on this information are attention and classification, rehearsal, encoding, and retrieval.

Sensory Register

The sensory register is the first memory store of the information processing system.

The sensory register stores information very briefly. If the information does not quickly move on to short-term memory, then it will be completely lost from the system.

Working Memory, or Short-Term Memory

Working memory, also known as short-term memory is the memory store that holds information and processes that are currently active.

The size of working memory is extremely limited. It can only hold 7 ± 2 pieces of information.

Chunking is a method to place larger amounts of information into working memory. Another method is making processes automatic.

The three components of working memory are the phonological loop system, the visuo-spatial sketchpad, and the central executive.

Perception

Perception is a process that moves information from the sensory register to working memory.

Two subprocesses of perception are classification and attention.

Classification involves both bottom-up and top-down processing.

Attention is when you attend to information and focus your awareness on it. Recent evidence suggests that information that is not attended to does not enter working memory.

Rehearsal

Rehearsal is the process that keeps information cycling within working memory. For example, you say something over and over to yourself to keep it in short-term memory. If you stop rehearsing the information, it will drop out of short-term memory.

Long-term memory

Long-term memory is the memory store where information is stored for very long periods of time.

There are several different kinds of knowledge in long-term memory: declarative, procedural, metacognitive, and episodic.

One proposal for how long-term memory is stored is that it is organized in semantic networks of nodes and links between the nodes. Spreading activation can lead nodes to become activated.

Encoding

Information is moved from STM to LTM by encoding the information.

There are three groups of encoding strategies: selection, organization, and integration.

Encoding is most effective when it is active and meaningful. Students learn more when they actively carry out encoding themselves, instead of having a teacher do it for them.

Retrieval

After the information is encoded, it can be retrieved by moving information from LTM to working memory.

Retrieval framework can facilitate remembering, as do multiple retrieval paths.

Forgetting

People forget some of what they learn, and they tend to forget most rapidly soon after the learning period is over.

People also forget less than they often think they do.

Several factors mediate how slowly or rapidly forgetting proceeds: initial learning, occasional use of ideas, and spaced study.

There are two main theories of why forgetting occurs: the fading theory and the interference theory. There is evidence at least for the interference theory.

[TRY TO HAVE ONE BULLET PER B-HEAD.]

Constructivism

According to the theory of constructivism, people learn by actively building up ideas on their own

There are many different versions of constructivism. Constructivism can be divided into two broad camps (cognitive constructivism and social constructivism) based on how much they emphasize the role of social interaction in learning.

Eight principles of constructivist are related to the learner, to learning environments, and to the role of others.

Learners

The first three constructivist principles focus on the learning processes of learners.

Learners actively construct their own understandings of the world.

Knowledge construction is driven forward by problems and challenges.

Students learn most when engaged in inquiry.

Learning Environments

The job of the educator is to design environments in which students can construct knowledge effectively.

Learning environments should facilitate inquiry and the use of higher-order thinking processes.

Learning environments should center around learners' choices and learning goals.

Learners should engage in authentic, relevant tasks.

Learning from Others

Constructivists envision a different role for students and teachers than in traditional transmission model of teachers lecturing to students.

In constructivist models, students facilitate each others' learning, and teachers are facilitators and orchestrators, not information providers.

CHAPTER 6
Students' Prior Conceptions and How They Affect Learning

Chapter Outline

Reflecting on Students' Thinking
How Do Prior Conceptions Affect Learning?
Consistent Prior Conceptions
- Schemas
- How consistent schemas affect learning
- Consistent prior conceptions without schemas
- Implications for instruction

Alternative Conceptions
- How alternative conceptions emerge
- Are learners' alternative conceptions coherent?
- The importance of understanding students' alternative conceptions
- Alternative conceptions can interfere with both understanding and belief
- Implications for instruction

Novice Conceptions
- Few concepts that are poorly interconnected
- Organization by surface similarity
- Implications for instruction

Conceptual Resources
- Knowledge of relevant evidence
- Conceptions from previously learned topics
- Conceptions derived from previous experiences
- Conceptions about analogical situations
- Implications for instruction

Conceptions about Learning and about Knowledge
- Conceptions about learning
- Conceptions about knowledge
- Implications for instruction

Finding Out About Students' Prior Conceptions
Extensions
- Development
- Cultural and linguistic diversity
- Students with learning disabilities

Summary
Application Problems

Applied goals

Explain how students' ideas differ from ideas that are the goal of instruction.

Explain why students may have difficulty remembering and understanding new ideas, and why they may not believe what they are learning.

Analyze students' talk and work to work out what students' prior conceptions.

Predict how students' prior conceptions will affect learning.

Develop basic forms of instruction that foster the use of consistent conceptions, address alternative conceptions, encourage more expert conceptions, and build on conceptual resources.

Reflecting on Students' Thinking

Lilly Drake is a third grade teacher in Atlanta, Georgia. She has recently learned in a graduate course that young children frequently have ideas about the world that are very different from the ideas of adults and scientists. For example, she found out that some young children think that when they eat food, the food quickly disperses throughout their body rather than entering any kind of digestive system (Carvalho, Silva, Lima, Coquet, & Clément, 2004). On the subject of earth science, she learned that some students think that the earth is flat rather than round << Brewer, in press >>.

These ideas were all quite new to Lilly, and they led her to wonder about her own students. She had recently completed a two-week lesson on the solar system. The students had learned about all of the planets and how they revolve around the sun. Surely it wasn't possible that her students would still think that the earth was flat, was it?

To find out, she decided to interview several of her students using the same interview questions that she had read about in a study (Vosniadou & Brewer, 1992). She started by interviewing one of her students, Daryl, who stayed late after school one day. Here is the interview:

Lilly: Daryl, tell me what you think about the shape of the earth. What is the earth's shape?

Daryl: It's all round.

Lilly: OK, and if you want to look to see the earth, which way do you look?

Daryl: Up.

Lilly: Up? OK. Would you draw a picture of what the earth looks like? Here's some paper.

Daryl: [Draws part of the picture shown in Figure 6.1a]

Lilly: Now show me where the moon and stars are, and where the sky is.

Daryl: [Draws the moon, stars, and sky in Figure 6.1a]

Lilly: And finally, draw where the people are.

Figure 6.1a. Daryl's first drawing.

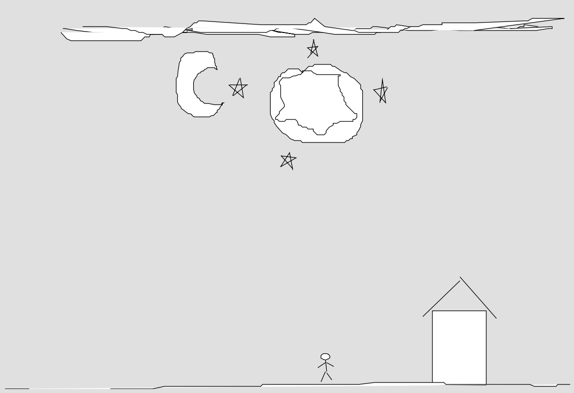
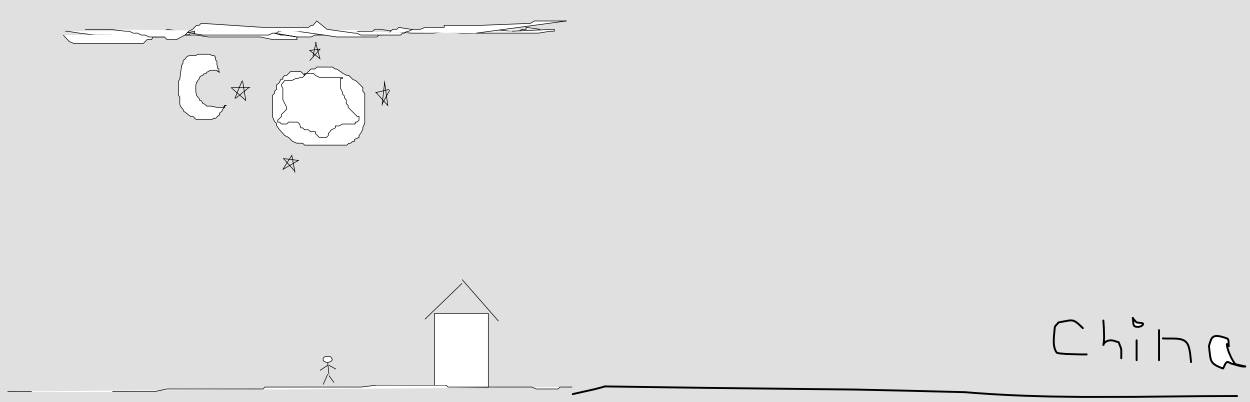


Figure 6.1b. Daryl's second drawing.



Lilly: Here is a picture of a house. This house is on the earth, isn't it?
Daryl: No, it's on the ground.
Lilly: Why is the earth in this picture flat, but you drew it round at the top of the picture?
Daryl: Because this one [points at the flat picture] is the ground.
Lilly: Why does it look flat?
Daryl: Because we're on the ground.
Lilly: If you walked and walked for many days in a straight line, where would you end up?
Daryl: I think you'd come to the edge.
Lilly: So there is an edge to the earth?
Daryl: No. The earth doesn't have an edge.
Lilly: OK…. Hmmm. Well, can you fall off the edge?
Daryl: Of this? [He points to the straight line at the bottom of the picture.] Yeah.
Lilly: Now I want you to show me where Atlanta is.
Daryl: [points next to the house.]
Lilly: Now show me where China is.
Daryl: [Draws the line under the house farther out and points to the end of the line. See Figure 6.1b.]
Lilly: Now tell me what is down here below the earth.
Daryl: The sky and the sun or moon. And the ground.

Think carefully about Lilly's interview with Daryl, and answer these questions:

1. Does Daryl have a consistent or coherent idea about the earth's shape, or is he just confused? Present evidence for your answer.
2. If he does have a consistent or coherent idea about the earth's shape, what is that idea, and what is your evidence for your conclusion?

Drawn from Vosniadou & Brewer (1992).

The Reflection above is about a topic that is central to good teaching. Students have ideas about the world (in this case, about the earth's shape) which are often very different from the ideas that teachers are hoping that their students will learn. This chapter is about these conceptions and how they affect learning. As we will see as we examine students' ideas about the earth's shape later in the chapter, Daryl's ideas arise because the new ideas he is learning (e.g., the earth is round) are incompatible with some of this prior conceptions (e.g., the earth we walk around on looks flat). So he develops new ideas that are very different from what the teacher intended to teach him.

We have previously discussed the transmission theory of learning that underlies much school instruction (Biesta & Miedema, 2002; Rogoff, Paradise, Arauz, Correa-Chávez, & Angelillo, 2003; Zuljan, 2007). Teachers who hold the transmission view believe that students' minds are like empty vessels and that their job is to pour knowledge into these vessels. In other words, if teachers explain ideas well and if students simply pay attention, then students will learn what the teacher taught them. However, we now know that this view is completely and utterly wrong. Students interpret what teachers (and textbooks and peers) say using their prior conceptions. Prior conceptions shape what students learn—sometimes in ways that facilitate learning, and sometimes in ways that impede learning. Teachers need to take these prior conceptions into account when they design learning environments.

Let's begin by defining *prior conceptions*. **Prior conceptions** are the ideas that students have about a topic to be learned before they begin learning it. For example, students' prior conceptions related to a lesson on the history of music are their ideas about what music is and what forms of music have existed in the past. Students' prior conceptions about a unit on Martin Luther King include their ideas about African-American history, civil rights, and U.S. political history. Students' prior conceptions about algebra include their ideas about what a variable is and their ideas about how to solve equations.

HOW DO PRIOR CONCEPTIONS AFFECT LEARNING?

How do prior conceptions influence learning? Prior conceptions vary according to how consistent or inconsistent they are with the **target** conceptions**—**the ideas that teachers are aiming to teach. Sometimes prior conceptions are highly consistent with the target conceptions; in these cases, learning is usually facilitated. On other occasions, prior conceptions are inconsistent with target conceptions; in other words, the prior conceptions are contradictory or incompatible in some way with the target conceptions. In these cases, learning is often impeded. Thus, the key to understanding how prior conceptions influence learning is to understand the different ways in which prior conceptions can be consistent or inconsistent with the target conceptions.

In this chapter, we will focus on five types of prior conceptions that influence learning in different ways because they are similar or dissimilar to target conceptions. These five forms of prior conceptions and their effects on learning are summarized in Table 6.1, which serves as a summary of the central ideas in this chapter. The five types of prior conceptions are *consistent conceptions, alternative conceptions, novice conceptions, conceptual resources, and core conceptions about learning and knowledge.*

Table 6.1:
Five types of prior conceptions

Type of prior conception	Definition	How this type of prior conception affects learning
Consistent conceptions	Conceptions that are compatible with new ideas	Usually facilitate learning
Alternative conceptions	Conceptions that are inconsistent or incompatible with new ideas	Usually impede learning
Novice conceptions	Conceptions that are typical of students who are just learning	Tend to impede learning
Conceptual resources	Conceptions that teachers can build on to help students learn difficult new ideas	Facilitate learning
Core conceptions about knowledge and learning	Basic conceptions about what knowledge is and about how people learn	Depending on the specific conception, can facilitate or impede learning

To provide an initial overview of the five types of knowledge summarized in Table 6.1, let's consider a classroom example. A teacher—Jeanine—is beginning a unit on the living things, kingdoms, and the taxonomy of the plant and animal kingdoms. This is a topic that may appear in middle school, in elementary school, or in both; Jeanine is a seventh-grade teacher. She knows that each of the five types of conceptions will be held by at least some students in her classes, and she knows that she will need to design instruction that will take these various kinds of conceptions into account.

The first kind of conception is consistent conceptions. Jeanine knows that some of her students have read many books about animals and therefore already have many conceptions, most of which are accurate, about the animal kingdom. These students' prior conceptions are highly **consistent** with what they are learning. These students will find it easy to learn additional information that fits well with what they have already learned. Their prior conceptions will give them a solid framework to understand and remember the new information.

Second, Jeanine knows that some of her students have conceptions that are inconsistent or incompatible with what they are learning. These are called **alternative conceptions** because they are the students' own ideas about the world, different from the ideas they are learning. They are the student's own alternative perspective on the world. For example, some of Jeanine's students have the alternative conception that fire is alive because fire seems to meet all of the defining characteristics of living things (it moves, it uses energy, it seems to reproduce, and so on). This is of course inconsistent with the adult and scientific view that denies that fire is alive. When these students are learning about living things, some of them persist in believing that fire is alive, even if Jeanine tells them that it is not alive. In addition, their idea that fire is alive may interfere with efforts to learn other ideas about reproduction or growth. When Jeanine teaches students about living things, she must devise ways of teaching that will address this alternative conception, because she does not want students to leave the unit still thinking that fire is alive.

Third, many of Jeanine's students also have conceptions that are typical of **novices**—that is, students who have immature ideas that are very different from expert ideas. One hallmark of novice conceptions is that they are organized by how things look on the surface—that is, how they look on the outside, not the inside. Thus, students think that octopuses and starfish must be closely related because they look similar on the outside; they both have lots of legs. Because Jeanine knows that many of her students will focus on such surface similarities, she must help students to think more in terms of internal characteristics, such as the fact that octopuses have brains and a central cavity for internal organs, whereas starfish do not. Novices need to be directed to think about these internal, less obvious characteristics.

The fourth type of prior conception consists of conceptual resources. **Conceptual resources** are student ideas that teachers can build on to help them understand new ideas that are different from their current ideas. Although students might hold alternative conceptions or novice conceptions that can interfere with learning, they might also have ideas that can be used as the foundation to help them understand difficult new ideas that they are learning. For example, even though many of Jeanine's students have the novice's tendency to focus on surface similarity when they classify animals, there are certain contexts in which they know that internal characteristics are more important for classification than surface characteristics. Jeanine knows from past experience that her students think that worms and snakes are very different, even though they are superficially similar. By asking students *why* they are very different, despite their surface similarity, she helps them understand that many of the critical defining characteristics are internal characteristics that they cannot see—backbones, the structure of the brain and organs, the circulatory system, and so on. Snakes share more of these characteristics with reptiles than with worms, even though snakes lack legs, and reptiles have them. Then Jeanine can help students see that the same ideas apply to other animals that look similar on the surface. They are closely related only if they also share internal characteristics. Students' prior ideas about snakes and worms are a conceptual resource that Jeanine builds on to help them understand the basic principles of classification.

The fifth type of prior conceptions consists of core conceptions about knowledge and about how people learn. Core conceptions about knowledge includes ideas such as “the knowledge I am learning is very simple,” and core conceptions about learning include ideas such as “I learn best when I repeat ideas to myself over and over.” Jeanine knows that her students’ core conceptions about knowledge and about learning can either facilitate or impede their learning, depending on what those ideas are. For example, Jeanine knows that those students who think that they learn best by repeating ideas to themselves over and over will have more trouble learning, because simply repeating ideas over and over (“octopuses are in the mollusk phylum; octopuses are in the mollusk phylum, octopuses are in the mollusk phylum”) is a poor learning strategy. In contrast, those students who think that they learn best by elaborating ideas (“octopuses are in the mollusk phylum, which is surprising, since they don’t have shells, but they have a lot of internal characteristics in common with those animals, even though they look different”) will be more successful, because by elaborating, they will gain a deeper understanding of the ideas they are learning.

CONSISTENT PRIOR CONCEPTIONS

When students have prior conceptions that are consistent with what they are learning, they learn more than when they do not have or do not use such conceptions. In other words, for students’ consistent prior conceptions to help them, they must not only have the consistent conceptions, but they must also utilize them (R. C. Anderson, Hiebert, Scott, & Wilkinson, 1985; R. C. Anderson & Pearson, 1984). Following up on the example from Jeanine’s classes on animal taxonomy, if students have a great deal of accurate knowledge about many kinds of animals—from mammals to mollusks--they will learn a great deal from reading a textbook chapter on animal taxonomy. If they do not, or if they only know about mammals but not other kinds of animals, they will learn less. Students will also learn less if they have consistent knowledge but do not bring it to mind when reading this chapter.

Schemas

Much of the research on the effects of prior conceptions on learning has employed the idea of *schemas* (Bartlett, 1932; Rumelhart, 1980)**.** Schemas are an important type of consistent knowledge. Students learn more if they have and use schemas that are consistent with what they are learning.

A **schema** is an organized knowledge structure stored in long-term memory (Rumelhart, 1980). Schemas summarize what we know about the world. Schemas typically capture what is common to many examples of a thing or a process. For example, most people have schemas that tell them in general what dogs are—what is true of most or all dogs that they have seen. Similarly, people have schemas that tell them in general what birds are, how food gets to the market, what governments are, and what usually happens when they go to the doctor.

Let’s look in more detail at what schemas are and how schemas affect learning. Consider people’s schema for *birds*. Most people have a great deal of organized information about birds. They know that birds have *two legs*, *beaks*, and *feathers*. Feathers enable adults of most species of birds to *fly* from one place to another. Birds are *warm blooded*. They *lay eggs*, and they typically build nests for these eggs. Different *beaks* are *adapted* for eating different kinds of food. Different kinds of *feet* are adapted for different settings (e.g., webbed feet for aquatic birds, feet adapted for perching, and so on).

The example of bird illustrates several important properties of schemas:

- Schemas specify *common features or elements*. The bird schema specifies what is common to most or all birds (two legs, a beak, feathers).
- Schemas indicate what is *typical*. For many people, robins are very typical birds, where as eagles are less typical, and penguins are seen as atypical. Knowing what is typically and atypically helps people make predictions about what most birds will be like.

- The schemas also indicate where there is a *range of different possibilities*. The bird schema indicates that birds have a range of different kinds of beaks and a range of different kinds of feet. It also indicates that birds make sounds ranging from raucous caws to lovely songs.
- The schemas typically identify some *causal relations*. Birds' feathers are causally relevant to their ability to fly. Webbed feet enable birds to thrive in water.
- They typically include some *imagery* (McVee, Dunsmore, & Gavelek, 2005). Although bird schemas express what is generally true of most or all birds, they are not purely abstract. Features such as beaks, wings, and feet can give rise to specific imagery such as what a prototypical beak looks like or what common bird songs and calls sound like.

Table 6.2 presents three other examples of schemas.

Table 6.2:
Examples of schemas that an American student might have

Component of schema	Examples of schemas		
	Democracy	Going to recess	A novel
Important features	All democracies have some kind of free elections.	We usually go get our coats, get balls and other equipment, go outside, and play for a short period of time.	*Novels* have a *plot* with c*haracters.* In the plot, the characters usually face some problem that they must solve. There is also a *setting*.
Typical examples	The U.S. is a prototypical democracy.	Going outside on the playground to play is prototypical.	A typical example is *To Kill a Mockingbird*.
Range of possibilities	Democracies may range from complete participation to representative democracy.	The location can vary between going outside and going to the gym. Most but not all students play games with balls.	The novel may range from around 100 pages to well over 1000 pages.
Causal relations	Free elections are needed to ensure that politicians listen to the will of the people.	Recess is not done in the classroom because it's too hard to play athletic games in a cramped space.	Features such as character development and a problem to solve are what make a novel interesting.
Imagery	Imagery may include politicians speaking and going to the polls.	Images of playing games such as kickball and dodge ball.	The actions of characters can be vividly imagined.

Different people have different schemas for the same concept. An ornithologist's schema for *bird* will be much more complex and elaborate than a second grader's *bird* schema. A child living in Minnesota may think of a sparrow as a very prototypical bird whereas a child living in the Brazilian rainforest may instead view a parrot as a very prototypical bird.

People's schemas can also be incorrect. A young child may think that penguins are not birds because they do not fly. A middle school student may have a schema for matter that does not include molecules. A teacher may have a schema for teaching that says that students are empty vessels into which they should pour knowledge. When schemas are incorrect, we say that students have alternative conceptions. We will discuss alternative conceptions in the next section.

How Consistent Schemas Affect Learning

Consistent schemas facilitate learning. People learn more when they have consistent schemas stored in long-term memory than when they do not (P. T. Wilson & Anderson, 1986). People also learn more when they **activate** those schemas by retrieving consistent schemas into short-term memory than when they fail to activate those schemas.

Table 6.3:
Two passages on which most Americans lack relevant schemas

Passage A	Passage B
Logistic regression applies maximum likelihood estimation after transforming the dependent variable into a logit variable (the natural log of the odds of the dependent occurring or not). In this way, logistic regression estimates the probability of a certain event occurring. Note that logistic regression calculates changes in the log odds of the dependent, not changes in the dependent itself as OLS regression does. Logistic regression can be used to predict a dependent variable on the basis of continuous and/or categorical independents and to determine the percent of variance in the dependent variable explained by the independents, to rank the relative importance of independents, to assess interaction effects and to understand the impact of covariate control variables. (Garson, 2008)	A dogged 82 on a green pitch by Mark Taylor, the opening batsman, put Australia on top at the end of the first day of the first Test match against New Zealand here yesterday. Taylor received solid support from Justin Langer, who was 63 not out, and finished the day in partnership with Steve Waugh, who was on 33. Taylor had not passed 50 in a Test since he scored a century against India in January 1992. Martin Crowe, the New Zealand captain, quickly found that his four-man fast attack bowled a poor line. Boon was out for 15, flashing at a wide ball in Michael Owens' first over to give the wicketkeeper a diving catch. Taylor began scratchily, and it was a surprise when he miscued a pull off Danny Morrison to give a catch to Martin Crowe. In nearly five hours at the crease he hit six fours. When Mark Waugh was caught behind from the off spinner, Dipak Patel, for 13, New Zealand had a glimmer of hope at 170 for three, but Steve Waugh joined the solid left-hander, Langer, and unleashed some fierce drives as he overcame a shaky start. Ref xx.

Lacking consistent schemas. When people lack relevant schemas to help them understand new information, they have difficulty understanding or recalling new material. Read the two examples in Table 6.3. Imagine how much you would recall if you were asked to write down everything you could remember from a single reading in two hours. Unless you have at some time in your life learned schemas for advanced statistics (for Passage A) or cricket (for Passage B), you would probably recall little of either passage. Without such schemas, it is very difficult to make sense of the new information.

In one famous study, cognitive psychologists asked undergraduates with high baseball knowledge and undergraduates with low baseball knowledge to read reports of what had happened in a baseball game. High-knowledge students recalled much more than low-knowledge students did (Chiesi, Spilich, & Voss, 1979).

It is important for teachers to realize that their students often lack relevant schemas, even when teachers think that the students should in fact have relevant schemas. For instance, in one study, sixth graders who were reading a history text about the American Revolution had great difficulty understanding this text, partly because of references to the French and Indian War. They lacked a schema for understanding what had happened in the French and Indian War, even though they previously studied this war (Beck, McKeown, Sinatra, & Loxterman, 1991). Although the teacher had assumed they the students had built up relevant schemas to understand the references to the French and Indian War, the students had not in fact done so. When teachers realize that students lack needed schemas, they can help them build the needed schemas in order to better comprehend new information. When teachers assume incorrectly that their students already have the needed schemas, the consequence is that their students do not learn as much.

Failing to activate consistent schemas. Learning is also impeded when students have consistent schemas but do not activate them. To see what it is like to read a passage for which you have a relevant schema but do not activate it, read the following passage:

> The procedure is actually quite simple. First, you arrange items into different groups. Of course one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities, that is the next step; otherwise you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run, this may not seem important but complications can easily arise. A mistake can be expensive as well. At first, the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then, one never can tell. After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated. However, that is part of life. (John D. Bransford & Johnson, 1972, p. 722)

Did you have trouble understanding this passage? Most students report having difficulty understanding it, and they also recall little of it when they are asked to write down what was said. Now read the passage again, but this time, before you read it, activate your *doing laundry* schema. Once you have activated your *doing laundry* schema, you will probably find the passage much more understandable.

Learning scientists John Bransford and Marcia Johnson (1972) used this passage to investigate the effects of having students activate schemas before reading passages. Some students read the passage without any cues to activate a schema. These students typically failed to activate a relevant schema, and they could recall little that they had read. Other students were told that the passage was about doing laundry. These students activated their schema for doing laundry, and they recalled much more of what they had read.

The laundry paragraph was specially designed to be difficult to understand if readers do not activate the relevant laundry schema. But students also have difficulty learning from ordinary passages if they do activate their prior schemas. Consider students who are reading a textbook chapter about ordinary life in the American West. Many students will learn more from reading such passages if teachers take time to help students recall what they already know about life in the American West before they read the passage. If the teacher finds that the students know little about this topic, she can take additional time to teach them some additional information that will be useful to understand the passage (Dole, Valencia, Greer, & Wardrop, 1991).

Activating inappropriate schemas. Sometimes learners run into trouble because they activate the *wrong* schema. Here is an example from a sixth-grade girl (Colleen) reading a piece of literature (Norris & Phillips, 1987). As you read the transcript, you will see that Colleen has activated the wrong schema for understanding this passage.

	Commentary:
<u>TEXT 1.</u> The stillness of the morning air was broken. Then men headed down the bay. Colleen: The men are going shopping. They're going to buy clothes at The Bay. That's a shopping center . . . They're going shopping because it seems like they broke something.	Colleen has interpreted "the bay" to mean a shopping center she is familiar with, which was named *The Bay*.
<u>TEXT 2.</u> The net was hard to pull. The heavy sea and strong tide made it even more difficult for the girdie. The meshed catch encouraged us to try harder. Colleen: I guess The Bay must have a big water fountain. Interviewer: Why was the net hard to pull? Colleen: There was a lot of force on the water	Colleen has activated a schema for *The Bay*, and she continues to apply this schema. She ignore information that does not fit this schema, and she distorts other information (treating the "sea" as a water fountain) to make it fit the schema for *The Bay*.
<u>TEXT 3.</u> With four quintels aboard, we were now ready to leave. The skipper saw mares' tails in the north. Colleen: They were finished their shopping and were ready to go home . . . . Interviewer: Why were they worried about the mares' tails? Colleen: There were a group of horses on the street, and they wouldn't move and the men were afraid they would attack the car	In reading Text 3, she again ignores material that did not fit her mall schema. When pressed by the interviewer, she interpreted some words she didn't know into something that would at least make some sense in a mall setting.
<u>TEXT 4.</u> We tied up to the wharf. We hastily grabbed our prongs and set to work. The catch was left in the stage while we had breakfast. Colleen: They are on a wharf and are going for breakfast . . . . Interviewer: So first the men went to The Bay to go shopping and then what happened? Colleen: They went shopping and saw a waterfall with fish. They were catching some fish with little nets like in the stores to bring home and when they were finished they met some horses on the street . . . . I think that they are now going to a play or some show because it says about a stage.	Colleen continues to take the text and try to make what she is reading fit into her shopping mall schema. However, she is having a harder time making things fit, so she is adding new elements that are less mall-like: a waterfall with fish and a play on a stage.

It is possible that Colleen did not have a schema for understanding fishing on the open sea. Instead of trying to puzzle through and trying to understand a difficult text, she instead rashly activated a shopping mall schema, and then she attempted to construe the text as talking about a shopping trip. She simply ignored those parts that she could not fit in to the shopping mall schema.

Schemas and memory. Now we are ready to summarize four important ways in which schemas influence memory (Brewer & Nakamura, 1984):

- When people activate a schema, they often *interpret information in a way that fits the schema*. Colleen interprets "headed down the bay" to mean that they went to the mall.
- People may *ignore information that does not fit their schema*. Colleen ignores many words and statements referring to ships and water. However, sometimes information that does not fit a schema is remembered well because it is so very surprising. If Colleen's teacher usually wore ordinary clothes to class but one day came to class wearing a ship captain's outfit, that class would likely stand out in Colleen's mind, precisely because it was out of the ordinary.
- When people activate a schema, they may even *distort information to fit the schema*. The phrase "the heavy sea and strong tide" does *not* readily fit with a shopping mall schema, but Colleen managed to distort this information to fit her schema.

- When people activate a schema, they may use that schema to *mistakenly recall information that was not ever present*. Colleen may recall that the text said that the men walked into the mall, even though the text never said this.

Although schemas can lead to memory errors, they also help students learn more effectively when the students activate appropriate schemas. When reading a passage about the American West, a student who activates an appropriate “American West” schema will remember more events relevant to the schema, and he can use the schema to draw sound inferences. For instance, when reading that “the family headed home with their winter’s supplies,” a student who activates an appropriate schema about life in the Old West will correctly infer that the family were likely on a horse-drawn wagon,” even though the text did not say so explicitly.

Figure 6.2 shows a second grader’s drawing that illustrates the effects of schemas on memory. The child, Evan, has gone with his class on a field trip to a farm. Evan already had a strong farm schema from books he had read with his parents and from a toy farm set that he likes to play with. His schema has helped him recall every single animal seen on the farm. But his schema also led to two errors. There were ducks on the farm that the class saw, but Evan distorted what he saw, drawing chickens instead of ducks because he strongly expected to see chickens rather than ducks. He also drew horses in his picture, even though there were no horses on the farm, thus recalling information that was not present. Thus, schemas facilitate memory, but they also can cause distortions in memory (Brewer & Nakamura, 1984).

Figure 6.1:
Evan’s drawing of what he saw at the farm

The left panel shows a photograph of a farm.
The caption says: This is the farm that Evan’s class visited. The animals seen by the children were: ducks, goats, hogs, cows, cats, and a dog.

The right panel shows a child’s drawing of a farm house, a tree, and the following animals: chickens, goats, pigs, cows, and a cat.

Problem 6.1: Understanding Students' Thinking
Effects of Schemas on Memory

In each of these scenarios, explain the source of the students' errors. Think about the schemas that students are activating and how they are using these schemas.

A. A high school teacher explains Marxist economic theory to his class. On a quick formative posttest at the end of the class, the teacher finds that the students' level of understanding of four key questions is about 35%. Why did they do so poorly?

B. A mother asks her 5-year old daughter what she did in kindergarten that day. The child talks about painting, going outside to the playground, story time, snack time, and taking a nap. In fact, she did all of these things except painting that day. Why did she make this memory error?

C. A third grader watches a video about China and its people. Included in the video is a three-minute excerpt showing a Chinese wedding ceremony that is very different in format from the traditional Western wedding ceremonies with which the children are familiar. Later that night, the boy tries to tell his father what he had seen, but he discovers he remembers very little of it. He can only say: "They had a long ceremony, and they got married." Why does he remember so little?

D. A fifth grader learning about Columbus and other early explorers has read this statement in a trade book: "Millions of Native Americans died from smallpox and other diseases brought by early explorers and settlers." Later, the student writes on an essay question on an exam, "Some Native Americans got sick from diseases that the early explorers brought." Why has the child made this memory error?

Responses: A. There are at least two possibilities here. One is that students simply lack any prior schemas which they could use to try to understand this new information. Another is that their prior schemas conflict with Marxist ideas. Either situation could yield very poor performance on a posttest.

B. The girl has recalled something that is part of her going-to-school schema that did not actually occur that day. Because painting regularly occurs when she is at school, painting has become part of the girl's schema for the day's events. As a result, she mistakenly inserts this event into her recall of what happened that day.

C. Because the wedding ceremony is very dissimilar to what the student is used to, he probably lacks any relevant schemas to connect to the unfamiliar events in a Chinese wedding. In addition, there may be interference from his schemas for American weddings; this may also make it difficult to recall the new ideas.

D. Because early instruction on Columbus and other earlier explorers is so positive, this student may have developed schemas that depict Columbus and other explorers as heroes. Causing such widespread death is inconsistent with the "hero" schema, so the student distorts what was read to fit the hero schema.

Consistent Prior Conceptions without Schemas

Students can have consistent prior conceptions that facilitate learning, even if they do not have ready-made schemas. For example, consider a fourth grader who is watching a video in social studies class about the ancient Sumerian civilization. The student has no prior schemas for ancient Sumer or for ancient civilizations. However, the student does have many relevant conceptions for understanding ancient Sumer—conceptions about cities and rural areas, trade and money, kings and wars, religions with many gods (such as Rome and Greece), and buildings and technology. *If* the student activates some or all of these prior conceptions, she can use these conceptions to help her understand what she is learning in the video (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987).

The important lesson is that people can use consistent prior conceptions to understand a novel situation, even though they lack a schema that already fits that novel situation. This will be true for many novel topics that you are teaching in the future. Even if your students lack ready-made schemas, they may have a variety of different consistent conceptions that they can bring together to help them understand a novel topic.

Implications for Instruction

Research on consistent conceptions has yielded four very useful teaching techniques for helping students make effective use of consistent prior conceptions when they are learning new material. Teachers who regularly employ the following techniques will help their students learn more effectively.

Help students activate prior conceptions. Because students do not automatically activate prior conceptions even when they have them, teachers can help students learn more by prompting them to activate those conceptions before they begin learning new material. One way to do this is through the technique of **K-W-L** (Jonson, 2005; Ogle, 1986). Teachers using K-W-L ask students to tell or write down what they Know, what they Want to know, and what they have Learned after they have studied the new material. Figure 6.3 presents an example of an eighth grader who has filled out a K-W-L sheet before and after a weeklong unit on poetry.

Another straightforward way to activate prior conceptions is to hold a discussion about an upcoming topic. For instance, before beginning a unit on the desert, a third-grade teacher could lead a discussion about what students know about the desert. The teacher could highlight students' prior conceptions by writing them on the chalkboard or by creating a concept map that shows interlinked concepts such as climate (dry and often hot), animal life (with different species listed), and plant life (with cactus and other species listed).

Figure 6.3:
A K-W-L sheet completed by a student

Topic: Mountain States		
K What I KNOW	W What I WANT to Know	L What I LEARNED
Mountain states: Colorado, Washington, Wyoming Lots of mountains in the states. Skiing and tourism is important. Famous places: Yellowstone.	What are nice places to visit in the Mountain States? What are the main industries in the mountain states? How many people are there? Do people do lots of skiing there?	The Mountain States are Montana, Idaho, Wyoming, Colorado, Utah, and Nevada. Washington has mountains but is a Pacific Coast state. Although all of these states have lots of mountains, most of them also have parts that are plains. Tourism is an important industry, but so are mining and agriculture. Agriculture is especially on the broad plains. Ranching, too, because much of the area is dry. Denver is a financial and high technology center. So is Salt Lake City. Las Vegas is a famous city for gambling and casinos. There are many National Parks and many other places to visit: Yellowstone, Grand Tetons, Glacier, Rocky Mountain, and many beautiful desert places in Utah. Except for Salt Lake City and Denver, and Las Vegas, the cities are not big, and there are lots of rural areas. I didn’t find out if people there go skiing a lot. I suppose that some must.

Teach students to activate prior conceptions on their own. If a teacher begins every lesson with discussion questions to activate students' prior conceptions, her students will likely learn more from her lessons. But what will happen when the students are studying something on their own, when the teacher is not present? Without the teacher there to ask those questions, the students may fail to activate their prior conceptions. Therefore, teachers should teach students to take control of their own learning by teaching them to activate their prior conceptions on their own. For example, teachers can encourage students to spend a few minutes asking themselves questions such as these: What do I know about this topic? What did we learn earlier in the year that is relevant to this topic? What do the pictures in the book tell me about this topic?

3. Provide relevant instruction when student lack sufficient prior conceptions. As we have seen, students often lack sufficient relevant prior conceptions, which makes it difficult for them to learn new material. When students' prior conceptions are too scanty, teachers should help them build up their conceptual base before starting in on new material. For instance, consider a middle-school teacher teaching a unit on food webs. Her plan is to have students engage in inquiry by working out a food web for a small woodland on the school grounds. Unfortunately, she fails to anticipate that many of her students are not familiar with some of the key kinds of plants and animals (such as fungi, arthropods, and protists) that they will need to incorporate into their food web. As a result, the students struggle with their task because they lack the needed prior conceptions. The teacher should have taken time to help students relearn key ideas that they had forgotten.

4. Teach retrieval frames. Teachers can also help students learn new material by teaching them retrieval frames, or schemas that are generally useful across many different specific learning topics. For example, suppose a class is studying a sixth-grade social studies text in which each chapter describes a different nation. The teacher could help students remember the information in each chapter better by teaching them this set of categories:

NATIONS:	
people	______________
language	______________
geography	______________
government	______________
religion	______________
customs	______________
economy	______________

Students can use this schema whenever they study a new nation to help them remember the important information about that nation.

Why do schemas such as these help students learn more? One reason is that the schema helps students select which information to encode into long-term memory as they are learning. A student using the nation schema will know that it is important to remember that Morocco's official language is Arabic and that the government is a constitutional monarchy with a powerful king and a parliament. Second, the schemas aid retrieval from LTM. Students can use schemas to make sure they do not leave out important categories of information (customs, economy, and so on) as they are recalling what they know about Morocco.

Table 6.4
Examples of generally useful schemas

Age Level	Description	Example of Schema
Elementary	A **story grammar** is a schema that tells the parts of a story. A story grammar helps students write stories as well as understand and remember stories by specifying the parts of the story.	Characters: ______________ Place: ______________ Time: ______________ Problem: ______________ Solution: ______________
Middle school	Students learning social studies benefit from learning a schema to organize their understanding of historical events.	People have a goal: ______________ People formulate a plan: ______________ People take action: ______________ People achieve goal: ______________ (If people don't achieve goal, go back to formulate a new plan)
High school and older	Students understand and remember research reports better when they learn a general schema telling the parts of a research article.	Purpose of study: ______________ Hypothesis: ______________ Method: ______________ Results: ______________ Interpretation: ______________

Students using schemas such as the nation schema can write the information onto a chart as they are studying, or they can simply use the schema to help them organize their thoughts without actually writing anything down. Studies with sixth-graders (Ohlhausen & Roller, 1987) have shown that students who use this type of schema when they study learn more than students who do not. Table 6.4 presents examples of other generally useful schemas that have been used effectively to help students learn (Armbruster et al., 1991; Boulineau, Fore, Hagan-Burke, & Burke, 2004; Dansereau, 1985; Santangelo, Harris, & Graham, 2008).

Problem 6.2: Evaluating teaching
A generally useful schema

A fourth-grade teacher is beginning a section of social studies in which the students will study regions of the country. She wants to help them encode and retrieve what they are learning by developing a generally useful schema that students can use across these topics. The first region covered is New England, and the second is the Mid-Atlantic states. Intending to create a generally useful schema, she creates these questions to help students organize their ideas:

New England	Mid-Atlantic States
1. Summarize its history:	1. Summarize its history:
2. Describe Boston	2. Describe New York City
3. Describe Providence.	3. Describe Philadelphia
4. Why is agriculture not an important industry?	4. Why is the Mid-Atlantic a financial center?
5. Why is fishing an important industry?	5. How are the industries of New Jersey and Pennsylvania different?
6. What are well-known attractions?	6. What are well-known attractions?
7. What is its climate?	7. What is its climate?

Evaluate the teacher's questions. Has she succeeded in creating a generally useful schema? Why or why not?

Response: This teacher's schema includes a common mistake that teachers and preservice teachers make when trying to create generally useful schemas. Three of the questions are appropriate for a generally useful schema: Questions 1, 6, and 7 are general questions that can be asked about any region of the U.S. However, the other questions are not general questions about any region, but rather specific questions about a specific region. To convert these questions into a generally useful schema applicable to any geographical region, the questions must become more general. Questions 2 and 3 could be converted to: Describe the region's two largest cities. Questions 4 and 5 should be changed to more general questions about industry, such as: What are the major industries? How does its geography affect its industries? The teacher might also want to include some other categories such as geography, the people, and natural resources.

The teacher could opt to use questions, as she has done here, or she could shift to words and phrases, such as: history, people, geography, climate, natural resources, major industries, description of the two largest cities, and major attractions.

ALTERNATIVE CONCEPTIONS

So far we have considered situations in which students have prior conceptions that are consistent with what they are learning. Now we turn to a second very important kind of prior conceptions—alternative conceptions, which are *inconsistent* with what the students are learning. Alternative conceptions typically interfere with learning the target conceptions (Chinn & Brewer, 2001; Eryilmaz, 2002; Kendeou & van den Broek, 2005). Because of their alternative conceptions, students may misunderstand what they are learning, or they may simply not believe what they are learning (Chinn & Samarapungavan, 2001).

As an introduction to students' alternative conceptions, let's consider Alexis Robbins, a fifth-grade teacher, who is planning a lesson on the Western migration during the Great Depression in the U.S. One of Alexis's instructional goals is for her students to learn that migrations often occur when people's desired way of life (economic, religious, political, etc.) is threatened or unfulfilled (Ferretti, MacArthur, & Okolo, 2007). Because Alexis has learned that her students may have prior conceptions about any topic she teaches, she decides to find out about what their prior conceptions are on this topic. A week before starting the unit, she asks several students who stayed after school why very large numbers of people in the U.S. in the 1930s might have moved West. Some typical responses were: "People moved because they wanted a better home, like a bigger house or a bigger yard, or like because they wanted to be closer to their work." "Maybe they got more money and wanted to live in a nicer neighborhood." "The parents might have gotten a promotion, and they had to move to a different office" (cf. Ferretti et al., 2007).

Alexis notices that these students share a common alternative conception. They think that the reasons for large-scale migration to different parts of the country are the same as the reasons why their own families might move to a different house. She now realizes that when her students read textbook sentences such as "Many families in Oklahoma packed all their belongings into their trucks and moved to California because they were looking for better lives," they might misinterpret this to mean that the migrants had plenty of money and therefore wanted to move to nicer homes near California beaches. She realizes that her students would fail to appreciate the depths of the economic despair that prompted Oklahoman farmers to move to California.

As a result, Alexis realizes that she must address these alternative conceptions in her class. She therefore adds a discussion to her lesson that carefully draws students' attention to the contrast between everyday reasons for moving and reasons for mass migrations. Specifically, she asks students why people they know move. When they give answers such as "they want a bigger house," she will explicitly point out that although this is why *their* families might move, it is *not* why most families moved in the 1930s. Then she will draw their attention to the hardships of the Great Depression and the drought that created the Dust Bowl. Through discussion, she will help her students gain an understanding that the plight of Oklahoma farmers of that era was completely different from their own situation. This will make them better prepared to understand the mass migrations of the Great Depression.

How Alternative Conceptions Emerge

In this section, we will examine *why* students have alternative conceptions and *how* their alternative conceptions affect learning. These insights will help us see how we can use this information as teachers to improve instruction. To gain a better understanding of what alternative conceptions are and how they arise, we will begin by exploring one alternative conception in depth—children's conceptions of the earth's shape.

Psychologists Stella Vosniadou and William Brewer investigated elementary school children's conceptions about the earth's shape (Vosniadou & Brewer, 1992; Vosniadou & Brewer, 1994). They wanted to find out (1) what alternative conceptions children had and (2) how the conceptions of younger and older children differed. To address these questions, Vosniadou and Brewer interviewed first graders, third graders, and fifth graders, asking them a series of questions about the earth's shape. An important characteristic of the questions that they asked was that most of the questions could not be answered by rote memory—simply by repeating a memorized word or phrase. Instead, the questions required students to reflect on questions that they had probably never thought about before, so that they would have to use their real ideas about the earth's shape to answer the questions. Examples of these questions are:

- Which way do we look to see the earth?
- Can you draw a picture of the earth? Now on this drawing show me where the stars go….. Now draw the sky…. Show me where the people live.
- [The interviewer shows a picture of a house on a flat line.] Here is a picture of a house. This house is on the earth, isn't it? How come here (where the house is) the earth is flat, but before you made it round? [referring to the child's earlier picture]
- If you walked for many days in a straight line, where would you end up? … Would you ever reach the end of edge of the earth? … Is there an end or edge to the earth? … Can you fall off the edge? … Where would you end up? .
- Now tell me what is below the earth?

Some of these questions appeared in the Reflection at the beginning of this chapter.

When Vosniadou and Brewer analyzed the children's responses to these and other questions, they found that most children (82%) had coherent conceptions of the earth's shape. This means that these children answered *all* the questions in a way that was consistent with one distinct conception of the earth's shape. There were five distinct conceptions (see Figure 6.4). The correct conception, of course, is the *spherical earth* conception that appears in Figure 6.4e. The other four conceptions were alternative conceptions that were very different from the correct conception. These alternative conceptions provide important insights into how alternative conceptions arise and why they persist despite instruction. We will first survey the five conceptions, and then we will ask what insights we can gain from understanding these alternative conceptions.

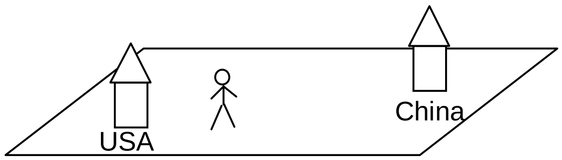
The flat-earth conception. Children who held the flat-earth conception viewed the earth either as a flat rectangle or a flat disc (see Figure 6.1a). People all live on the top of the flat surface. Places where people live, such as the U.S. and China, are all located on the top of this surface. These children think that there is an edge to the earth, and it is possible to fall off the edge. Other studies have found this to be the most common conception among first graders and younger children (Brewer, in press; Samarapungavan, Vosniadou, & Brewer, 1996).

Dual-earth conception. According to the dual-earth conception, there are two earths, the flat earth (or "ground") we live on and a round earth in the sky that people do not live on. The dual-earth conception is the conception expressed by Daryl, the child interviewed by his teacher in the Reflection at the beginning of this chapter. This transcript shows how another child, a third grader, with this conception answered the questions about the edge of the earth (Vosniadou & Brewer, 1992, pp. 570-571):

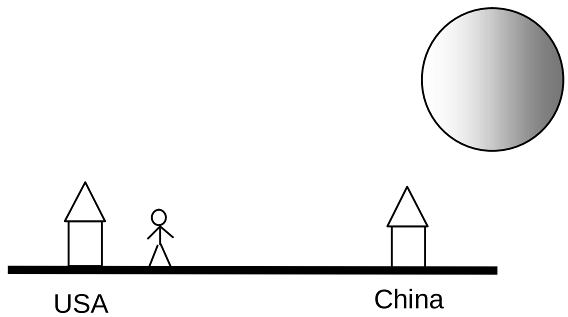
Interview:		Commentary:
Interviewer:	Would you ever reach the end of the earth?	The "earth" that the child refers to is the earth high up in the sky. There is an edge to the earth, and if one fell off the edge, one would fall downward, onto the flat ground that is under the earth in Figure 6.4b.
Child:	No … because it's so high.	
Interviewer:	Could you fall off the edge of the earth?	
Child:	Yes.	
Interviewer:	Where would you fall?	
Child:	Down on the ground.	

In Vosniadou and Brewer's study, the dual-earth conception was held by almost half of the first graders who had a coherent conception of the earth's shape. Ten percent of third graders also held this conception. No fifth graders held this conception. Most first grade teachers are probably unaware that a large number of their students think that there are two separate earths!

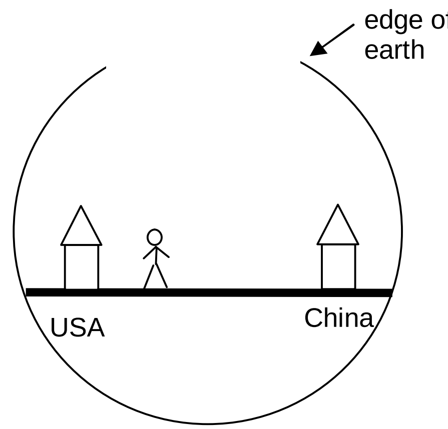
Figure 6.4: Five conceptions of the earth's shape



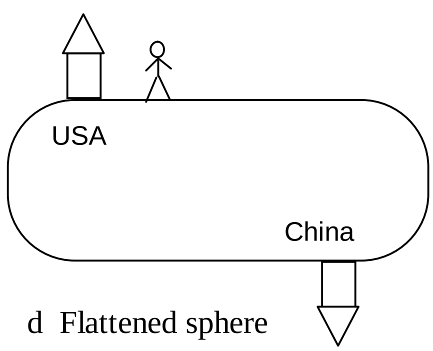
a Flat earth



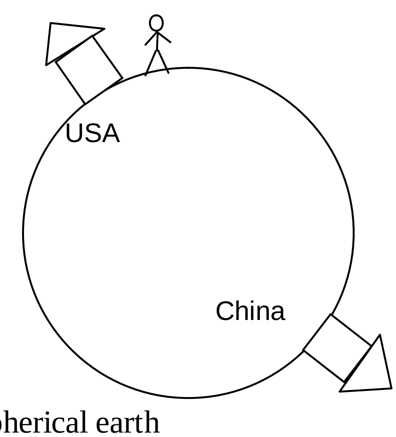
b Dual earth



c Hollow sphere



d Flattened sphere



e Spherical earth

Note: Drawings highlight important features of children's conceptions and are not drawn to scale.

Hollow-sphere conception. Children with the hollow-earth conception think that the earth is hollow like a jack-o'-lantern or a goldfish bowl. People live on the flat part at the bottom of the earth, as shown in Figure 6.4c. We live not on the outside of the ball, but on the inside, in the middle of the ball. Places such as the U.S. and China are on the flat surface on the inside. According to one idea held by these children, the edge of the earth is high in the sky! (Vosniadou & Brewer, 1992, p. 564).

Interview:		Commentary:
Interviewer:	Would you ever reach the edge of the earth [if you kept walking and walking]?	
Child:	No, you would have to be in a spaceship if you're going to go to the end of the earth.	The edge of the earth is the point marked "edge" in Figure 6.4d. To get to that edge, one must fly far up in a spaceship.
Interviewer:	Is there an edge to the earth?	
Child:	No. Only if you go up.	

The hollow earth conception was held by 10% of first graders, 20% of third graders, and 30% of fifth graders. Most elementary school teachers have probably never imagined that some of their students think that we live in the inside of a sphere, that there is a kind of sky-wall at the end of the earth, or that the edge of the earth is high up in the sky!

Flattened-sphere conception. Children with this conception thought that the earth was round like a thick pancake. In fact, the children explicitly said it was like a pancake. These children believe that one can walk all the way around the earth—there is no edge to the earth. However, the earth is mainly flat on the top and the bottom. This conception was held by 5% of the first graders, 15% of the third graders, and none of the fifth graders.

Spherical-earth conception. The final conception of the earth's shape was the conception of the earth as a sphere, which is the scientific conception. Children with this conception believed that the earth was round like a ball, that people do not fall off the earth because of gravity, and that people can travel all the way around the earth. This conception was held by 15% of first graders, 40% of third graders, and 60% of fifth graders.

Why do children develop these conceptions of the earth's shape? We have seen that children develop five different conceptions of the earth's shape. The flat-earth conception is prevalent among five- or six-year-old children and then quickly become less common. Later, children tend to develop other conceptions such as the dual-earth conception, the flattened-sphere conception, and the hollow-earth conception. Only at about fifth or sixth grade do a majority of children develop the spherical-earth conception.

How do these very different ideas arise? Parents and teachers do not intentionally teach children that the earth is flat, that there are two earths, or that the earth is hollow. Then where do these ideas come from? Vosniadou and Brewer noted that the initial idea that many children hold—the flat-earth conception—is consistent with two important facts about the earth that young children are familiar with: (1) the earth *looks* flat and (2) things fall downward. In fact, the flat-earth conception gives a very good explanation of these facts. According to the flat-earth conception, the earth *looks* flat because it *is* flat. And when we drop things, those things fall downward and hit the flat earth that we are standing on.

As children grow older, they begin to encounter new ideas presented by teachers, parents, and the media. They hear that the earth is round. They see globes and pictures of the earth taken from space. But these ideas do not make sense to most children, given the facts they know (the earth is flat, and things fall downward). The earth cannot be round because it looks flat and because people would fall off the bottom half of the ball. Faced with these new ideas, children develop new alternative conceptions to make sense of what adults are telling them.

Some children develop the dual-earth conception. This conception explains the apparent flatness of the earth, because we live on the flat ground, not the earth up in the sky. And on the flat ground, things fall downward. This conception also explains the "round earth" that appears in NASA pictures and that is embodied in the globe in the classroom. This round earth is the earth up in the sky.

Other children develop the hollow-earth conception. This conception explains the flatness of the earth by assuming that we live on the flat ground inside the earth. Things fall down as expected on this flat earth. And the idea that the earth is round is explained by having us live on the inside of the round, hollow earth. What we see in globes and pictures of the earth is the outside of this sphere.

The flattened-sphere conception is a more advanced conception, because these children have come to understand something about gravity. These children allow people to live on the bottom of the earth, because they know that gravity keeps people on the bottom of the earth from falling down off the earth. However, these children still cannot see how a round earth is compatible with the apparent flatness of the earth, so they make the earth a flattened sphere, rather than a fully rounded sphere. These children do not yet understand that a very, very large sphere will appear flat to those on its surface.

Children who adopt the spherical conception have a new understanding of the original facts. They understand that the earth looks flat because very, very large round things look flat when they are standing on the surface. And they have a new understanding of what it means for things to fall "down." Things fall downward toward the center of the earth, because of gravity. They therefore understand that people and things on the bottom half of a spherical earth will not fall off the earth.

Why alternative conceptions arise and why they persist. Now let's summarize what we have learned from the research on the earth's shape. First, *learners' alternative conceptions arise because they do a good job of explaining the facts that they know about*. Alternative conceptions are not silly or misguided; they are the product of *very impressive, creative* thinking by learners as they actively invent ideas that can explain what they know. Alternative conceptions arise because learners are actively trying to make sense of the world (Brewer, in press; Vosniadou & Brewer, 1992; Vosniadou & Brewer, 1994; Vosniadou & Verschaffel, 2004).

Second, *students often resist changing their ideas because the new ideas taught by adults do not make sense to them*. When teachers and parents say that the earth is round and show children a globe, they cannot understand how people could live on the bottom of the earth or how the earth can look flat. They may therefore ignore what their teachers say because they cannot make sense of them.

Third, when presented with the correct conceptions, *students often develop new alternative conceptions that combine elements of their previous conceptions with elements of the target conceptions.* When children learn that the earth is spherical, they develop a new idea that incorporates a round earth but retains elements of a flat earth (as in the dual-earth and hollow-earth conceptions).

The earth's shape is a topic on which most students do eventually change their ideas after a period of several years. Most adults do not believe that the earth is flat or hollow. However, on many other topics (in science and in other disciplines), students' alternative conceptions may persist into adulthood. For example, many or most adults retain alternative conceptions about how we see things (Winer, Cottrell, Gregg, Fournier, & Bica, 2002). Many adults erroneously think that a visual emanation leaves the eyes when we see things. In fact, we see things when light travels from a light source such as the sun, reflects off the object we see, and then strikes our retina. Adults also have alternative conceptions about topics such as the U.S. constitution, such as the conception that the judiciary has the power to make laws (New Hampshire Bar Association, 2005).

Are Learners' Alternative Conceptions Coherent?

In the research on the earth's shape, most children seemed to have **coherent conceptions**. Learners have a single conception that they use to think about a topic. A consequence of having a coherent conception is that when students are asked questions about a topic, they give answers that are all consistent with that single conception. For example, in the research on children's conception of the earth's shape, most children gave answers consistent with a single conception of the earth's shape. But notice that it would be possible for children to give answers to different questions that were not consistent with a single conception. For instance, a child could respond to one question by saying that the earth is flat like a coin, but respond to another by saying that the earth does not have an edge. If a child answered different questions in different ways, we would conclude that the child does not have a coherent conception of the earth's shape that she uses consistently to answer questions about the earth. We would say instead that her conceptions are **fragmented**, because she uses different conceptions to answer different questions.

Are learners' alternative conceptions generally coherent or fragmented? This is a hotly debated question (refs xx), and the answer appears to depend on the topic. Students appear to have coherent ideas about a number of topics, including how species develop (Samarapungavan & Wiers, 1994, 1997), why we have night and day (Vosniadou & Brewer, 1994), and the number system (Stafylidou & Vosniadou, 2004; Vamvakoussi & Vosniadou, 2004; Vosniadou & Verschaffel, 2004). However, on other topics, such as some topics in chemistry and physics, learners' ideas appear to be less coherent (diSessa, 1993; diSessa, Gillespie, & Esterly, 2004; Nakhleh & Samarapungavan, 1999; Nakhleh, Samarapungavan, & Saglam, 2005). For example, in one study I conducted, I found that most middle school students did not have a single coherent idea about topics such as evaporation (Chinn, 1997). For example, asked about what happens during evaporation, students gave different answers about similar substances. Students might say that rubbing alcohol evaporates by "disappearing" into the air, whereas water evaporates by "turning into" water vapor. These children did not have a single conception of evaporation that applied to all liquids.

Learning scientist Andy diSessa (diSessa, 1993; diSessa et al., 2004)has argued that prior conceptions are often fragmented and poorly interconnected. For instance, when thinking about forces and motion, students may have a mixed set of poorly connected conceptions such as (diSessa, 1993):

- Motion gradually dies away.
- Things tend to return to a state of balance.
- Sometimes one force can overcome another.

Students may randomly apply different these conceptions to very similar situations. When asked why a *truck* rolls to a stop when the engine is turned off, a student says that it is because motion dies away if there's no engine. Asked why a *sports car* rolls to a stop when the engine is turned off, the student says that it is because the force of friction overcomes the force of the car moving. Asked why a *bicycle* rolls to a stop when the rider stops pedaling, the student says that the bicycle wants to return to its normal state of rest, because that is its natural balance.

According to diSessa and some other learning scientists, small changes in the situation may cue the use of different fragmented conceptions. To a physicist, the explanation for why the truck rolls to a stop is exactly the same as the explanation for why the sports car and the bicycle roll to a stop (all three roll to a stop because of the force of friction). To a student, each context triggers, perhaps even randomly, the use of a different conception to answer the question.

Whether learners' alternative conceptions on a given topic are coherent or fragmented, their alternative conceptions can still create challenges for learning. For example, a child who believes that some substances disappear during evaporation will have difficulty understanding the concept that matter never disappears, even if he does not believe that all substances disappear during evaporation. Thus, whether alternative conceptions are coherent or fragmented, the alternative conceptions can make learning difficult, and it is therefore vital for teachers to know what these conceptions are so that they can design more effective instruction.

The Importance of Understanding Students' Alternative Conceptions

When teachers understand their students' alternative conceptions, they can alter instruction to meet students' needs. Very often, when teachers gain a complete understanding of students' alternative conceptions, they gain new insights into how to develop instruction (Ballenger & Rosebery, 2003). Sometimes these insights are surprising. Most elementary school teachers that I have talked with over the years are unaware that many of their students have dual-earth and hollow-earth conceptions of the earth. Once teachers realize this, and once they realize that these alternative conceptions are grounded in children's beliefs that things must always fall downward and that round things must always look round, it gives them new ideas about how to develop instruction. For example, they may now realize that instruction on the earth's shape might start with instruction on how very, very large round things will look flat to someone standing on the surface. One way to do this might be to show how the surface of an extremely large inflatable ball looks flatter and flatter as it expands.

It is important to try to gain a complete understanding of students' alternative conceptions in order to understand how to develop instruction. Sometimes students' prior conceptions form a complex system of interrelated ideas; we can call this an *alternative conceptual system*. It is important to understand these interrelated ideas in order to know how to instruct students. A good example comes from mathematics—specifically, from students learning fractions. As we examine the alternative conceptual system that makes learning fractions difficult, we will see that it would be very difficult to teach fractions effectively without understanding these conceptions (Stafylidou & Vosniadou, 2004).

The alternative conceptual system that interferes with students' attempts to learn about fractions is students' conceptions about the natural number systems. Natural numbers are the whole numbers we can count—1, 2, 3, 4, and so on; natural numbers do not include fractions such as ½ or 7/15 or decimals such as 3.29. Students learn about the natural number system at home and in early school grades. Most children learn the natural number system very well. But then, later in elementary school, their successful learning of the natural number system gets in the way of learning fractions.

Let's explore in more detail how this happens. By third or fourth grade, students have mastered many important ideas about natural numbers. For example, they have learned that 15 is larger than 9. They have learned how to add, subtract, and multiply. They know that when two numbers are added together, the sum is larger than the numbers added. They know that 9 is 1 more than 8, that 117 is one more than 116, and so on. They know that there is no natural number between adjacent numbers (e.g., there is no natural number between 23 and 24). They know that you can add numbers by counting them together; you can add 11 pennies to 6 pennies by putting all the pennies together and counting them all. By third or fourth grade, students have mastered these ideas and more. A more complete list of what they have learned appears appear on the left side of Table 6.5.

Table 6.5:
Differences between natural numbers and fractions

Feature	Natural Number System	Fractions
Locating positions on the number line	Each position on the number line is indicated by a single number (1, 2, 3, 4, 5, 50, 389, etc.) .	Two numbers are needed to indicate position on a continuous number line, as in 2/5, 33/35, or 15/2.
Ordering	Larger digits mean larger numbers. Every number has exactly one number that comes before it and exactly one number that comes after it.	Larger digits do not mean larger numbers (1/15 is not larger than 1/8 even though 15 is larger than 8). There is no single unique number that comes before or after a number.
Numbers between numbers	There is no number between two consecutive numbers (e.g., there is no number between 16 and 17).	There infinitely many numbers between any two other numbers (e.g., between 16 and 17, or between 16.000001 and 16.000002).
The smallest positive number	One (1) is the smallest positive number.	There is no unique smallest positive number.
Operations		
Addition-Subtraction	You can add by counting combining objects and counting. E.g., you can add 3 buttons to 4 buttons by putting the buttons together and counting them, giving 7 buttons.	You cannot add by counting. 4/7 + 3/5 is not equal to 4 + 3, or 7 + 5, or any other straightforward sum of numbers.
Subtraction	You can subtract by counting the number removed and then counting what is left. If you have 9 buttons, and remove 3, then you can find what 9 minus 3 is by counting the buttons that remain.	You cannot subtract 4/7 minus 3/5 by any straightforward subtraction of 4 minus 3, 7 minus 5, etc.
Multiplication	Multiplication makes the number bigger.	Multiplication makes the number either bigger or smaller (e.g., ½ * ½ = ¼ vs. 2 x 3 = 6).
Division	Division makes the number smaller.	Division makes the number either smaller or bigger (e.g., ½ ÷ 1/5 = 5/2 vs. 5/2 ÷ 7/2 = 5/7).

Adapted from (Vamvakoussi & Vosniadou, 2004)

However, when students apply these conceptions about the natural number system to fractions, they run into serious difficulties. The rules that govern fractions are not the same as the rules that govern natural numbers, and this leads students to misunderstand fractions. Here is a transcript of a teacher working with a seventh grader that illustrates some of these difficulties (based on research by Stafylidou & Vosniadou, 2004; Vamvakoussi & Vosniadou, 2004).

Transcript:		Commentary:
Teacher:	Desmond, what is the smallest fraction that you can think of? Write it down for me.	Desmond has picked this number because 1 is the smallest natural number he knows, and 2 is the next smallest natural number he knows. Because 1 and 2 are small, he thinks that ½ must be a very small fraction.
Desmond:	[He writes: $\frac{1}{2}$]	
Teacher:	One half? Why do you think so?	
Desmond:	Because both of the numbers are pretty small.	Because 2 is smaller than 9999, Desmond thinks that ½ is smaller than 1/9999.
Teacher:	Which of these is smaller? [She writes ½ and 1/9999]	
Desmond:	One half.	Desmond is incorrectly applying ideas about natural numbers to fractions.
Teacher:	And what is the biggest fraction you can think of?	Desmond thinks that this fraction with lots of 9's is a large fraction because both the numerator and denominator are very large numbers.
Desmond:	[Pauses a few seconds before writing: $\frac{99{,}999{,}999{,}999}{999{,}999{,}999{,}999}$]	
Teacher:	Now, look at this list of numbers. Put these in order from the smallest to the biggest. [The teacher shows these numbers: 5/6 1 1/7 4/3]	
Desmond:	[Puts them in this order: 1 1/7 4/3 5/6]	
Teacher:	Why did you pick that order?	
Desmond:	Well, the first two numbers both have a "1," but the second one [1/7] also has a "7." And the next one has "4" on the top, and then the last one is bigger, because it has a "5."	Desmond is ordering the numbers according to how large the numerator is. When there is a tie between 1 and 1/7, he judges 1/7 to be larger because of the 7.
Teacher:	And which of these is bigger? [She shows him 4/15 and 4/7.]	When evaluating this pair of numbers, the numerators are the same, so Desmond ranks them by the size of the denominators.
Desmond:	4/15, because 15 is bigger than 7, and the 4's are the same.	

Now let's reflect on what Desmond's answers reveal about his thinking. Desmond has successfully learned the natural number system, and he is trying to apply this understanding to fractions. The fraction 4/15 is larger than 4/7 because the 4's are the same and 15 is larger than 7. One half is a small fraction because both numbers are small. The fraction 1/7 is larger than 1 because 7 is larger than 1. Desmond does conceive of these numbers as fractions. He is simply using his basic understanding of natural numbers--the numbers that he can count as 1, 2, 3, 4, and so on.

The problem for Desmond (and many other students) is that the rules that apply to natural numbers do not apply to fractions. There are many important conceptual differences between the natural number system and the number system of fractions (Jones, Langrall, Thornton, & Nisbet, 2002; Stafylidou & Vosniadou, 2004; Vamvakoussi & Vosniadou, 2004). Table 6.5 shows some of the important differences. Each of these differences is a source of difficulty in learning about fractions. For example, in the natural number system, there is exactly 1 number between 8 and 10, and that number is 9. But when fractions are included, there are infinitely many numbers between 8 and 10. This will make no sense to students like Desmond who are applying the natural number system because Desmond cannot envision having any fractions between 8 and 9 or 9 and 10. This makes the very idea of fractions quite difficult for Desmond to grasp.

Similarly, the idea that you can no longer add numbers by counting them (1, 2, 3, 4, etc.) makes it hard to understand the entirely different rules for adding fractions. The idea that multiplying two fractions can yield a number *smaller* than the two numbers multiplied makes no sense to Desmond, who has mastered the natural-numbers idea that multiplying two numbers always yields a product greater than or equal to the two numbers multiplied. In sum, because Desmond is trying to understand fractions using the rules of the natural number system (shown on the left side of Table 6.5), he has difficulty understanding fractions, which are governed by a different set of rules (shown on the right side of Table 6.5).

To teach students like Desmond, a teacher cannot simply start teaching the rules for fractions, because the new conceptual basis for these rules will make no sense to these students. The thoroughness with which students have successfully learned the natural number system now interferes with learning about fractions. Instead, the teacher will need to devote considerable time helping students understand how the fractional number system differs from the natural number system, so that they learn that they cannot apply their ideas about natural numbers to fractions. We will address in later chapters how to help students learn new conceptual systems of this sort. For now, the critical point is that when teachers understand students' alternative conceptual systems, they will realize that they need to help students understand the various differences between their prior conceptions and the target conceptions that they are learning.

Table 6.6
Examples of alternative conceptions

Topic	Target conception	Common alternative conceptions
Light and vision	We see objects because light (such as light from the sun) bounces off of that object and then strikes our eyes.	1. We see objects because a visual emanation of some kind travels from our eyes to the object. 2. We see objects because a visual emanation of some kind travels from our eyes to the object, then bounces off the object and travels back to our eyes.
Matter	Matter is composed of molecules which are elastic and do not individually have the same properties as the substance (e.g., individual water molecules are not wet).	1. Matter is simply matter through and through. For example, water is water, and it is not composed of any smaller particles. 2. Matter is composed of small particles that have the same properties as the whole substance. For example, water molecules are tiny, wet drops of water, just like water.
Photosyn-thesis	Plants get their energy from photosynthesis. In photosynthesis, light triggers a reaction in which carbon dioxide and water combine to produce glucose and oxygen. The mass of a plant comes mainly from the carbon dioxide and the water.	1. Plants get their energy (or food) from the soil. The plant absorbs its mass from the soil. 2. Plants get their energy from plant food given to the plants by humans.
Prices	Prices are determined by an interaction of supply and demand. Supply, in turn, can depend on the cost of producing an item.	1. Children younger than 7 think that the price of things depends on size. Expensive things are expensive because they are large (e.g., large furniture and automobiles). A diamond is inexpensive because it is small. 2. At around 10, many students think that the price of a product depend on the amount of work that goes into producing the product.

Political world	A nation is a political entity with a central government, which can take many forms, including democracies.	1. Some elementary school children think that "nations" are simply large tracts of land. 2. Other elementary school children develop a feudal conception of government of nations. There is a single central power who gives laws to local officials such as mayors, who then give orders to the population.
Equals sign	The equals sign in mathematics indicates that the two quantities on each side of the equal sign are equivalent.	1. Many elementary school (and even older) children think that the equals sign is an instruction to carry out an operation. For example, in the problem "3 x 15 = ____," students the equals sign is taken to mean "multiply 3 and 15 and then write down the product on the right side." When students see problems such as ___ = 5 + 8, they may object that this is illegitimate, because the equals sign is telling you to do something to the numbers on its left, but there are no numbers on the left."

Sources: (Ambos et al., 2007; Berti, 2005; Berti & Bombi, 1988; Berti & Vanni, 2000; Chinn, 1997; Ergazaki, Komis, & Zogza, 2005; Kaput, Carraher, & Blanton, 2008; Lin & Hu, 2003; Nakhleh & Samarapungavan, 1999; Nakhleh et al., 2005; Webley, 2005; Winer et al., 2002)

Students exhibit alternative conceptions on many topics covered in the K-12 curriculum. Table 6.6 presents examples of several other alternative conceptions. We have seen that students' alternative conceptions can be grounded in their own experiences, as when children's idea that the earth is flat is grounded in their experiences that things fall downward and the earth looks flat. We have now seen that students' alternative conceptions can also be grounded in successful prior learning, as when students' mastery of the natural number system interferes with learning fractions in later grades. Regardless of the source of the prior conceptions, it is important for teachers to learn about conceptions such as these in order to design more effective instruction.

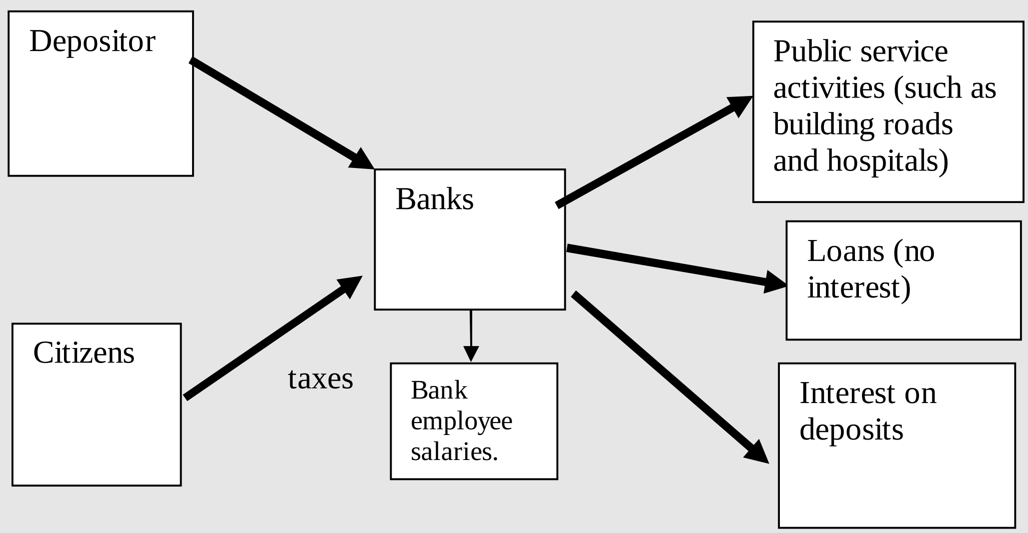
Problem 6.3: Understanding Students' Thinking:
The banking system

Read the following transcripts and determine what Erin's conception of the banking system is. Erin (E) is 16 years old and is being interviewed by her teacher (T).

T What can you do at a bank?
E Borrow money and save money.
T Is there anything else you can do?
E No, not really.
T How would things be different if there weren't any banks?
E You wouldn't be able to get interest on your money, and you wouldn't be able borrow money like to buy a house.
T Suppose that you put $100 in the bank. After one year, you withdraw it. How much money will you receive?
E About $110.
T Where does the bank get the money to pay you?
E It gets it back from the government.
T Where does the bank get the extra $10 to pay you?
E From the government.
T What does a bank do with the $100 you put in the bank?
E It uses it to make roads and build hospitals and stuff.
T What happens when you write a check?
E The bank gives you some of your money back.
T Suppose you borrow $100 from a bank. After one year, when you return the money, how much will you give back?
E $100.
T Why is that?
E It would be stealing to make me give back more than that.
T Where does the bank get the money to loan you $100.
E It comes from taxes.
T What do you mean by "It comes from taxes"?
E That's one of the things the government does.
T Where did the bank get all its money.
E Same thing—from taxes.
T Does the bank pay its employees?
E Yeah.
T Where does the bank get the money to pay its employees?
E They're like teachers. They get paid by the government.

Response: *Here are some key components of Erin's conception: Banks are part of the government. When you put money in the bank, banks take the money and use it (as a branch of the government) to build things like roads and hospitals. Interest, loans, and bank employees' salaries are paid by the government using taxes. This suggests that the student thinks that the government has two sources of money: bank deposits and taxes. Both are used to build roads, etc. Interest on deposits is paid strictly using taxes.*

Each individual has a checking account in which they keep money, and they cannot take out more than they put in. However, you can take extra money out by taking a loan. There is no interest on loans because this would be unfair. We can represent many key components of Erin's conceptions in the *diagram shown below:*



Alternative Conceptions can Interfere with Both Understanding and Belief

Students' alternative conceptions can interfere with learning in one or both of two distinct ways (Chinn & Samarapungavan, 2001, 2008; Ohlsson, in press). Alternative conceptions can make it difficult to *understand* new ideas. Or they can make it difficult to *believe* new ideas, even if the ideas are understood. People **understand** a conception when they can explain what the conception means, explain how the conception is similar to and different from related conceptions, describe examples of the conception, and apply the conception to new situations. People **believe** conceptions when they think those conceptions are correct or true. People can understand ideas without believing them, and *vice versa*. For example, an economics student can understand Marxist economic theory without believing it. Conversely, a committed communist who has never studied economics might fervently believe Marxism without having any real understanding of it.

As an example of how alternative conceptions can influence both understanding and belief, let's consider a sixth grader, Tracey, learning about water molecules. Tracey believes that water is made up of "molecules," but she thinks that molecules are tiny drops of water. Then Tracey learns about a very different idea in science class: Water is made of hard, elastic molecules that are constantly bumping against each other. How might Tracey's alternative conception impede learning of this idea?

One possibility is that Tracey's alternative conception leads to a misunderstanding of the new ideas. The idea that water is made of hard molecules might simply makes no sense to Tracey. How could something wet be made of particles that are not wet? As a result, Tracey might combine what she learned with her prior conceptions to develop a common alternative conception—namely, that water molecules are hard particles found in water, and mixed in with the tiny drops that water is made of (Chinn & Samarapungavan, 2001).

Another possibility is that Tracey fails to believe the ideas, even though she understands them pretty well. Tracey understands the teacher when the teacher explains that water can be poured for the same reason that a bucket of tiny hard seeds can be poured. Just as bird seeds are individually hard but can be stirred and poured, water molecules are individually hard but can be stirred and poured. Although Tracey understands this idea, she says to herself, "I don't really think that water is like bird seed. The teacher hasn't shown me any proof that water molecules are hard. I still think water molecules are wet drops of water."

The fact that Tracey may understand ideas without believing them complicates her teacher's efforts to appraise Tracey's thinking. If Tracey writes on an exam, "water molecules are hard like bird seed," does it mean that Tracey now *believes* this, or only that Tracey understands this idea, but still believes something else? Without asking follow-up questions about Tracey's beliefs, the teacher cannot know whether or not Tracey believes what she has written down. When asked by researchers, science students often assert that their *real* beliefs differ from the scientific ideas they are being taught in topics including molecular theory, forces and motion, and heat and temperature (Chinn & Samarapungavan, 2001).

People tend to resist changing beliefs in response to new information (Brewer, Chinn, & Samarapungavan, 1998; Chinn & Brewer, 1993). Beliefs about the social world are particularly resistant to change. For example, as we discussed in Chapter 5, stereotypes are very resistant to change, even in the face of evidence that strongly contradicts these stereotypes (Kunda & Oleson, 1995). Similarly, people's beliefs about issues such as whether or not capital punishment deters crime tend to be very resistant to change in response to sociological data about the actual effects of capital punishment on crime (J. Glaser, 2005; Lord, Ross, & Lepper, 1979). Beliefs about the natural world are perhaps less resistant to change than beliefs about the social world, but science students also frequently resist changing beliefs about the natural world in response to new evidence (Chinn & Brewer, 1993).

Implications for Instruction

When learners' prior conceptions and beliefs are fundamentally different from the new ideas that they are trying to learn, we say that learning involves **conceptual change**. Conceptual change requires students to develop new conceptions that are different in substantial ways from the prior conceptions. Many forms of learning do not involve conceptual change. For example, when a child who already understands the structure of the solar system learns about a new planet (e.g., Uranus), there is no conceptual change. This is simply an addition of a new fact to one's knowledge. In contrast, learning about the concept of fractions entails conceptual change because students must shift from the conceptual system of natural numbers to the very different conceptual system of fractions.

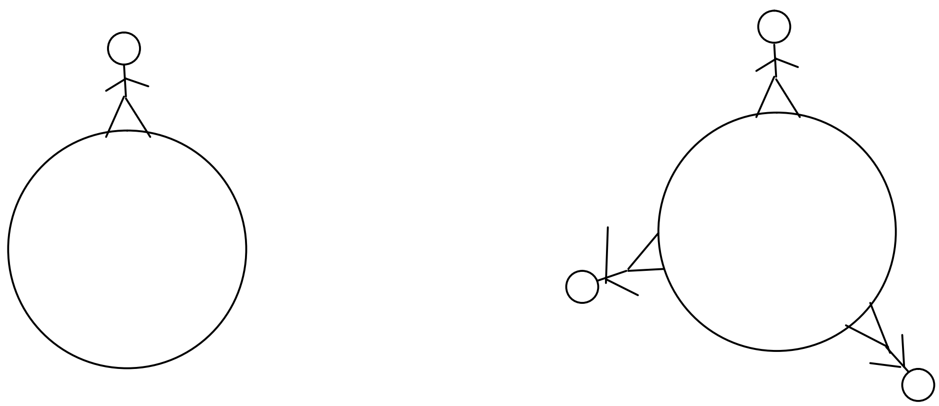
Promoting conceptual change is one of the major challenges in education. There is no single set of teaching strategies that will guarantee success. In later chapters, we will explore some advanced teaching methods that can encourage conceptual change. In this chapter, we will begin by discussing three relatively simple instructional techniques that can encourage conceptual change.

Provide clear explanations, avoiding ambiguous language. When explaining ideas to their students, teachers are more likely to promote conceptual change if they provide clear explanations that avoid ambiguous language. If a teacher tells second graders, "The earth is round like this globe," she has made an ambiguous statement that can readily be reinterpreted to fit students' alternative conceptions. Children who have the dual-earth conception will think, "Right—that is the second earth somewhere up in the sky." Children with the hollow-earth conception will think, "Right—and we live on a flat surface on the inside of this." The teacher's statement is ambiguous because students with two different alternative conceptions can readily reinterpret her statement to fit their own alternative conceptions.
Even worse, teachers and textbooks can be misleading. A teacher or a textbook that draws pictures of the earth as shown in Figure 6.5a, with people standing on the top of the earth, seems to confirm students'

conception that people cannot live on the bottom half of the earth. It is very easy to unintentionally provide support for students' alternative conceptions in this way.

Figure 6.5:
Drawing people on the earth

6.5a 6.5b



The teacher could improve her explanation by being clearer and more explicit: "The earth is round like this globe. People all live on the outside of this sphere. Some people live up here [pointing to Asia and North America]. Other people live down here [pointing to South American and Australia]. And there are even some scientists who live way down here [pointing to Antarctica]." Then she draws the picture in Figure 6.5b to help make these ideas clear. Of course, this explanation would only be a starting point. The teacher would need to work to help students understand that people living in Australia do not feel themselves to be standing upside down and that gravity keeps them on the earth. But in beginning with a clear, unambiguous explanation, the teacher alerts students with the dual-earth and hollow-earth conceptions that what she is saying is not consistent with their conceptions. This makes it less likely that they will simply try to assimilate what she is saying into their current conceptions.

Explicitly note common alternative conceptions. Another instructional technique that can promote conceptual change is to explicitly mention common alternative conceptions (Broughton, Sinatra, & Reynolds, 2007; Guzzetti, Snyder, Glass, & Gamas, 1993; L. Mason, 2007). By pointing out the alternative conception to students, she is trying to make sure that they know that the new conceptions are different from their current ideas. For instance, imagine a teacher teaching fourth graders about the banking system. She knows that many of her students think that banks are literally place the money deposited on a shelf, and then return the exact same money to the depositor when the money is withdrawn. To She begins her lesson in this way:

> "Many of you probably think that when you take money to the bank, the banker puts your money on a shelf, and then gives it back to you when you are ready for it. How many of you think that? ….

> Well, we are going to learn about banks today, and you will find out that banks do *not* work in this way. Banks do not keep your money on a shelf. Instead, they give it to other people to use, while you aren't using it."

Through this introduction, the teacher has alerted students who hold this alternative conception that they will need to change their ideas in order to understand how banks really work. When teachers draw students' attention to common alternative conceptions, they promote conceptual change by helping students realize that these are new ideas that are inconsistent with their old framework.

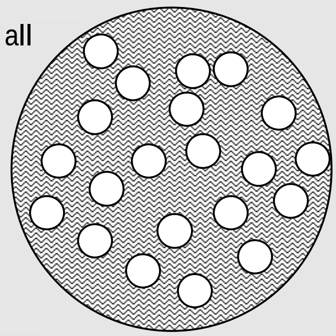
Provide evidence. A third instructional technique for promoting conceptual change is to provide students with evidence (Chinn & Samarapungavan, 2008). **Evidence** refers to data or facts or observations that provide a reason to believe an idea. For instance, evidence in science usually consists of experiments and observations. Evidence in history consists of primary source materials such as diaries or government documents. Sometimes evidence is as simple as an example. Young children who believe that size determines price (so that things are expensive because they are large; see Table 6.6) can be shown internet catalog pages with some small but very expensive objects, such as diamond rings and rare coins. This can lead students to see that their current idea does not fit the facts, and it can stimulate them to begin developing new ideas about what makes things expensive.

Schools tend not to provide very much evidence about topics in the curriculum. As a result, students learn what experts (scientists, historians, political scientists, literature critics, and so on) think is true, but not *why* they think it is true. When my daughter was taking high school biology, she once asked me: "We learn all this stuff about organelles, molecules, and atoms. But how do they know that this is true?" She was right to ask this question. Neither her textbook nor her teachers had presented any evidence for believing that mitochondria were the powerhouse of the cell, that molecules are made up of atoms, or almost any other idea. Teachers can encourage belief and understanding by bringing evidence into the classroom to supplement curricula which typically provide little evidence.

Problem 6.4: Evaluating teaching:
Instruction for conceptual change

Sharon, a fifth-grade teacher, is making plans to teach the next science unit on matter and molecules. She finds the following passage and diagram in her textbook.

Water is made of tiny molecules moving around all the time. The molecules in water never stop moving. As they move, they bounce against each other over and over.



Evaluate this textbook passage in terms of whether it is misleading in a way that promotes any alternative conceptions. If it is, what alternative conceptions might it promote? Should Sharon adjust her instruction in any way to make sure that students do not misinterpret this passage and diagram? If so, how?

Response: One serious problem with this passage is that both the text and the diagram strongly imply that the molecules are in water—that water molecules and water are different, and that the molecules are swimming around in the water. Notice that the textbook passage states that water molecules are in water and that the diagram shows a wavy gray background that students can readily interpret as water. Thus, this text and diagram are likely to contribute to some students developing an alternative conception that water molecules are little particles of some kind that are surrounded by water. If Sharon realizes this, she will want to clearly explain to students that this idea is not what is intended by the text. She might explicitly note this alternative conception and explain how the scientific explanation is different—explaining that the water molecules are the water, not that they are in the water.

NOTE: Another issue that could be considered is that this diagram depicts water molecules as single circles rather than as the well-known three-atom molecule containing one oxygen and two hydrogen atoms. The argument for presenting a simple idea first is that students are not yet ready to learn about atoms. There is as yet little or no research on whether it is better to teach simpler conceptualizations before moving on to more complex conceptualizations later or to teach more complex conceptualizations from the start.

NOVICE CONCEPTIONS

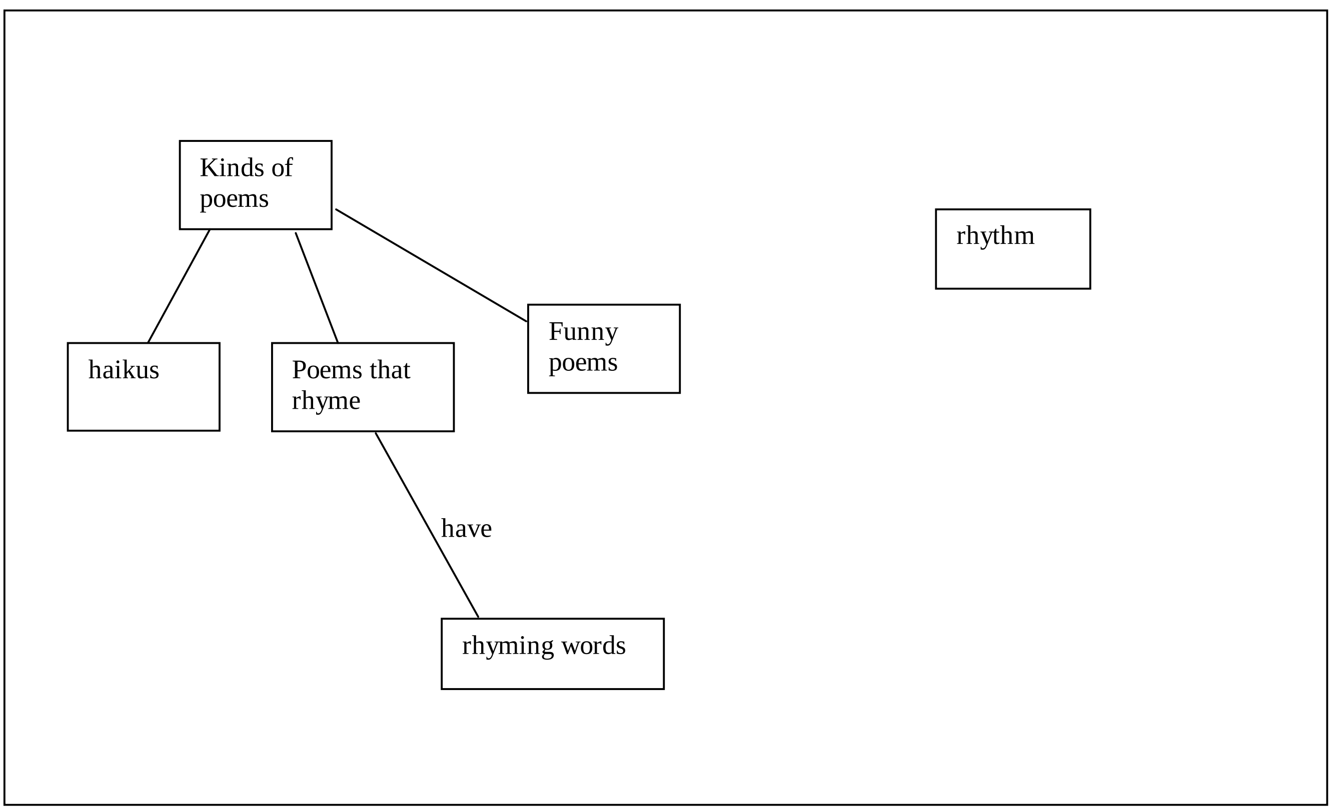
Novice conceptions are immature conceptions that learners have when they do not yet know much about a topic. Novice conceptions contrast with **expert conceptions**, the conceptions of people who know a great deal about a topic. Many studies in education and psychology have compared the conceptions of novices with those of experts (K. Anders Ericsson, 2005, 2006; Schunn, in press). According to this research, there are two important differences between novice conceptions and expert conceptions. First, novice conceptions are much less extensive and interconnected than the conceptions of experts. Second, novice conceptions are organized differently than expert conceptions.

Few Concepts that are Poorly Interconnected

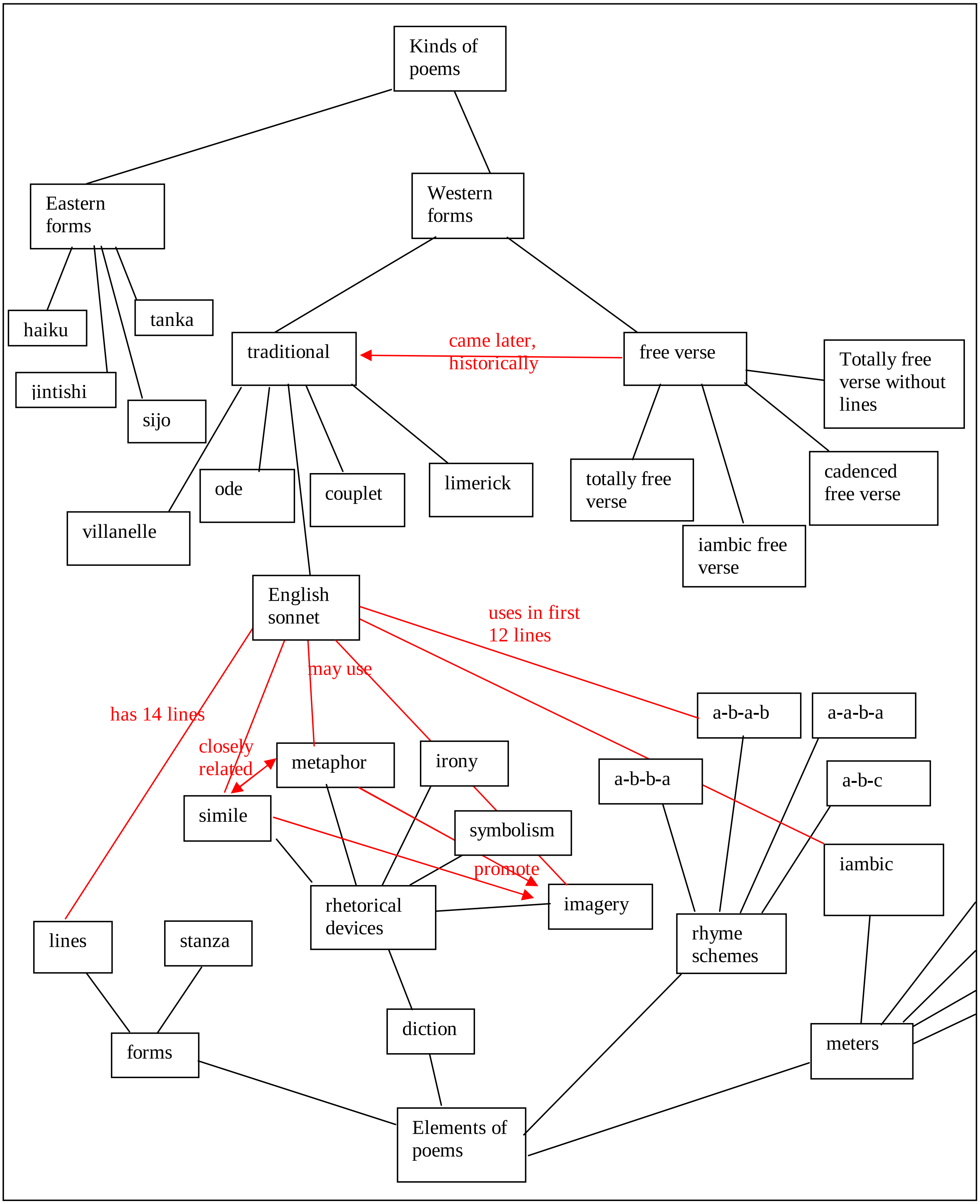
In comparison to experts, novices have conceptions that are both less extensive and less interconnected. This means both that novices have fewer concepts in long-term memory, and the concepts that they have are more isolated and less linked together. Experts know many more concepts, and they know many different ways in which these concepts are interrelated.

Figure 6.6:
Novice and expert conceptions of poetry

6.6a A novice student's conceptions of poetry



6.6b Part of a more expert student's conceptions of poetry



As an example, let's consider how novices and experts might differ in their concepts about poetry (Zeitz, 1994). Figure 6.6a shows a concept map representing a novice student's conceptions; Figure 6.6b shows just a few of the conceptions of a more expert student. (A full representation of the student's conceptions would take many pages.) Figure 6.6 highlights that the novice has fewer concepts in long-term memory, and their concepts are also less richly interconnected.

- There are many fewer concepts in the novice's conceptual structures than in the expert's novice structures. The novice knows only a few types of poetry, and only two components of poems. The expert knows many, many more.
- The novice's ideas are organized in a very rudimentary hierarchy. There are fewer categories along which the novice's ideas are organized. "Funny poems" are categorized together with "haiku" and "poems that rhyme" as different types of poems, even though these do not seem to belong together coherently in the same group. Concepts are arranged in a flat hierarchy, with only two levels. In contrast, the expert's ideas have a much richer hierarchical organization, and similar concepts are grouped appropriately together.
- The novice's concepts are interconnected with few links. The expert's ideas have many links connecting them. To avoid overwhelming Figure 6.6b with lines, only a very few of these links are shown in red. The expert knows, for example, that similes and metaphors can foster imagery and that similes and metaphors are closely related. The expert knows which elements of poems are present in sonnets. The red lines shown in Figure 6.6b are only the beginning. The expert is aware of dozens or even hundreds of interrelationships among the concepts shown in the diagram.

On most topics they learn in school, students are initially novices. A goal of instruction is to help novices develop the richer and better organized conceptual structures of experts (Chi, 2006a).

Organization by Surface Similarity

In addition to having fewer concepts with fewer interconnections than experts, the novice's concepts are organized differently from experts'. Specifically, novice's concepts are organized by *surface similarity*, whereas experts' concepts are organized by *deep similarity* (Chi, 2006b; Chi, Feltovich, & Glaser, 1981). **Surface similarity** is similarity based on external appearances. A real beagle and a realistic-looking and feeling toy stuffed beagle are similar at the level of surface similarity. They both look and feel the same on the outside. **Deep similarity**, on the other hand, is similarity based on important underlying relationships that lie beneath external appearances. Deep similarity is similarity at a level of important conceptual relationships even when surface similarity is low. At a level of deep similarity, a living beagle is more similar to a living fish than it is to a toy beagle, because a real beagle and a fish turtle share an underlying, deep similarity of being alive. This is true even though the living beagle and the living fish do not look similar, and hence do not have a high degree of surface similarity.

Novices tend to organize their knowledge by surface similarity, whereas experts tend to organize by deep similarity. For example, preschool children are novices on the topic of kinship relationships (the relationships among mothers, fathers, sisters, brothers, uncles, aunts, and so on). As novices, they often classify kin by surface similarity. Consider the three people depicted in Figure 6.7. Many preschool children will say that Jim and Bob are Sarah's uncle, because both Jim and Bob *look* like typical uncles, even though Bob is only a friend of the family. They do not think that Sam can be an uncle because Sam does not look like an uncle; he is far too young. In contrast, adults are experts on kinship relationships, and they classify Sam and Jim as Sarah's uncle because both are Sarah's father's brothers. The adult classifies people into kin categories based on underlying family relationships, not surface appearance (Keil, 1989).

Figure 6.7: Which are uncles?

This figure has three photos of males.

The first male is middle aged and has a graying beard. Its caption says: Bob is Sarah's father's friend.

The second male is a teenage boy. Its caption says: Sam is Sarah's father's brother .

The third man is middle aged and has graying hair and a moustache beginning to turn gray. Its caption says: Jim is Sarah's father's brother.

When students are begin to learn to solve problems in areas such as arithmetic, chemistry, or physics, they organize their knowledge as novices do, by surface similarity. Experts organize knowledge by the underlying principles of how to solve the problems. Consider the following simple arithmetic problems.

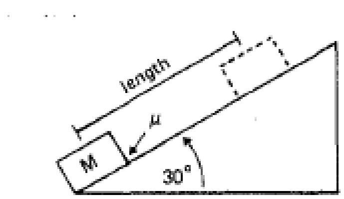
#1. Julio has 3 apples, and then his mother gives him 8 more. How many apples does he have now?
#2. Shelby had 11 dollars but spent 6 dollars to buy a CD on sale. How many dollars does he have now?
#3. Nadia gave 7 of her 9 oranges to her brother. How many oranges does Nadia have now?
#4. Pam has saved 5 dollars, and now she earns 4 dollars by doing her chores. How many dollars does she have now?

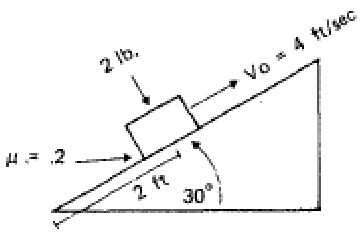
An expert (anyone very familiar with arithmetic problems) would typically classify these problems according to the deep similarity of how to solve the problems: #1 and #4 are similar because both are solved using addition, and #2 and #3 are similar because they are solved using subtraction. In contrast, a typical novice would classify these problems by surface similarity: #1 and #3 are similar because they are about fruit, and #2 and #4 are similar because they are about money. The expert immediately focuses on the underlying solution procedure. The novice has more trouble getting beyond the surface level of the story.

Figure 6.8:
Classifying physics problems

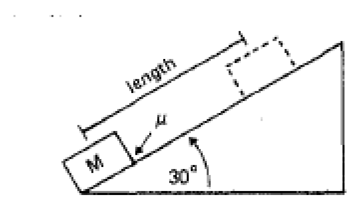
This figure presents three of the figures from Chi's well-known study on expert-novice differences in solving physics problems.

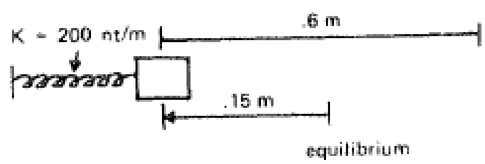
Novices grouped the problems associated with these diagrams together because both problems involved blocks on a ramp.





Experts grouped the problems associated with these diagrams together because both problems are solved using the idea of conservation of energy.





From (Chi et al., 1981)

In the early stages of learning to solve problems in an area, students at any age are prone to organize problems based on surface similarity rather than deep similarity. It can take a very long time to shift from novice organization to expert organization. Cognitive scientist Michelene Chi has found that university students who have earned A's or B's in university physics courses classify physics problems as novices do—by surface similarity. In a famous study, students were asked to classify physics problems involving forces and motion (Chi et al., 1981). The undergraduates classified problems based on surface similarity—problems with ramps were groups together in one group, problems with pulleys were grouped together in another group, and so on (see Figure 6.8). In contrast, experts (physics professors) classified problems according to the solution procedure needed to solve the problems. For instance, a ramp problem and a spring problem were classified as similar both are solved using Newton's Second Law. It is important to note that the undergraduates were still thinking as novices despite very successful completion of a physics course on forces and motion. The shift from novice to expert organization of conceptions can take years, even many years.

Implications for Instruction

One instructional implication of research on novice conceptions is that teachers should help students notice deep similarities between problems and not just surface similarities. One way to do this is to ask students to reflect on similarities between problems that are different at the surface level. For example, a fourth grade teacher could ask students what these two problems have in common:

#1. Julio has 3 apples, and then his mother gives him 8 more. How many apples does he have now?

#4. Pam has saved 5 dollars, and now she earns 4 dollars by doing her chores. How many dollars does she have now?

This question would encourage students to notice that despite the fact that one is about oranges and the other about money, the two problems are fundamentally similar because both solved by addition. The teacher can then encourage students to contrast these problems with a third problem that requires subtraction. By comparing and contrasting problems, students can learn to identify ways in which problems are similar at a deep level.

Problem 6.5. Understanding students' thinking. A ninth grade language arts teacher is teaching his students about the structure of arguments. He gives students the following arguments to compare and contrast.

1. *Andreas's paper.* We ignore global warming at our own peril. Glaciers are melting. The temperature is gradually rising. The ice caps are diminishing. We may be reaching the tipping point, and if we do not act now, it will be too late. Global warming is a big problem, and we need to take steps to try to stop it.	2. *Michelle's paper.* Global warming is accelerating, and we need to do something about it. Core samples from Greenland ice show a large increase in temperature over the last 100 years. Some have argued that there was a decrease in temperatures from 1940 to 1960, when the industrial gases were rapidly increasing, but you have to look at long-term trends, and the longer trends show an increase. Also, many glaciers have disappeared or decreased by half or more.

Here are several statements written by students. Which are more typical of novices, and which are more typical of experts. Explain your answers.

#1: Both papers are about global warming. Michelle's paper is longer.

#2: The first paper has more pieces of evidence, but it doesn't talk about the source of the

evidence at all. The second one tells the source of the evidence (ice core samples).
#3: The second paper talks about a counterargument, and it rebuts the counterargument. The first paper doesn't do this.
#4: The papers are about global warming. They both think that something should be done about global warming. They both talk about glaciers.

Response:
Student #1 mentions only surface characteristics of the essays; this is characteristic of novices.
Student #2 refers to evidence and sources. These are not mentioned explicitly in the essays; Student #2 is aware of these deeper categories of argumentation because she is more expert about the structure of argumentative essays.
Student #3 refers to counterarguments and rebuttals—also indicative of understanding the deeper structure of argumentative essays, and more characteristic of experts.
Like Student #1, Student #4 makes no reference to argumentation categories that are not explicitly mentioned in the essays. He refers only to more surface-level features of the essays (topic is global warming; both talk about glaciers).

CONCEPTUAL RESOURCES

Conceptual resources are the fourth type of prior conception. Even when students lack prior schemas or have strong alternative conceptions or strong novice conceptions, they will almost certainly have some conceptions that teachers can draw on to help them learn the new ideas (Hammer, 1996; J. P. Smith, III, diSessa, & Roschelle, 1993/1994). We call these conceptions **conceptual resources** because they are ideas that students can use to build new knowledge. There are four types of conceptual resources that are often useful to help students build new conceptions: *knowledge of relevant evidence*, *conceptions from previously learned topics*, *conceptions derived from prior experiences*, and *conceptions about analogical situations*.

Knowledge of Relevant Evidence

Sometimes students who have an alternative conception may be aware of evidence that is contrary to their own conception. This evidence may help them realize that their conception is in error. Knowledge of relevant evidence is especially helpful in promoting a change in beliefs. For instance, when asked how cells let substances in through their membrane, some middle school students say that the cell can identify what chemicals should be let in, and then it allows only those "good" chemicals to enter (Dreyfus, Jungwirth, & Eliovitch, 1990). However, this conception is contradicted by a piece of evidence that most students know about—namely, that poisons sometimes get into cells. When students come up with the alternative conception that cells can identify which chemicals should be let in, they do not notice that their idea is inconsistent with what they know about poisons. Teachers can help students start to build new ideas by reminding them of evidence that they know about—in this case, that poisons sometimes enter the cell.

Conceptions from Previously Learned Topics

When students are learning about a new topic, they may have conceptions about related, earlier-learned topics that can help them learn that new topic. We have seen that many third graders have alternative conceptions of the earth's shape. What related topics have students learned about that can help them learn about the earth's shape? Most third graders have some ideas about planets and moons that teachers can build on (Skopeliti & Vosniadou, 2007). Specifically, most third graders know that there are planets and moons, that planets and moons are round and solid, that they travel in circles in space, and that they rotate. They just do not think that the *earth* is one of these bodies. Students' previously learned conceptions about planets and moons are conceptual resources that teachers can build upon. The teacher can build on these ideas by explicitly explaining to students that the earth that we live on is a planet like the other planets. Even if students do not yet fully understand why people do not fall off the bottom of the earth, they will begin to understand that the adult idea is that the earth is flying through space around the sun like the planets. They will begin constructing ideas that are on the right track.

Conceptions Derived from Previous Experiences

When students are having difficulty learning a topic, teachers can often draw on students' out-of-school experiences to help them understand a topic (Clement, Brown, & Zietsman, 1989; J. P. Smith, III et al., 1993/1994). Students have many experiences at home, in sports, and in their community that are relevant to many school topics.

For example, to help students understand the difficult idea that increased demand causes prices to rise, teachers can capitalize on students' own experiences with buying and selling things. Imagine that a teacher asks a class of high school students what would happen if a student who had a very outdated video game tried to sell it to her classmates. Students agree that no one would pay very much for it; the teacher points out that this is a situation in which demand is low. Then the teacher asks what would happen if the same student offered to sell a brand new video game that everyone in the class was eager to have. This time, students agree that if one student offered to pay the store price, others would offer to pay a little more, gradually bidding up the price due to the high demand. By developing an example that builds on students' understanding of familiar products in a familiar setting, teachers can help students construct an understanding of the relationship between price and demand.

Conceptions about Analogical Situations

A fourth kind of conceptual resource that can help students understand difficult topics is conceptions about **analogical situations** (Glynn, 2007; Yerrick, Doster, Nugent, Parke, & Crawley, 2003). An analogical situation is a situation that is superficially dissimilar to a target situation but similar in some other important ways. For example, consider middle school students learning about cell organelles (nuclei, the membrane, mitochondria, chloroplasts, and so on). The students are completely unfamiliar with cells and their organelles, so the teacher helps them by describing an analogical situation. She explains that in some ways, cells are like cities, and the organelles are like different parts of the cities. Mitochondria (the powerhouse of the cell) are like energy plants. The nucleus is like the town hall, where the government makes decisions. The membrane is like a city wall that surrounds the city. The teacher has endeavored to help students learn about unfamiliar target conceptions by drawing on their conceptions about cities as an analogous situation. Cities are superficially very different from cells; in reality, a city looks nothing like a cell. But there are certain important similarities (even though power plants look nothing like mitochondria, they have a similar function of producing energy) that can help students use their ideas about cities to help them build knowledge about cells.

The process of making connections between the analogical situation to the target situation is called **analogical mapping**. For example, here are some of the ideas that can be *mapped* from the process of energy production in power plants to the process of energy production in mitochondria. Mapping means that ideas from one situation are placed in correspondence with related idea from the other situation. For example:

- The idea that there are *inputs* to a power plant (*natural gas and oxygen*) is mapped to the idea that there are *inputs* to the process of respiration in mitochondria (*glucose and oxygen*). The particular inputs are different, but both power plants and mitochondria have inputs.
- The idea that there are *outputs* from a power plant (*energy, water, and carbon dioxide*) is mapped to the idea that there are *outputs* from the process of respiration in mitochondria (*energy, water, and carbon dioxide)*. Unlike with the inputs, this time the outputs are the same in the two processes.
- The idea that energy production occurs *inside the power plant* is mapped to the idea that energy production occurs *inside the mitochondrion.*

Some elements must be changed during the mapping. For example, "natural gas" is used as an input in some power plants, but the corresponding input in cellular energy production is glucose.

When using analogies, there is a danger that students may map ideas incorrectly so that the analogy causes students to form alternative conceptions. For example, students learning about the power plant-mitochondria analogy might mistakenly map these ideas.

- The idea that power plants also release pollution into the air and water might mistakenly be mapped to mitochondria, yielding the idea that mitochondria release pollution into the cell. This would be an error, because there is no counterpart to pollution production in the activities of mitochondria.

Thus, it is important to help students make correct mappings and avoid incorrect mappings when using analogies (Glynn, 2007).

Problem 6.6 Designing instruction.

When students of any age are learning to write persuasive essays, they typically fail to consider arguments against their position. Students have a real bias against thinking about the other side of a question. For example, a student may write, "Schools should not be held all year round because students need a break so that they can relax" without thinking about counterarguments such as "Students forget a lot over the summer when they get the summer off, and this slows their learning down." How can teachers encourage students to consider counterarguments when writing persuasive essays? What conceptual resource can teachers draw on?

Response: There are many possible responses to this question. The response here was provided by a middle-school teacher I have worked with in recent research. This teacher identified a conceptual resource in students' personal experiences. She noticed that even though her students seldom considered counterarguments when they wrote essays, there was one context in which her students did regularly consider counterarguments: when they were trying to persuade their parents to give them permission to do something such as sleep at a friend's house. In this situation in their everyday lives, students regularly anticipate their parents' counterarguments and take their parents' counterarguments into account when they make their arguments. For example, when they argue that their parents should let them sleep over at a friend's house, they anticipate their parents' potential counterarguments ("you can't sleep over because you have to get up early tomorrow morning") and try to undermine these potential counterarguments in their own arguments ("If you let us go, we promise to go to bed early!"). In this way,

> *students' ability to argue successfully in one situation (persuading their parents to give them permission to do something) is a conceptual resource that teachers can use to help students learn to argue successfully in a different situation (writing better persuasive essays).*

Implications for Instructions

On topics that are difficult because students lack schemas or have alternative conceptions, it is critical for you as a teacher to identify and use students' conceptual resources. As you teach year by year, you should aim to identify more and more conceptual resources that will help you build on students' current ideas. When you begin teaching, a very valuable source of information about useful conceptual resources will be your colleagues. In effective schools, teachers share information about how to teach difficult concepts (Ma, 1999); much of this information consists of ideas students have that teachers can productively build on.

CONCEPTIONS ABOUT LEARNING AND ABOUT KNOWLEDGE

The fifth type of prior conception affecting learning consists of conceptions about learning and knowledge (Hofer & Pintrich, 1997; L. Mason, 2003). **Conceptions about learning** are people's conceptions about how they learn. They include conceptions such as "I learn best by saying things over and over" or "I learn more if I can talk about my ideas." **Conceptions about knowledge** are conceptions are about the nature of knowledge (such as how complex or how certain knowledge is) and how we know that our knowledge is true. Conceptions about the nature of knowledge include ideas such as "I believe that most topics I learn in school are quite simple" and "I believe that scientific knowledge is absolutely certain." Conceptions about how we know that our knowledge is true includes ideas such as "I can be sure something is true only if I have some personal experience that proves it to me" or "I know science is true because the textbook says so." Conceptions about learning and about knowledge are also called *beliefs* by many researchers because they people often seem to have strong beliefs about these topics. Following the use of many current researchers, we will use the terms *beliefs* as well as the term *conceptions* in this section.

Conceptions about Learning

Conceptions about learning influence how students learn by influencing the strategies that students use to learn or the amount of effort that students will exert to learn. **Availing conceptions** are conceptions that facilitate learning; **nonavailing conceptions** are conceptions that tend to impede learning (Muis, 2004). In this section, we consider three availing and nonavailing conceptions about learning.

Learning is quick. Some students believe that many or most topics they learn can be learned very quickly. This conception is a nonavailing conception; students who think that learning is quick tend to learn less (Chinn, in press-c; Muis, 2004). They tend to give up quickly if they do not understand something right away. They expect that if something cannot be learned quickly, it cannot be learned at all, so there is no point trying to learn it. In contrast, students who believe that learning often takes time are more likely to exert the effort and spend the time needed to learn complex material.

Rote memory is an effective learning strategy. In chapter 2, we learned that effective learners use active learning strategies such as elaboration, explanation, and visualization. Effective learners do *not* simply try to rote memorize material. However, many students believe that rote memorization is an effective learning strategy, such as a foreign language student who studies vocabulary simply by reading words over and over. A belief that rote memory is effective tends to impede learning (Chan & Sachs, 2001) as students fail to use the more active, elaborative strategies that are more conducive to learning, such as studying vocabulary using the keyword method or by trying to actively use words in meaningful sentences.

Ability is fixed. Students vary according to whether they believe that ability is fixed or changeable. Students who believe that ability is fixed believe that their ability is innate and cannot be changed. Students who believe that ability is changeable believe that they can improve their ability by studying harder and learning more.

The belief that ability is fixed is a nonavailing belief; the belief that ability is changeable is an availing belief (Dweck, 2002). To see why, let's consider two middle school students, Kevin and Jeffrey, who have different beliefs about writing ability. Kevin thinks that writing ability is fixed and unchangeable, because it is innate. Kevin may be highly motivated to engage in writing tasks as long as he is doing well. But if he gets D's on two consecutive essays that he has written for English class, he may take this D as evidence that his writing ability is not high. There will be no reason for him to work harder, as he believes he simply lacks writing ability.

Jeffrey, on the other hand, believes that ability can be changed. For instance, he thinks that if he doesn't have the ability to write very well right now, he can learn to write better by learning strategies that will make him a better writer. If Jeffrey gets two consecutive D's on essays, he responds by working hard and seeking help from his teacher, because he believes that he can improve with help and effort. As s consequence, he strongly improves his writing, and he concludes—appropriately—that he has increased his writing ability. Thus, a belief in fixed ability impedes learning, whereas a belief in changeable ability enhances learning.

Conceptions about Knowledge

Students' conceptions or beliefs about knowledge are also called epistemological conceptions or beliefs, because epistemology is the branch of philosophy that examines knowledge. Philosophers who specialize in epistemology study issues including what counts as knowledge, how certain knowledge is, and how we justify saying that "we know" something. Ordinary people's **epistemological beliefs** are people's beliefs about these same issues. We will discuss several areas of availing and nonavailing epistemological beliefs below.

Complexity of knowledge. Students who believe that *knowledge is **complex*** believe that ideas learned in school such as molecular theory, economics, historical periods, and calculus are complex bodies of knowledge. Students who believe that *knowledge is simple* believe that these ideas are simple and straightforward--that there are only a few things to learn in order to master these ideas. Researchers have found that students who report believing that knowledge is complex learn more when they are studying and write more complex essays than students who think that knowledge is simple (Chinn, in press-c; L. Mason, 2003). This is because most bodies of knowledge to be learned are indeed relatively complex, and an expectation that the knowledge will be complex prepares learners to exert the needed effort and use the cognitive strategies needed to master complex material.

Certainty of knowledge. The **certainty** of knowledge refers to the extent to which knowledge can be viewed as true, unconditionally and without any question. Scientists that scientific knowledge is never certain because we may develop better theories on any topic in the future. On the frontiers of knowledge, where research is active, knowledge may be highly uncertain. Research on the effects of cholesterol is a good example. Studies often yield conflicting results, and it can take years to gain a full understanding of how different kinds of cholesterol affect health.

Students vary in the extent to which they think that knowledge is certain or uncertain. A belief that knowledge is uncertain is an availing student belief. For example, students who think that knowledge is certain are less likely to understand and remember two different arguments on a position than students who think that knowledge is not certain. In contrast, students who believe that knowledge is certain have difficult learning topics in which there is disagreement and controversy (Chinn, in press-c). They may be confused by why there are different positions presented, and they just want to be told the "right answer."

Justifications of knowledge. The **justification of knowledge** is the grounds on which we believe that a claim is true (Hofer, 2000; Hofer & Pintrich, 2002). Why do we believe that atoms exist? Why do we believe that colonial opposition to the British policy of taxation without representation was a cause of the American Revolutionary War? Why do we believe that stereotypes can be harmful to individuals? The answers to these questions are our grounds for believing what we believe. For example, a student might believe that stereotypes are harmful to individuals based on *authority* (my psychology professor said so, and I believe she is an authority on this subject), based on personal experience ("I have personally experienced the negative effects of people's stereotypes about me"), or based on evaluation of arguments ("I have considered arguments on both sides of this questions, and I think that overall, the evidence supports the idea that stereotypes are harmful"). Several common student conceptions of how knowledge is justified are summarized in Table 6.7 (Hammer & Elby, 2002, 2003; Hofer, 2001).

Table 6.7
Common conceptions of how knowledge is justified

Type of justification	Definition	Examples
Authority	A student believes an idea because a trusted person (including a textbook author) says that it is true.	Jennifer believes molecular theory because the textbook says matter is made of molecules. Doug believes that the Vietnam War could have been won because her father says so.
Inference from other knowledge	A student believes something by drawing inferences from other ideas that are known.	Fatima derives a new geometric principle through mathematical proof from other, more basic principles. Max infers that whales must bear live young based on his other knowledge that whales are mammals.
Intuition	A student believes that something is true because he just feels that it is true.	Isabelle believes that flash cards are a good way to study vocabulary because she just knows it. There's no need to give any further reason.
Personal experience	A student believes something based on her own life experiences. Personal experiences can include one's own observations of the world.	Kylie believes that sexism exists based on her own experiences of being treated in a sexist manner. Toby believes matter is conserved because of experiments in class that showed that the amount of matter stayed constant through all kinds of physical and chemical changes.
Empirical evidence	A student believes an idea because others (e.g., scientists, social scientists, historians) gave gathered data that show it is true.	Rachel believes that eyewitness testimony is not very trustworthy because of psychological experiments she read about in her high school psychology class. Augustin believes that global warming is occurring based on some recent data his teacher showed to his science class.
Evaluation of	A student believes that an	Brayden has examined evidence and arguments for and

opposing arguments and/or evidence	idea is most likely to be true because, although there are arguments for and against the idea, the arguments for it are stronger.	against the Adkins diet and has concluded that it would be dangerous to his long-term health to follow that diet. Ivana has listened to arguments for and against current U.S. Middle East policy and has concluded that a drastically different course is needed to enhance U.S. security.

Sources: (Hammer & Elby, 2002; Hofer, 2000; Hofer & Pintrich, 2002):

Among the conceptions about justification in Table 6.7, one conception that appears to be nonavailing is the conception that knowledge is justified based on authority. Students who take knowledge to be based on authority seem to gain a more superficial understanding of what they are learning. The process of deciding whether an idea makes sense based on one's own knowledge and experiences may help students understand new ideas more deeply, and it also encourages more active cognitive processing.

In contrast, the conception that knowledge should be justified based on evaluation of arguments appears to be an availing conception about epistemology (Kuhn & Weinstock, 2002). Students who believe that they should evaluate arguments on each side of a question are better prepared to learn the complexities of real-world topics, many of which are controversial and have arguments on two or more sides to consider.

Variation in Students' Epistemological Conceptions. Students' epistemological conceptions can vary from subject to subject (Muis, Bendixen, & Haerle, 2006). A student may believe that knowledge of mathematics is certain and based on authority, whereas scientific knowledge is uncertain and grounded in empirical observations of scientists. Epistemological conceptions can also even vary from topic to topic within the same subject (Louca, Elby, Hammer, & Kagey, 2004; Rosenberg, Hammer, & Phelan, 2006). A history student may believe what she is taught about the Revolutionary War based on the authority of the textbook and the teacher, but when the class discusses the Iraq War that began in 2003, she may insist on evaluating arguments herself before deciding what is true.

Implications for Instruction [B—HEAD]

The central implication of research on students' conceptions about learning and knowledge is that teachers should encourage students to adopt availing conceptions and abandon unavailing conceptions. For example, teachers should encourage the conceptions that learning takes time and that knowledge is often complex and uncertain because these conceptions facilitate learning of many school topics. In later chapters, we will learn many instructional techniques for promoting availing beliefs in the chapters on motivation, promoting self-regulated learning, and inquiry environments.

One basic technique that teachers can use to promote more availing epistemological conceptions is to straightforwardly direct students to different kinds of justifications. In one study by learning scientists Seth Rosenberg, David Hammer, and Jessica Phelan, an eight-grade earth science teacher assigned students to develop an explanation of the rock cycle. The teacher noticed that one group of students was developing their explanation based on the textbook, but they had a poor understanding of what the textbook said, and they were essentially copying ideas without understanding them. She encouraged them to shift from a conception of justification based on the authority of the textbook to a justification based on their own knowledge by saying, "You're looking at a lot of papers and using a lot of words that you don't know what they mean…. And if you're doing that, for your [explanation], it's not going to be very good. So, I want to start with what you know, not with what the paper says." (Rosenberg et al., 2006, p. 272)

Although one student immediately responded, "Well, then we don't know anything!" other students started generated ideas that they *did* know—that lava comes out of volcanoes and hardens, that volcanoes erupt and lava shoots out, that lava cools to become rock, and that wind and water can chip away at that rock during erosion. They continued to build on their own knowledge instead of trying to copy ideas from the book, and as a result they developed a much deeper understanding of the rock cycle. The improved learning was triggered directly by a teacher encouraging them to shift from an epistemology based on authority to an epistemology based on drawing inferences from their own knowledge.

FINDING OUT ABOUT STUDENTS' PRIOR CONCEPTIONS

A core theme of this chapter is that it is vital for teachers to understand their students' prior conceptions. If teachers are aware of what their students' prior conceptions are, they will design better instruction. Despite the great benefit to teachers of finding out about their students' prior conceptions, many teachers do this much less than they should (Morrison & Lederman, 2003). New teachers are particularly unlikely to find out about students' prior conceptions and thus unlikely to develop instruction that takes prior conceptions into account (Meyer, 2004). More experienced, expert teachers know much more about students' prior knowledge, which enables them to find ways to adapt instruction effectively (Meyer, 2004).

How can teachers find out about their students' prior conceptions? The techniques teachers can use include:

- Administer pretests at the beginning of a unit to assess students' prior conceptions.
- Talk with or even interview students in informal settings (after school, during down time in class).
- Hold class discussions with questions about students' ideas on a topic.
- During small group work, talk with groups of students about their ideas on a topic.
- To evaluate conceptions about learning and epistemology, administer questionnaires that researchers have developed and that teachers can administer in their own classrooms. (Several examples are included in online resources.)
- Read research that describes common alternative conceptions, common novice conceptions, and conceptual resources that can be drawn on to teach various topics.

It is important not to overlook the last technique—reading research. There are many hundreds of studies by researchers investigating students' prior conceptions, and these studies yield many insights that teachers would never be able to uncover all on their own. Books are available that summarize important research on alternative conceptions (e.g., Barrett & Buchanan-Barrow, 2005; Rosalind Driver, Squires, Rushworth, & Wood-Robinson, 1994; Vosniadou, in press).

As teachers ask questions to find out what their students are thinking, it is important that they ask questions to which students have not already memorized the answers. Asked what water is made of, most upper elementary and middle schools students who have started learning about matter will answer the word they have memorized, "molecules." But the student may mean that molecules are tiny drops of water or that molecules are lumps of clay surrounded by water. If the teacher asks questions that require students to think more creatively, she can get a better idea of what their real conceptions are. For example, in this exchange, the teacher asks questions that clarify what one of her fifth grade students thinks molecules are.

The conversation:		Commentary:
Teacher:	You said that water is made of molecules. Is it possible to divide water molecules in half?	Here is the first question that requires the student to think.
Sophie:	Yeah.	
Teacher:	What would we get?	
Sophie:	The water would come out and get in the other water.	This answer shows that Sophie is not thinking of molecules in the same way that the teacher is.
Teacher:	How would the water get out?	The teacher now follows up to find out what the student means. The answers reveal that the student thinks that water molecules are little shells filled with water, and there is more water between these shells, which float on all this water. Now the teacher has a much better understanding of Sophie's ideas.
Sophie:	The little shell would crack.	
Teacher:	And what do you mean by "the other water."	
Sophie:	All the water that is *between* the water molecules. The molecules float in all the other water.	

When teachers ask questions to assess prior conceptions, the questions should require students to think so that they cannot give rote responses.

When teachers strive understand their students' conceptions, they assume the role of an intent *listener*--both literally and figuratively (Ballenger & Rosebery, 2003). Literally, they listen attentively to what their students say, reflecting on the meanings that might lie behind the students' comments. Figuratively, teachers "listen" to their students when they read students' written work. As teachers read students' papers, they look for clues to how their students are thinking. An error on a written quiz is no longer just an error; each error gives the teacher a window into students' thinking, and this window enables teachers to begin to see what their students' conceptions are.

In their role as listeners, teachers are also alert to surprising things that students say or write. Suppose in a social studies discussion, a student, Anna, says, "The British would have been mad that all the people in the Unites States wanted to make their own country." On hearing this, the teacher notes several possible implications of what Anna said. First, Anna speaks of the people "in the United States." Is this a slip of the tongue, or does Anna really think that the United States already existed, even before the Revolutionary War? If so, what does Anna think the war was about? In addition, the sentence indicates that Anna mistakenly thinks that *all* people in the colonies were for independence. Perhaps Anna thinks more generally that all people in a country support a country's wars. The teacher cannot know right now which of these possibilities is correct and which is not. The teacher will need to follow up later with other questions to find out more about the ideas of Anna and her classmates. The teacher can also encourage students to ask their own questions, which can give her further insights into their thinking. If Anna asks why the colonists needed their own country when they were already part of the United States, the teacher will know that Anna has an alternative conception that the colonies were already a nation prior to the Revolutionary War.

In short, an effective teacher listens for student statements and questions that might indicate alternative conceptions or conceptual resources and makes some conjectures about what those conceptions might be. Then, the teacher follow ups on these conjectures by asking more questions in formal pretests, in class discussions, in discussions with groups during group work, or with individual students out of class.

EXTENSIONS

In the final section of this chapter, we discuss how the ideas of this chapter apply to children of differing ages, to children of different cultures and languages, and to students with learning disabilities.

Development

The ideas in this chapter are generally applicable to students of all ages. Students of all ages have consistent conceptions, alternative conceptions, novice conceptions, conceptual resources, and conceptions about learning and knowledge.

One form of knowledge for which there is a clear developmental trend is in novice conceptions. Young children are novices on nearly every topic. Thus, teachers of young children can expect to see novice conceptions on many topics that they discuss. This is not to say that young children are never experts on any topics; some five-year olds, for example, develop expertise on topics such as dinosaurs. But as children grow older, they slowly take steps on the road to expertise on more and more topics.

Another area in which developmental trends occur is in conceptions of learning and knowledge. Older learners are more likely to be aware of active learning strategies than younger learners (Flavell, 1999, 2004). On the other hand, as children get older, they are more likely to adopt a fixed view of ability, especially on activities at which that they are not proficient (Freedman-Doan et al., 2000). This suggests that as students get older, teachers need to work especially hard to help students understand that they can overcome difficulties and succeed even on activities that they are currently less successful at.

Much research supports the idea that there is a developmental trend in epistemological conceptions (P. M. King & Kitchener, 1994; Kuhn, 2002; Kuhn & Weinstock, 2002; W. Perry, G., Jr., 1999).

According to developmental psychologist Deanna Kuhn and her colleagues (Kuhn & Weinstock, 2002), young children (around 3 years old) have a **realist** epistemology. Whatever people say is exactly the way reality is. It is not possible for a person to say something that is not true. These children have not yet developed the idea that statements can be false--either intentionally (lies) or unintentionally (errors).

By the age of 5 or so, children become **absolutists.** They now believe that knowledge is absolutely certain, and any statement that is not right is wrong. Reality is directly knowable just by observing it. If two people disagree, it means that one is right, and the other is wrong.

The next level is the **multiplist** level, in which students think that multiple ideas can be equally correct. No longer is there an absolute, knowable right and wrong. If two people have different ideas, then they each have their own opinion, and it is not possible to say that one is right and one is wrong. There is no way at all to justify any general knowledge that is true for more than just one person. Some research suggests that multiplist conceptions emerge after high school, though other research suggests that some high schoolers adopt a multiplist stance.

Finally is the **evaluativist level**. At this level, students do not think that one opinion is as good as another. Rather, a statement can be evaluated by considering arguments and evidence for and against it; these students take the view that knowledge is justified on the basis of evaluating arguments on different sides of a question and deciding which arguments are strongest. Reality cannot be *directly* known. One cannot directly see entities such as atoms and stereotypes. Instead, one can only infer the existence of such entities from the available evidence. Some research suggests that the evaluativist stance may be relatively rare, even among adults.

Cultural and Linguistic Diversity .

Students' cultural and linguistic backgrounds are an important source of consistent conceptions, alternative conceptions, and conceptual resources. Teachers can learn more about students' prior conceptions by gaining an understanding of their cultural and linguistic background (Cazden, 1988; Nieto, 2004).

For example, consider an immigrant high school student from Japan who has learned in Japan a way of writing creative essays that differs strikingly from what her American teacher is trying to teach her. In Japanese writing, a mark of good writing is that the author include a digression on a tangential topic at one point in the essay. This practice conflicts with the American teacher's insistence, based on norms for writing essays in English, that everything in the essay should be tightly organized and on topic. This Japanese student has an alternative conception about writing—a conception perfectly acceptable within Japanese literary norms but at odds with English literary norms. If the teacher understands this aspect of Japanese culture, she will understand the student's alternative conception. Then she will be better able to work with this student to help her understand that norms for writing in Japanese and English are different.

Students' cultural background can be a source of consistent conceptions on school topics. Consider a high school class reading Ralph Ellison's novel *The Invisible Man*, which describes events in the life of an African-American man. African-American and other minority students are likely to have prior experiences with racism that will help them make sense of the ideas expressed in the book. In other words, they have consistent conceptions that will facilitate their understanding. The astute teacher can use these students' prior experiences as conceptual resources that can help *other* students in the class understand the book. By having students elaborate on their experiences so that students who have not had such experiences gain a deeper understanding of racism, the teacher helps other students gain a deeper understanding. When one student relates her experiences, these experiences can serve as conceptual resources to help other students understand the novel better.

Students with Learning Disabilities

Like typical students, students with learning disabilities will have all the kinds of conceptions that we have discussed in this chapter—consistent conceptions, alternative conceptions, novice conceptions, conceptual resources, and conceptions about learning and knowledge. On some of these topics (alternative conceptions, conceptual resources, and conceptions about knowledge), there is not yet a great deal of research with students with learning disabilities (Ferretti et al., 2007; Franklin-Guy, 2007). Three potential differences between students with learning disabilities and typical children are as follows:

- As we have learned, students with learning disabilities often exhibit less integration among their conceptions (M. Friend, 2004; Geary, Hoard, & Hamson, 1999; Swanson, Cooney, & McNamara, 2004). Their conceptions are more likely to be poorly interconnected. Poorly interconnected conceptions are the hallmark of both novice conceptions and of fragmented alternative conceptions. Hence, students will learning disabilities may be especially likely to have novice conceptions and fragmented alternative conceptions.
- On at least some topics, directing students to activate prior consistent conceptions may be less effective with students with learning disabilities than with typical students (Pflaum, Pascarella, Auer, Augustyn, & Boswick, 1982). One reason for this may be that students with learning disabilities are less likely to have coherent consistent conceptions that they can use to understand new topics.
- It is especially important for teachers to pay attention to the ability beliefs of students with learning disabilities. If students with learning disabilities have received messages from previous teachers, classmates, or others that they lack the ability to learn effectively, they may come to believe that their ability is fixed at a low level. It is important for teachers to convince these students that they are fully capable of changing their ability through effort and study.

In general, listening carefully to find out the prior conceptions of students with learning disabilities will help teachers learn better how to address their learning difficulties. By identifying possible conceptual resources as well as areas in which learning difficulties exist, teachers can design more effective instruction for these students.

Chapter Summary

HOW DO PRIOR CONCEPTIONS AFFECT LEARNING?

-Prior conceptions can affect learning in various ways because some prior conceptions are consistent with the target conception whereas others are inconsistent with or contradict target conceptions.
-There are five types of prior conceptions: consistent conceptions, alternative conceptions, novice conceptions, conceptual conceptions, and core conceptions about learning and knowledge

CONSISTENT PRIOR CONCEPTIONS

-When students' prior conceptions are consistent with what they are learning, they learn more than when they do not have or do not use such conceptions.

Schemas

-Schemas, which are organized knowledge structures stored in long-term memory, can facilitate learning when they are accurate, but inaccurate schemas can hinder learning.

How consistent schemas affect learning

-People learn more when they have consistent schemas to help them organize new information.

-When students lack consistent schemas, fail to activate schemas, or activate inappropriate or inaccurate schemas, it hinders learning because students lack a framework to help them organize what they are learning.

Consistent prior conceptions without schemas

-People can use consistent prior conceptions to understand new situations, even when they lack a schema for the situation.

Implications for instruction

-Implications for instruction include: Teachers should help students activate prior conceptions, teach students to activate prior conceptions on their own, provide relevant instruction when students lack sufficient prior conception, and teach generally useful schemas.

ALTERNATIVE CONCEPTIONS

-Alternative conceptions are prior conceptions that are inconsistent with the teachers' target conceptions.

How alternative conceptions emerge

-Learners develop alternative conceptions because they are actively trying to make sense of what they know. Alternative conceptions frequently do a good job of explaining what learners know about the world.

Are learners' alternative conceptions coherent?

-It appears that whether or not learners' alternative conceptions are coherent depends on the topic. Even when students lack coherent alternative conceptions, these conceptions can interfere with learning.

The importance of understanding students' alternative conceptions

-It is helpful for teachers to address common alternative conceptions so as to draw students' attention to the differences between their conceptions and the target conceptions and to meet their students' needs.

Alternative conceptions can interfere with both understanding and belief

-Alternative conceptions can interfere with learning by making it difficult for students to understand new ideas or by making it difficult for them to believe new ideas, even when they understand the ideas.

Implications for instruction

-When students have alternative conceptions, learning involves conceptual change, which means that students must develop new conceptions that are very different from their current conceptions.
-Three instructional techniques that can encourage conceptual change are to provide clear, unambiguous explanations, to explicitly note common alternative conceptions, and to provide evidence.

NOVICE CONCEPTIONS

-When students are still beginners on a certain topic and hold immature conceptions about that topic, they are said to hold novice conceptions; these novice conceptions differ notably from expert conceptions.

Few concepts that are poorly interconnected

-One way in which novice conceptions differ from expert conceptions is that novice conceptions are much less extensive and interconnected than expert conceptions.

Organization by surface similarity
-A second way that novice conceptions and expert conceptions differ is that novices organize information based on surface similarity, whereas experts organize information by deep similarity.

Implications for Instruction
-Teachers can help students notice deep similarities between problems by asking students to reflect on similarities between problems that are different at a surface level.

CONCEPTUAL RESOURCES
-The fourth type of prior conception, conceptual resources, includes any prior conceptions that students have about a topic that teachers can build upon to help students learn new ideas.
-Four types of conceptual resources are knowledge of relevant evidence, conceptions from previously learned topics, conceptions derived from prior experiences, and conceptions about analogical situations.

Knowledge of relevant evidence
-Teachers can help students start to build new ideas by reminding them of evidence that they already know.

Conceptions from previously learned topics
-When students are learning about a new topic, they might have conceptions about previously learned topics that can help them learn the new topic.

Conceptions derived from previous experiences
-Teachers can also draw upon students' prior out-of-school experiences to help the understand a topic.

Conceptions about analogical situations
-Teachers can utilize analogical situations, situations that are superficially dissimilar to target situations but similar in some other important ways, can also be used to help students learn new ideas.

Implications for Instruction
-It is important for teachers to identify and use students' conceptual resources, especially on topics that are difficult for students because they lack schemas or have alternative conceptions. Each year, teachers should aim to identify more conceptual resources to help build on students' current ideas.

CONCEPTIONS ABOUT LEARNING AND ABOUT KNOWLEDGE
-Conceptions about learning are people's conceptions about how people learn, and conceptions about knowledge are conceptions about the nature of knowledge, which are also known as epistemological conceptions. Conceptions about learning and about knowledge are frequently called beliefs about learning and about knowledge. Conceptions about learning and knowledge can be availing or nonavailing.

Conceptions about learning
-Three nonavailing conceptions about how people learn are that learning is quick, that learning is a matter of rote memory rather than a matter of more elaborated strategies, and that ability is fixed.

Conceptions about knowledge
-Three nonavailing conceptions about knowledge are that knowledge is simple, that knowledge is certain, and that knowledge is justified based on authority.

Implications for instruction

-It is important for teachers to find out more about students' ideas about learning and knowledge in order to facilitate learning.
-An important part of learning should include these conceptions about learning and knowledge.

FINDING OUT ABOUT STUDENTS' PRIOR CONCEPTIONS

-Research has made clear that prior conceptions significantly affect learning, so if teachers can find out what their students' prior conceptions are, they can design instruction to facilitate learning.
-In order to find out about students' conceptions, teachers must take on the role of an active listener, really listening to what the students' ideas are in order to understand their prior conceptions.

EXTENSIONS

Development

-The ideas in this chapter are generally applicable to students of all ages.
-Young children tend to be novices on nearly every topic and increase their expertise as they grow older.
-Research also shows that there are developmental trends in epistemological beliefs, culminating in some learners in an evaluativist viewpoint.

Cultural and linguistic diversity

-Teachers can learn more about students' prior conceptions by gaining an understanding of their cultural and linguistic background.

Students with learning disabilities

-The conceptions of students with learning disabilities tend to be poorly interconnected (like novice conceptions). Students with learning disabilities may have greater difficulty activating prior consistent conceptions, and teachers should be alert for fixed ability beliefs.

CHAPTER 7
Complex Cognitive Strategies and Self-Regulated Learning

Chapter Outline	Applied goals
• **Reflecting on Student Thinking**	
• **Core theoretical concepts: Cognitive strategies, metacognition, and self-regulation** Cognitive strategies Metacognition Self-regulated learning	**What these key concepts mean.** You will learn new concepts that will become a central focus of every lesson you plan as a teacher.
• **Why are cognitive strategies important?** Comparisons of experts with novices, and of high achievers with low achievers Training studies Large-scale instructional experiments Comparisons of instruction in effective and ineffective schools Implications for teachers	**Importance of strategy instruction.** You will learn ways to make strategy instruction an important part of your curriculum.
• **Strategies for learning, problem solving, and reasoning** General self-regulation strategies Comprehension and memory strategies Problem-solving strategies Writing strategies Reasoning strategies	**Useful cognitive strategies.** You will learn a range of cognitive strategies that will be beneficial for your students to learn. You may find them useful, too, in your own studying.
• **How are students' self-regulated strategy use evaluated?** Administering self-report assessments Students' talk and written work	**Methods to evaluate students' strategy use.** You will learn about three ways to evaluate your students' strategy use. **Diagnosing students' strategy use during think alouds, group work, and class discussions.** You will learn how to interpret students' talk to diagnose their strategy use.
• **Strategy instruction: Making thinking public**	**Encouraging strategy use.** You will learn how to help students make their thinking public, which is a good way to promote strategy development in classrooms. (You will learn more about strategy instruction in Chapter 16.)
• **Extensions** Developmental changes Cultural and linguistic diversity Learning disabilities	

Reflecting on Student Thinking

In this chapter, you will begin thinking about the kinds of strategies that effective students use when they are learning. You have already learned about memory strategies in Chapter 2. In this chapter, you will learn about a broader range of strategies for learning, problem solving, and reasoning. This Reflection is designed to help you start thinking about the strategies that effective learners use, and how these strategies compare to the strategies used by less effective learners.

This Reflection shows data based on a study by educational psychologists (Chan, Burtis, Scardamalia, & Bereiter, 1992) who were interested in why some children learn more as they read text passages than other children do. They were also interested in why older children learn more from what they read than younger children do. To investigate these questions, the research team had students individually read two short nonfiction passages. The students ranged in age from first through sixth grade. Each passage had 12 sentences. One passage was about germs, and the other was about dinosaurs. Interviewers asked the students to think aloud about whatever came to mind after they read each sentence in the passage. Specifically, researchers instructed: “Say out loud everything that comes to mind as you try to learn from this statement.” After the students finished reading both passages, each student recalled everything he or she could remember from the texts and reported all of the new ideas they had learned.

Table 7.1:
Twelve students’ think aloud responses to sentences in nonfiction texts, with each student’s recall score.

Stu-dent	Text	Think aloud response	Recall score
1	Many kinds of bacteria are harmless and some are even helpful to us. Some of them fight other harmful bacteria. Others make vitamins in bodies and help us digest our food.	What are vitamins C and D?	8%
2	Before the microscope was invented, the smallest living things that people knew about were tiny insects.	I know about small insects. I know the tiny lady bugs because the lady bug can fly and it can walk. When there are two lady bugs, they fight with each other.	9%
3	Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.	Wow. Germs are stupid.	10%
4	Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.	I know that. And as soon as you have a cut, you suck on it—sucked cuts heal faster. Well, because I think you suck all the open blood that’s right there. If you go on like this, no more blood is going to come. Then you immediately put a band-aid on. A band-aid actually has three protections—a box, a wrapper, and a little strip of paper on it. Once I got such a large cut that I needed a large band-aid to cover it.	18%
5	Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.	Why do germs get into your body in three ways?	21%
6	Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.	That’s true. Germs get into your body in three ways.	22%
7	No one knows for sure why the dinosaurs died out. One theory is that the smarter, quicker mammals appeared and killed them off, perhaps by eating their eggs.	I don’t really believe that because most people say dinosaurs died because they got this really cold winter and they all died off slowly.	34%
8	Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.	So when you breathe with your nose and you get bacteria, if you eat something you get bacteria in the food, and if you have a cut, bacteria just slides into the cut.	35%

9	Harmful germs are not trying to be bad when they settle down in your body. They just want to live quietly, eat, and make more germs.	That means they don't really want to hurt you, but they just want to live quietly and eat the food you digest and all the things that could go in your stomach and they just want to get more bacteria.	37%
10	Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.	They get in through your moth and nose, and um . . . cut . . .what I am thinking is, how can they get in because the cut is so little . . . but maybe it really got in through your skin . . . so it might not be getting exactly right in.	49%
11	In the beginning dinosaurs were fairly small and weighed about 20 kilograms, about as much as a 6-year-old child.	A long time ago, people started to have a lot of hair like monkeys, but now people don't have as much hair as before. So I think dinosaurs are probably the same because they started to get bigger and bigger.	51%
12	Harmful germs are not trying to be bad when they settle down in your body. They just want to live quietly, eat, and make more germs.	I wonder if germs are intelligent. I guess not . . . maybe there's a whole new world . . . .like there's fighting going on between the good and the bad germs . . . . It's kind of neat when you think about it, 'cause to think of a whole new world inside the body."	61%

[1]The data are adapted from Chan et al. (1992, pp. 104-105, 115).

Table 7.1 presents examples from twelve of the students in the study. Each row of the table shows an example of a think-aloud response by a different student. Column 2 presents one of the sentences that the student read, and Column 3 presents the student's think aloud response to that sentence. Column 4 shows the percentage of ideas in the passages that each student recalled. The table is sorted by recall score, so that the students with low recall scores are presented first.

Classify the think-aloud responses in Table 7.1 in a way that can explain why some students recall more than others. Present a graphical analysis of your results.

The Reflection you just read is about the relationship between students' learning and the cognitive strategies they use. Researchers have found that effective students use more sophisticated strategies for reading, writing, reasoning, and solving problems than ineffective students do. In Chapter 2 (Learning Theories), you learned about some powerful strategies for promoting better memory. In Chapter 4 (Social Development), you learned about some effective strategies for social interaction. In this chapter, you will learn about cognitive strategies that you can teach your future students to dramatically improve their comprehension, problem solving, writing, and reasoning.

Because the cognitive strategies students use are a very important determinant of how well they do in school as well as in the real world, it is important that you, as a teacher, learn to evaluate your students' strategy use. Effective teachers evaluate their students' strategies so that they can best work out which strategies they should teach their students and they can check whether their instruction has been effective. In this chapter, you will learn a powerful set of tools that will enable you to evaluate the quality of your students' strategy use.

Figure 7.1 lists the specific strategies that you will learn about in this chapter. This list presents only a fraction of the many useful cognitive strategies that psychologists and educators have studied over the past several decades. We are starting with the strategies on this list because they offer great potential for improving your students' learning, problem solving, and reasoning skills. Moreover, most of you reading this chapter can probably improve your own performance in your own college courses by adding some (or many) of these strategies to your repertoire of study strategies.

Figure 7.1:
Cognitive strategies discussed in this chapter

General purpose self-regulation strategies Goal setting Self-monitoring and self-evaluation Time management Regulating motivation and interest Executive control Strategies for comprehension (e.g., for understanding texts and lectures) Monitoring understanding Repairing understanding Using text structure Summarizing Elaborating Explanation Formulating problems Problem solving strategies (e.g., for math problems, chemistry problems, some problems in social studies, etc.) Representing the problem Formulating subgoals Checking for sense Noticing commonalities and differences	Writing strategies (for writing papers of all kinds). Planning Revising Writing for the audience Reasoning strategies (for deciding what conclusions are most consistent with the available data) Generating arguments and counterarguments Evaluating evidence fairly Considering sample size Considering comparison groups Sourcing Seeking corroboration

CORE THEORETICAL CONCEPTS: COGNITIVE STRATEGIES, METACOGNITION, AND SELF-REGULATION

In this section, we will examine three core concepts: *cognitive strategies, metacognition, and self-regulation.* These three interrelated concepts will provide the framework for the specific strategies we will discuss in the remainder of the chapter. To introduce some of the strategies we will be discussing, we will begin with a brief scenario of a university student —Gisela—who is proficient at studying and who employs a variety of effective cognitive strategies.

Gisela, a proficient student, has a one-page paper due tomorrow on whether schools should administer intelligence tests. Let's look at some of the strategies that Gisela employs as she plans her study time and writes her paper. It is 6:00 p.m., and Gisela has just finished dinner, following her jazz band rehearsal. She estimates that she needs to spend 3 hours on two other classes and that she can allot three hours to write her paper. By planning her time ahead in this way, she has engaged in effective *time management*. She realizes that she does not recall all the main points she learned about intelligence testing; this is an instance of *monitoring*—the strategy of checking how well she understands the ideas she is learning. Consequently, she decides to review the parts of the text that she has forgotten and to look up some additional material on the Internet; these are instances of *repair strategies*—strategies used to fill gaps in understanding.

After reviewing relevant material, Gisela plans her paper. To help her achieve her overall goal of writing the paper Gisela breaks down the process of writing the paper into a series of *subgoals*. As she achieves each subgoal, she will be one step closer to completing her paper. She sets the subgoals of brainstorming ideas, writing a first draft, writing a second draft, and proofreading her paper. She decides to spend 40 minutes brainstorming and creating a structure for her paper, and 50 minutes writing and revising the paper. Thus, she employs the strategies of *planning* and *goal setting*. As she reviews the main points, Gisela realizes that she doesn't understand several points (she is again *monitoring*), so she rereads some material she found on the Internet (again using a *repair* strategy). When she finds her attention waning, she reminds herself that she needs to stay focused so that she can go to bed as soon as possible (this is an example of the strategy of *self-motivation*). After reading and reflecting on the arguments for and against intelligence tests, she jots down some notes on each side of the question (she thus employs the strategy of *considering arguments on both sides of a question*). She knows that she will reach a better conclusion if she doesn't make up her mind until she's had a chance to weigh the evidence on both sides (this is an instance of using the strategy of *fair-minded argument evaluation*).

At this point, Gisela is a little ahead of schedule, and she is satisfied with her progress (by evaluating how well she is doing, she is using the strategy of *self-evaluation*). Therefore, she takes a brief break (to *maintain interest and focus*). When she returns to her computer, she begins to write a paper with three arguments on her side and briefly rebuts the best two arguments on the other side. As she begins writing, she discovers halfway through that there is a more compelling way to frame her first argument, so she starts over (thus making a *major revision* of her short paper). Her second draft goes more smoothly. Although she would like to work on it a little more, she thinks that the quality is good (another instance of *self-evaluation)*. Because she must get to work on her other classes, she quickly reads the paper aloud to detect any errors and prints out her paper.

This description helps illustrate several crucial points about effective studying:

- Gisela is effectively managing her own study processes. No one is telling her what to do. She is formulating effective plans and carrying them out on her own. This is referred to as **self-regulation of learning** (Schunk & Zimmerman, 2001; Winne, 2005).
- Central to her self-regulation processes, Gisela (a) *sets her own goals and subgoals*, (b) *monitors* her progress, (c) *evaluates* whether she is achieving her goals, and (d) *makes adjustments* when there are discrepancies between her goals and what she has accomplished. For example, she makes major revisions to her paper when she realizes that she has not yet written a paper up to the standards she has set.

- She knows many *cognitive strategies* and how to use them to achieve her goals and subgoals. Some of the cognitive strategies she uses are noted in italics in the description of Gisela's evening.
- She knows when it is appropriate to use particular strategies and when it isn't. For example, she knows that the best time to brainstorm ideas is at the beginning of the writing process.
- She knows how to adapt these strategies to the particular situation; for instance, she knows that 40 minutes is ample time to brainstorm for writing this paper, whereas another paper might require a longer period of time.
- She makes judgments about whether it is *cost effective* to use particular strategies. Although she could make further revisions to the paper, she decides that because the paper is already good, it is not worth spending the time to make further revisions, so she decides just to proofread the paper before printing out the final copy.
- She can effectively *orchestrate* the use of all these strategies, so that she uses the right strategies at the right time.

This example illustrates several closely interrelated theoretical concepts that have become prominent in recent years: *cognitive strategies*; *metacognition*; and *self-regulated learning.* We will examine each of these central concepts in the following sections.

Cognitive strategies

In the example above, Gisela uses many different cognitive strategies. As this example illustrates, a cognitive strategy is a mental process or procedure for achieving a cognitive goal. Cognitive strategies can be stated as "If you have a goal X, carry out process Y." Here are some examples of cognitive strategies:
--If your goal is to understand a paragraph, then try to summarize the paragraph to yourself.
--If your goal is to write a good essay, then spend time brainstorming and planning before you begin writing actual prose.
--If your goal is to decide which viewpoint is correct, then consider arguments on all sides of the question.

General versus specific cognitive strategies. There are two categories of cognitive strategies – general strategies and specific strategies (Alexander, Graham, & Harris, 1998; Pressley et al., 1989). *General strategies* are useful across many situations in many different domains of knowledge. Setting goals and evaluating whether we are achieving our goals is a useful strategy that can be used in almost any situation and discipline, whether it is studying history, mathematics, architecture, or any other field. There are other strategies, which are fairly general, but not universally so. In geometry and physics, drawing a diagram is often a useful strategy for illustrating and understanding concepts; this strategy can also be used in other fields, such as drawing a timeline when studying for a history test. But drawing diagrams is not applicable to all situations; for example, while geometry usually requires diagrams, algebra often does not. Other strategies are highly *specific* to a narrow range of situations. The strategy used to balance chemical equations, for instance, is useful only for this one type of problem. Effective learning and thinking requires students to use specific strategies and general strategies in combination (Alexander, Kulikowich, & Jetton, 1994; Alexander, Kulikowich, & Schulze, 1994; Chinn & Brewer, 2001; Many et al., 1996). For example, proficient mathematics students know how to use a series of strategy for solving math problems, such as drawing a diagram, outlining a series of subgoals to achieve the overall goal, carrying out the solution steps, and checking whether the answer makes sense.

Believing in the value of using strategies. In Chapter 6, you learned about how students' prior beliefs can affect learning. This is true of strategies, as well; students' beliefs about whether strategies are useful affect their willingness to use the strategies they learn. A number of studies have provided evidence that some students who know how to use strategies such as summarization and elaboration refrain from doing so because they do not believe that the strategies are useful (e.g., Chinn, 2006; Dole, Brown, & Trathen, 1996; Garner, 1990). For instance, a student who knows how to elaborate material may not believe that elaboration will help her understand texts better, and so she chooses not to use the strategy

(Dole et al., 1996). Thus, in addition to being aware of different strategies, the student also needs to *believe* that the strategy is effective and be willing to use it (Alexander, Graham et al., 1998; Chinn, 2006).

Strategies versus skills. In this book, we will frequently discus *strategies* that students learn. Many school curricula emphasize a related concept: *skills*. Teachers using these curricula are directed to teach a broad array of skills to their students. What is the difference between a skill and a strategy? Skills are procedures that are carried out automatically, whereas strategies include a reflective element of thinking about the procedure that one is using (Alexander, Graham, & Harris, 1998; Dole, Duffy, Roehler, & Pearson, 1991; Onatsu-Arvilommi, Nurmi, & Aunola, 2002). When a learner is performing automatically, her performance is skillful but not strategic; when "conscious, intentional, and effortful processing takes over, the learner is performing strategically" (Alexander, Graham et al., 1998, p. 135). Effective learners and problem solvers use many strategies automatically, so that one goal of strategy instruction should be to help students gain the ability to use many strategies automatically, while still being able to reflect about these strategies when the need arises.

Metacognition

Researchers who investigate cognitive strategies also use the term **metacognition.** Metacognition refers to people thinking about their own cognition (e.g., Brown, Bransford, Ferrara, & Campione, 1983; Coutinho, Wiemer-Hastings, & Skowronski, 2005; Garner & Alexander, 1989). People who are capable of metacognition are also said to have **metacognitive awareness or metacognitive knowledge** (awareness or knowledge of one's own cognitive processes). A student who can explain the cognitive strategies she is using has metacognitive knowledge. For instance, a student who can explain that she creates vivid mental images of what she is reading to help her remember has displayed metacognitive knowledge—knowledge of the strategies she is using to understand text. In our example of Gisela writing her paper, Gisela exhibits metacognitive awareness as she consciously chooses among different strategies. When she decides to spend time reviewing key ideas and to brainstorm before writing the paper, she does so because she is aware that these strategies are likely to help her write a better paper than if she begins to write the paper without any prior preparation. Although Gisela has metacognitive awareness of her strategy use, many learners use strategies without having metacognitive awareness. For instance, a student may remember a list of words by organizing them into categories, but be unable to recognize or explain that this is what she is doing.

Problem 7.1 Understanding students' thinking: Metacognitive awareness

An ESL teacher was interested in what strategies her fifth grade students used to study vocabulary and whether her students had metacognitive awareness of the vocabulary strategies they used. As opportunities arise during the course of a day, she asked four of her students to show her how they study vocabulary by thinking aloud as they study several words with definitions that she gives to them. This is what the four students said in response to the word *furious.*

Student 1 said: "This word is furious. It means angry. I am angry because my friend was mean."

Student 2 said the word and the definition several times: "Furious. Angry." Then he paused for several seconds without saying anything. When the teacher prompted him to say what he was thinking, he just said, "Angry."

Student 3 said: "I am imagining that I am very angry. I am furious."

Student 4 said: "I find that it helps me to make up a sentence with the word. So I can say something like, 'I am angry because my brother took my radio into his room."

Which students show proficient use of a cognitive strategy? What metacognitive knowledge, if any, is demonstrated by each student?

Response: *Students 1 and 3 demonstrated the ability to use cognitive strategies. Each was able to think out loud in a way that showed the use of a strategy being used. Student 1 used the word in a sentence; Student 3 used visual imagery. But neither exhibited any knowledge about his/her cognition. They did not make statements such as "I try using the word in a sentence to make sure I know how to use it" or "I like to make a mental image in my mind to help me remember." Statements such as these would indicate metacognitive awareness of the strategies they are using. Student 2 demonstrated no effective strategy use. He may have been using a rote learning memory strategy of saying the word and meaning over and over. We discussed in Chapter 2 that this is a very ineffective strategy. Student 4 demonstrated both conscious regulation of cognition and knowledge about cognition. He could not only think aloud in a way that showed how he was using the strategy, but also could state what his strategy was and why he thought it was useful.*

Self-Regulated Learning

A central goal of strategy instruction is to develop **self-regulated learners**. Self-regulated learners are students who are proficient at managing their own learning processes. Their strategies include :

- setting goals and subgoals,
- selecting and orchestrating strategies to achieve these goals and subgoals,
- monitoring progress by checking whether they are achieving their goals and subgoals, and

- adjusting the strategies they use based on their self-evaluations of how well they are progressing toward their goals (Butler & Winne, 1995; Paris & Paris, 2001; Souvignier & Mokhlesgerami, 2006; Zimmerman, 1998).

Researchers who study self-regulated learning investigate the use of a broad range of strategies, focusing especially on learners' self-control over all the strategies that are used (e.g., Souvignier & Mokhlesgerami, 2006). They also emphasize the importance of learners setting their own goals, monitoring their own performance, and evaluating how well they are doing at achieving their goals (e.g., Butler & Winne, 1995). They have also focused on how effective learners regulate their emotions, their interest, and their motivation (Wolters, 2003).

RESEARCH ON COGNITIVE STRATEGIES

As educational psychologists have studied cognitive strategies, they have become persuaded that *strategy instruction* should become an important part of the curriculum (De La Paz, 2005; Graham, Harris, & Mason, 2005; Pressley & Woloshyn, 1995). Strategy instruction refers to instruction that teaches students to use effective cognitive strategies. Four types of empirical studies have contributed to the enthusiasm among educators for helping students learn effective cognitive strategies:

1. Comparisons of experts with novices, and of proficient students with less proficient students
2. Strategy training studies
3. Large-scale instructional experiments
4. Comparisons of effective and ineffective schools or classes

We will discuss examples of each of these four types of studies below. Studies such as these present a powerful case for making strategy instruction a central goal of education.

Comparisons of Experts with Novices, and of Proficient Students with Less Proficient Students

In Chapter 6 (Prior Conceptions), you learned about expert-novice studies that highlighted differences in how experts and novices organize knowledge. Many studies comparing experts and novices have examined the strategies that experts and novices use when trying to solve problems or reason about data (e.g., Barnett & Koslowski, 2002; Clement, 1994; Noice & Noice, 2002; Schunn & Anderson, 1999; Voss et al., 1983). Other studies have compared high-performing students with low-performing students (such as good vs. poor readers) to see how their strategy use differs (e.g., Bereiter & Bird, 1985; Chan et al., 1992; Chi et al., 1989; Lundeberg, 1987). The results of these studies have yielded a powerful understanding of differences in strategy use between proficient learners and thinkers and less proficient learners and thinkers.

One well-known example of this type of study was an investigation of university students who were studying chapters from a physics textbook on the laws of motion (Chi et al., 1989). The students read earlier chapters for background information, and they took a pretest on the quality of their conceptual understanding of the key theoretical ideas from these earlier chapters. Then they read a target chapter that addressed particle dynamics (such as the motion of objects on an incline and the motion of objects hanging from pulleys). The chapter included explanatory material as well as three worked-out example problems. Then the students attempted to solve test problems, including problems from the end of the chapter. The students were asked to think aloud as they studied the three worked-out examples and as they worked on the test problems.

Chi et al. compared successful students, those who did well on these problems (82% success rate) with unsuccessful students, those who did not do well on these problems (46% success rate). The researchers found no differences on the test of conceptual understanding of the key theoretical ideas that students took before they began studying the worked-out examples. Instead, they found that there were major differences in study strategies between the two groups of students as they studied the worked examples. The successful students generated many more comments as they studied the three worked-out problems. The types of statements made between successful and unsuccessful students differed as well.

Successful students offered many more *explanations* of why each step in the worked-out problems was taken. Successful students also were much more likely to *monitor* their learning, by accurately detecting points that they did not understand. In contrast, unsuccessful students seldom explained steps in the worked-out problems, and they seldom commented on anything that they did not understand—even though their poor performance on the test showed that there were in fact many points that they did not understand. Table 7.2 summarizes the differences between successful and unsuccessful students.

Table 7.2:
Differences between successful and unsuccessful students in the Chi et al. (1989) study

Successful Students	Unsuccessful Students
1. Provided many explanations (15.3 per student). Examples: • Ummm, this would make sense, because since they're connected by a string that doesn't stretch. • If the string's going to be stretched, the earth's going to be moved, and the surface of the incline is going to be depressed. • Okay, so it's basically a way of adding them together and seeing if there is anything left over. And if there is anything left over, it equals the force: mass times acceleration.	1. Provided few explanations (2.8 per student). They were more likely to paraphrase statements from the worked examples without adding any new ideas to try to explain why certain steps were taken.
2. Noticed failures to comprehend (9.3 per student). Examples: • I was having trouble with F-mgsin $\theta = 0$. • I'm wondering whether there would be acceleration due to gravity? • Why the force has to change?	2. Seldom noticed their own failures to comprehend (1.1/student).

from Chi et al. (1989, pp. 161, 165, 171).

This study is one of a large body of studies that support the idea that effective and ineffective students often differ because effective students use different (and more effective) strategies. Together, these studies strongly suggest that teaching ineffective students to use more effective cognitive strategies would help them become more effective. The training studies that we discuss in the next section confirm this idea.

Strategy Training Studies

Strategy training studies are studies that investigate the effects of teaching students a strategy or a set of strategies. In typical training studies, one group of students is taught one or several strategies. This group is then compared with a control group of students who are not taught the strategy or strategies to see whether students who have been taught the strategies perform better. Many strategy training studies have documented that teaching students to use effective cognitive strategies improves performance (e.g., Friend, 2001; Graham et al., 2005; Taconis, Ferguson-Hessler, & Broekkamp, 2001).

As an example, consider the following experiment by educational researchers Victoria Page-Voth and Steve Graham (1999), who explored ways of helping learning-disabled (LD) seventh and eighth graders learn to write opinion essays. Their study was grounded in research that showed that learning-disabled middle-school students typically support their opinions with just one or two arguments and seldom consider or attempt to rebut any opposing arguments (De La Paz & Graham, 1997). The study focused on the strategy of goal setting. The research question was whether students who learned to set goals to support their opinions with more arguments and to rebut opposing arguments would write more effectively than students who did not learn to set these goals.

There were three groups of students in the experiment. Students in all groups were learning to write opinion essays. Students in the *goal setting* group were taught to set goals for how many reasons they would write that supported their opinion and how many times in their essay they would refute a counterargument that could be made against their position. The second group, the *goal setting plus strategy* group, set goals as indicated above, and they also learned a six-step strategy for writing opinion essays shown in Figure 7.2. Students in the *control* group learned to write opinion essays, but did not participate in goal setting and did not learn the six-step strategy. Students in each of the three groups wrote a series of three essays.

Figure 7.2:
A six-step strategy for writing opinion essays

1. Read the essay topic and identify my opinion (premise)
2. Brainstorm and write down enough ideas so that the goal could be satisfied
3. Write the essay, including the ideas that were brainstormed
4. Read the essay to see if all the ideas were included
5. Modify the essay by including brainstormed ideas not included.
   Add new ideas as needed.
   Or modify ideas that were already included to make them better.
6. Check to see if the goal was met.
   Return to Step 5 if it was not.

from Page-Voth & Graham (1999, p. 234).

Students' essays were scored according to how many argument components they included in their essays. Specifically, students' scores were computed based on the number of supporting reasons for their position, the number of times they elaborated their reasons with some details, the number of times they refuted counterarguments that could be made against their position, and the number of times they provided supporting details for these refutations. Students' essays were also scored holistically for overall holistic quality by raters who did not know which group (goal setting, goal setting plus strategy, or control) the students had been in. The results showed that by the third essay, students in the two goal-setting groups were strongly outperforming students in the control condition (see Figure 7.3). This study supports the idea that having LD students set goals for their writing can lead to strong gains in their writing. In general, training studies have demonstrated that teaching cognitive strategies to students can improve learning substantially.

Figure 7.3:
Performance of students in the goal setting, goal setting plus strategy, and control groups

Figure 7.3.a : Number of Argument Components

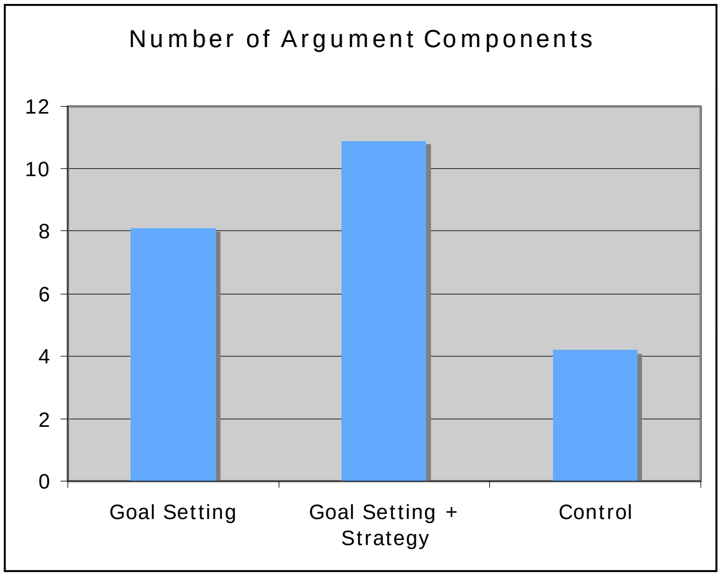
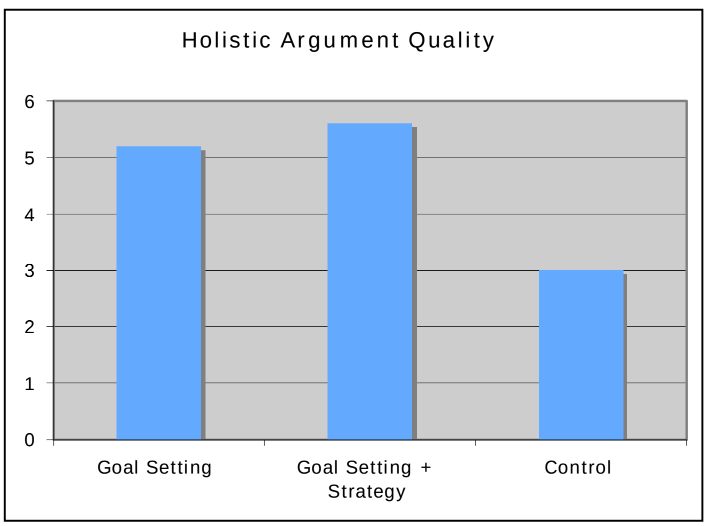


Figure 7.3.b :



Large-scale instructional experiments

Another type of study that supports the importance of making cognitive strategies a central focus in the classroom is the long-term classroom experiment or quasi-experiment. (These are two of the research designs we discussed in Chapter 1). These studies often span most of a school year or longer, and they contrast the effects of a curriculum that instructs students on many different cognitive strategies with the effects of a traditional curriculum that is less focused on strategy instruction. A number of these experiments have been carried out and have shown that students benefit from curricula that focus on cognitive strategy instruction (e.g., R. Brown et al., 1996; Guthrie et al., 2004).

As an example, educational psychologists Rachel Brown, Michael Pressley, Peggy Van Meter, and Ted Schuder (1996) reported the results of a yearlong study that evaluated the effects of a program that integrated reading comprehension strategies into the second grade curriculum. The program, called SAIL (Students Achieving Independent Learning), required teachers to provide extensive instruction and guided practice using a variety of strategies that promote reading comprehension. These strategies include making predictions, visualizing information, relating the text to prior knowledge or personal experiences (elaboration), summarizing, monitoring comprehension, setting goals, and looking back in the text for important information. Teachers regularly modeled multiple strategies and encouraged students to apply multiple strategies when reading.

In this study, there were two sets of reading groups. Reading groups taught by five teachers using SAIL were contrasted with the reading groups taught by five teachers who their principals and supervisors identified as being strong reading teachers. This was a quasi-experiment because teachers were not randomly assigned to condition. To form the groups, students were matched according to scores on a reading comprehension test that had been administered before the study began. Once the groups were established, some lessons were videotaped and analyzed. These analyses revealed that lessons taught by SAIL teachers incorporated the use of an average of 9.20 comprehension strategies per lesson, whereas the other teachers' lessons incorporated an average of only 2.00 comprehension strategies per lesson. In interviews in the spring, after a year of participating in SAIL, SAIL students were much more fluent than comparison students at talking about the strategies they had learned. The SAIL students also outperformed the comparison students on a standardized test of reading comprehension administered in the spring. The gains in comprehension test scores registered by SAIL students from fall to spring were double the gains of the students in comparison groups. Interestingly, SAIL students also outperformed comparison students on a standardized test of word skills (e.g., how to attack difficult-to-decode words), even though this was not a focus of the SAIL program. Studies such as this provide powerful evidence of the value of infusing strategy instruction into the school curriculum.

In addition to large-scale instructional experiments, researchers have compared high-performing schools with lower-performing schools to see how they differ. Strategy instruction is one difference that has emerged from a number of these studies. We discuss studies of this type in the next section.

Comparisons of instructional practices in effective and ineffective schools

There is evidence that highly successful schools place great emphasis on helping students learn effective strategies (Gaskins et al., 1993; Langer, 2001; Pressley & Woloshyn, 1995)(cf. Pressley, Raphael, Gallagher, & DiBella, 2004). Several studies have compared instructional practices in effective and ineffective schools and have found more and better strategy instruction in effective schools (Langer, 2001; Pressley et al., 1998; B. Taylor et al., 1999; Wharton-McDonald, Pressley, & Hampston, 1998). A study by literacy researcher Judith Langer (2001) provides a good illustration. Focusing on literacy instruction, Langer studied a diverse range of 25 schools in Florida, New York, California, and Texas. Among these schools, some were classified as schools that were "beating the odds." In these schools, students were performing higher on standardized literacy tests than were other schools serving populations that were demographically similar. Other schools were classified as "typically performing" schools; in these schools, students' literacy scores on standardized tests were typical of schools with the same demographic characteristics. Langer studied 26 secondary literacy teachers in the "beating the odds" schools and 12 typical secondary literacy teachers in typical schools. Langer found that there were major differences among literacy teachers and typical teachers in their focus on teaching strategies. Every teacher in the beating the odds schools (26 of 26 teachers) made cognitive strategy instruction an important emphasis. In contrast, only 2 of the 12 typical teachers provided cognitive strategy instruction. The following examples illustrate differences between the two groups of teachers.

Example of strategy instruction in a "beating the odds" school. Cathy Starr, a teacher at Hudson Middle School, was a teacher who was beating the odds. She decided to teach her students how to use strategies as a means of reflecting on how well they were doing. After completing the activity, the students were told to evaluate their performance on the research they did and the writing they finished by using self-developed rubrics. Some of the questions on these rubrics include:

"1. . . . Did you keep going until you had learned enough to write your report?
2. . . . Did you plan what you were going to say? Did you think about it? Did you review it and revise it before putting it in the back?
3. Did you edit? . . . " (Langer, 2001, p. 868).

Cathy thus worked explicitly with students to help them develop and understand criteria for evaluating their performance.

Example of strategy instruction in a typical school. Carol McGuiness was a teacher at a typical school. In one tenth grade class, she gave students an assignment to put 24 events in sequential order. Of the three groups in her class, only one of the groups was able to make a successful start at this task. The other groups were struggling. Instead of discussing possible strategies to solve the problem, Carol only said, 'OK. Divide your slips into thirds. OK? This is research. Start with the beginning, the middle, and then end and put the strips into three different piles. Get this done and you'll have a method.' However, this instruction was not effective. The students did not understand what she meant, and they did not reach a better understanding of the task. Thus, unlike Cathy, whose instruction made strategies clear to students, Cathy was not effective at helping students learn strategies to help them carry out the assignment (Langer 2001, p. 869).

Implications for Teachers

As we have just read, these is a large body of research that supports the conclusion that teachers should make strategies and strategy instruction a central part of the curriculum. By teaching strategies and helping students learn to become self-regulated learners, teachers can greatly increase their students' capacity to learn on their own. There are at least three major implications of these research findings for you as a teacher.

1. As a future teacher, you should develop a repertoire of strategies that you can teach students in your classes. Throughout the rest of this chapter, you will learn about a broad range of strategies that you can integrate into your own instruction.

2. You should become skilled at evaluating your students' strategy use. To understand what strategies your students need to learn, and to check whether students are learning the strategies that you are teaching, you will need to become adept at evaluating which strategies students are using and whether they are using strategies well. In the remainder of this chapter, you will learn several methods for evaluating students' strategy use.

3. You should become skilled at teaching strategies to students. Although this issue will be addressed primarily in later chapters, we will discuss one important instructional technique near the end of this chapter: encouraging students to make their thinking public.

In order to teach cognitive strategies to your students, you will need a good understanding of a variety of strategies that will help your students become better learners, problems solvers, and reasoners. In the next and longest section of this chapter, we will examine a broad range of strategies that you will want your future students to master.

STRATEGIES FOR LEARNING, PROBLEM SOLVING, AND REASONING

In the following sections, we will discuss some of the strategies that researchers have found to be important in effective learning, problem solving, and reasoning. We will begin with general strategies for self-regulation, because they provide a framework for other sets of strategies. We will then follow with strategies for comprehension, strategies for problem solving, strategies for writing, and strategies for reasoning.

General-Purpose Self-Regulation Strategies

Effective students use a variety of general purpose self-regulation strategies, which they can use in many different learning and problem solving situations. Five of these strategies are particularly useful (see Butler & Winne, 1995; Zimmerman, 1998): goal setting, self-monitoring and self-evaluation, time management, self-regulation of interest and motivation, and executive control.

Goal setting. **Goal setting** occurs when we specify what we aim to accomplish when we undertake a task (Locke & Latham, 2006). Goals can be *long-term* (e.g., a ninth grade math student setting a goal of passing AP calculus when she is a senior), *intermediate-term* (e.g., the math student aiming to get an A on the final exam in one month), or *short-term* (such as the math student aiming to get 95% of today's homework problems correct).

Effective learners and problem solvers set goals at all levels, though short-term goals are particularly productive (e.g., Getz & Rainey, 2001; Weldon & Yun, 2000). Effective short-term goals are often established to master a particular strategy, rather than focusing just on the outcome (Kitsantas, Reiser, & Doster, 2004). For example, the math student from our example above might set the short-term goal of making sure she can explain each step of the worked-out problems in the book to herself, rather than (or in addition to) aiming for a particular score on the homework assignment. Likewise, a soccer player might set a goal of keeping her head down when shooting rather than focusing on whether a goal was actually scored. By focusing on using targeted strategies or skills, learners improve their capacities, which enable them to achieve practical goals such as getting A's on exams or scoring more goals in games.

It can also be productive for learners to focus first on **strategy goals** (goals of mastering a strategy) and then shift to **outcome goals** (goals of getting a particular result) (Zimmerman & Kitsantas, 1999). For instance, a student learning vocabulary words in German might initially set a strategy goal of mastering the keyword method as a strategy for learning new words. After achieving this goal, he might set an outcome goal of learning 400 new words prior to the final examination. Strategy goals are also referred to as **process goals** because effective strategies provide the process by which one achieves outcome goals. Outcome goals are also called **product goals** because they refer to the finished products that one is trying to achieve.

Problem 7.2 Understanding students' thinking: Product versus product goals

Ami Sherman is a high school English teacher who also coaches the girls' basketball team. She has three basketball team players in her junior-level American literature class, and she is curious about whether these three students set process or product goals both in her class and in basketball. She asks each student about what their goals are as (a) they approach their next composition and (b) they approach their next game. The table below shows what each student said:

Student	Response to the question about goals for the next composition	Response to the question about goals for the next game
Dhriti	"I really want to get an A- on my next paper because that would give me a B+ average for the year."	"I want to get double digits in scoring for the next game. I got really close the last game, and I want to make it this time."
Chantoya	"I'm working on writing better thesis statements, so I'm hoping that for this next paper, I can come up with a good, arguable thesis statement and then hopefully the rest of the paper will flow once I have a good thesis."	"I want to work on my shooting technique this game. The last few games, we played against weaker teams, so I scored the same amount of points as always, but I feel like I may have formed some bad habits, so I want to really focus on correcting that in the next game."
Chelsea	"I want to get at least a letter grade higher on this paper than on my last paper."	"It's really an issue of footwork for the next game. If I can get my footwork down, I can improve my defense, and that's my focus right now."

Response: Dhriti expresses product goals for both tasks—a grade for the paper and a scoring goal for the game. Chantoya sets process goals for both tasks. For writing, she describes what she needs to work on to make her papers better, and for basketball, she focuses on her shooting technique rather than how many points she wants to score. Chelsea expresses a product goal on her paper (a higher grade); for basketball, she describes a process goal (footwork) which she sees leading to an important product (better defense).

Self-monitoring. Self-monitoring refers to observing and keeping track of the activities in which you are engaged and checking whether you are on track to achieve your goals (Israel, Block, Bauserman, & Kinnucan-Welsch, 2005; Yang, 2006). **Self-monitoring** thus involves evaluating how well you are progressing toward your goals. For this reason, the term **self-evaluation** can be used to refer to self-monitoring. Self-monitoring refers to checking your progress as you are working toward a goal. Self-evaluation can also refer to this process of checking progress along the way, or it can also refer to a more final evaluation at the end of the activity to determine how well your goals were met.

There are at least two separate processes involved in self-monitoring (Dole et al., 1991). The first is articulating the criteria that you will use to judge your performance. For example, if you are planning to write a term paper, you might decide that you are going to judge the quality of your own paper in terms of the number of articles cited, the complexity of the ideas you are presenting, the coherence of the paper, and the extent to which you have integrated the various findings. The second process is judging how well you have done in achieving the goals you have set. After writing the first draft of your term paper, you may decide that you have done well on three of the goals but that you have failed to develop complex ideas. Consequently, in working onIU9 the next draft, you try to brainstorm a web of complex and poignant ideas of your own that you could infuse into the paper.

Time management. Recall how Gisela assigned each course a designated amount of time as she planned her evening. Time management is organizing one's time effectively to accomplish one's goals (Rief & Heimburge, 2006). Students with higher academic achievement report greater use of effective time management strategies such as planning how to spend time, prioritizing activities, and allocating sufficient time to accomplish high-priority activities (e.g., Zimmerman, Greenberg, & Weinstein, 1994).

Self-regulation of motivation and interest. Effective learners can enhance their own interest and motivation more effectively than less effective learners can (Sansone et al., 1992). Effective learners have a variety of strategies for piquing their own interest and stimulating their own motivation (Wolters, 2003). For instance, they may reward themselves periodically by taking a break after reading each 10 pages in a textbook. They may tell themselves why it is important to learn this, or they may find ways to make a game of what they are learning (perhaps competing with themselves to see how many vocabulary words they can remember on each pass through the vocabulary cards). They may try to relate material they are learning to their own lives as much as possible by trying to come up with personal examples of key concepts. Or they may make predictions about the content of upcoming material and see whether their initial answers are borne out by the text as they read it.

Executive control. Effective strategy users select and orchestrate the many different strategies as they undertake complex learning, problem solving, and reasoning tasks, as Gisela did when writing her paper. Gisela used many different strategies and made appropriate choices about when to use each strategy. This requires the learner to be skilled at controlling and managing different strategies and to use the strategies at appropriate times. When learners can orchestrate strategies in this way, they are said to have **executive control** of all the strategies they are using. Executive control is such a critical aspect of self-regulation that it can be regarded as an important strategy in its own right.

To summarize this section: The core general-purpose self-regulation strategies are setting goals, selecting strategies to achieve these goals (which can include self-regulation of motivation and interest and of time), and then self-monitoring or self-evaluation to see how the process is going. Executive control strategies oversee the entire process. General purpose self-regulation strategies can be used on almost all tasks—from studying a textbook and writing a paper to carrying out a science experiment. In the next section, we will focus on strategies fairly specific to the task of comprehending texts or lectures.

Comprehension Strategies

In this section, we will discuss several of the strategies that are particularly useful to help students' improve their comprehension of texts and lectures. These strategies are monitoring understanding, repairing understanding, using text structure, summarizing, elaborating, explaining, and formulating problems.

Monitoring understanding. When students monitor understanding, they check as they go along to make sure they understand what they are learning (Donndelinger, 2005; Yang, 2006).. This is a specific version of self-monitoring applied to the task of understanding a text or lecture. Good learners are much better at monitoring understanding than poor learners. Many of the studies on monitoring have had students read passages such as this one (Markman, 1979):

> Many different kinds of fish live in the ocean. Some fish have heads that make them look like alligators, and some fish have heads that make them look like cats. Fish live in different parts of the ocean. Some fish live near the surface of the water, but some fish live way down at the bottom of the ocean. There is absolutely no light at the bottom of the ocean. Some fish that live at the bottom of the ocean know their food by its color. They will only eat red fungus.

Did you notice any inconsistencies in this passage? If not, then you failed to monitor your comprehension fully because there is an internal contradiction in the passage. If there is absolutely no light at the bottom of the ocean, then it is impossible to identify food by its color. In Markman's (1979) study, almost all children in grades 3, 5, and 6 failed to notice this contradiction. Even when the passage was more explicit and read, "[the fish] cannot even see colors. Some fish that live at the bottom of the ocean can see the color of their food," no more than 60% of the children at any grade level noticed the inconsistency. Proficiency at monitoring understanding so that one can notice inconsistencies like this one improves with age as well as with reading proficiency (Rubman & Waters, 2000).

Monitoring comprehension is at the heart of effective learning. Comprehension requires learners to set goals to understand the material and to check understanding as they go along. Poor learners often fail to do so. However—and this is very important—poor learners sometimes *think* they understand, even though they don't. Think back to the study with the physics students who studied the worked examples discussed earlier in this chapter. Recall that it was the students who understood least who asserted that they understood the problems (Chi et al., 1989).

Repairing understanding. Repair strategies (sometimes called **fix-up strategies)** are strategies that students use to overcome problems with memory or understanding (Schmitt, 2005). When proficient learners find that they don't understand something, they take steps to try to overcome their lack of understanding. In particular, they spend more time studying the more difficult material, whereas less proficient learners may spend the same amount of time on difficult material as on easy material (Owings et al., 1980). Effective learners are more likely simply to look back and reread what they don't understand (Alessi, Anderson, & Goetz, 1979; Garner & Reis, 1981).

The following example presents a very simple task. Study the list of nonsense syllables below for 45 seconds. Your task is to remember as many of them as you can.

vox baj lin fub wep muv sot dih yok waf tiz cov seg nud zib gak rux loq hap mes

Now, cover up the words and try to write down all the syllables you can remember. When you finish, study the syllables one more time, again for 45 seconds. Then do one more recall of the entire list. If you are like most undergraduates, when you studied the syllables the *second* time, you spent more time on the syllables that you got wrong than the syllables that you got right. Although this is a memory task rather than a comprehension task, it illustrates a strategy useful for repairing both memory errors and comprehension errors--spending more time on the things you don't know.

When my daughter, who is bilingual in English and Japanese, was in elementary school, she spent a portion of two summers in a Japanese school. Several months later, when she was back in her regular school, she showed me her algebra notebook when she was doing her homework. She had circled in red ink the problems that she had gotten wrong on homework assignments. She explained, “Dad, in Japan the teachers tell us to circle the problems that we got wrong, and then later we can study our errors so that we won’t make them again. But here, everyone erases their wrong answers and writes the correct answers over them. I don’t think that’s a very good idea, because then they can’t learn from their mistakes.” My daughter had been taught in Japan to use the repair strategy of circling errors and then studying them. This seems to me to be a very useful strategy, and one that could easily be taught to students (and there are undoubtedly many American teachers who do). By not teaching such strategies to students, teachers miss opportunities to help their students become more effective learners.

Problem 7.3
Understanding students’ thinking: Monitoring and Repairing Understanding

As a teacher, you will regularly observe students’ oral and written work to determine which strategies they are using, and if they are using these strategies effectively. Here is an example related to monitoring and repairing understanding. Evaluate the strategy use you see in these examples.

1. Teacher (talking to a student about her study strategies): Do you ever find things you don’t understand when you are reading?

Student: Yeah, a lot.
Teacher: So what do you do then?
Student: Usually I just keep on reading and hope I’ll understand later.

How would you evaluate this student’s approach to monitoring and repairing understanding? How should the teacher follow up this conversation.

2. Here Is the response of a middle-school student when her English teacher asks her how she has prepared a short speech for class.

Student: Well, I really wanted to get at least a B+ on this, so I spent all night, like from 7 to 9, on this.
Teacher: How did you decide when you were satisfied with your speech?
Student: Well, I just wanted it to sound good. [pause]
Teacher: How did you decide when it sounded good?
Student: Just kind of when it sounded the way I wanted it to sound.

Response: It appears that the student does have a capacity to monitor understanding at a broad level, because she notices that she often doesn’t understand things. However, it may be that she does not understand specifically what it is that she does not understand. The teacher should follow up with her questions to find out more about this, and perhaps have the student think aloud about a text used in class to see whether she can be specific about what she doesn’t understand. The last sentence indicates that she clearly does not use effective repair strategies for repairing understanding when she doesn’t understand a passage. Later text may sometimes clarify material not yet understood, but to be sure one understands, one needs to go back and reread and think more about the material that was not understood. Note that the student does seem to have metawareness of the repair strategy she is using; it’s just that her strategies are not particularly effective.

Using text structure. Effective learners use text structure to facilitate text comprehension much more successfully than ineffective learners do (Meyer, Brandt, & Bluth, 1980; Meyer & Rice, 1984; Williams, 2005). Text structure refers to the overall organization of the text. The structure of a text indicates how the ideas are organized into main ideas and supporting ideas. For instance, a persuasive essay arguing for government-provided universal health to may be organized as a claim (the U.S. government should provide universal health care) with supporting arguments, along with reasons why common arguments against government-provided universal health care should be rejected. The text structure of a passage in a textbook may be organized as a main idea (e.g., the statement that New Zealand has diverse geography) with several paragraphs of supporting details discussing different specific geographies in New Zealand (rain forest, desert, lowlands, etc.). Another textbook passages may be structured as a sequence of steps in a process (e.g., a step-by-step presentation of how a bill becomes law.)

Authors typically provide many cues to text structure when they write. Some of the most commonly used cues are:

- topic sentences
- headings
- underlined and boldfaced type to mark important ideas
- transition words such as *but* and *except for*

These cues are intended to help readers understand the way in which the ideas in the passage are organized.

To see how cues to text structure can help readers, consider the two passages in Figure 7.4. The texts are identical, except that the passage on the left (Figure 7.4b) includes a number of cues to text structure of the passage, whereas the passage on the left removes all such cues. The cues include headings, subheadings, words in bold, and transition words such as *but, then*, and *in addition*.

Figure 7.4a : Biology Passage With Text Structure Cues

Chordates--the most complex form of animal life. The phylum Chordata contains the most complex animals that have ever lived on this earth. This phylum has four subphyla. The largest and most important subphylum is the Vertebrata. This subphylum includes fish, amphibians, reptiles, birds, and mammals. All chordate embryos have a rod of connective tissue along the length of the dorsal side of their bodies. This rod is called a notochord. Primitive chordates have a notochord their entire lives. So do some lower vertebrates, such as the lamprey. The notochord of the lamprey becomes surrounded by cartilage parts of the spinal column. In other vertebrates, the notochord appears only in the embryo. But early in life, it changes into the vertebral column, or backbone. All chordates have a tubular nerve cord. It lies just above the notochord on the dorsal side. The anterior end of this nerve cord develops into a brain. The remaining part becomes the spinal cord. The brain and the spinal cord together make up the central nervous system. All chordata have paired gill slits at some time in their lives. These gill slits form openings in the throat. Fish and the more primitive vertebrates have gill slits throughout life. The higher vertebrates, including reptiles, birds, and mammals, lose their gill slits very early in life.

Figure 7.4b: Biology Passage Without Text Structure Cues

BIOLOGY OF THE VERTEBRATES

SECTION 1: CHORDATES--The most complex form of animal life

The phylum Chordata contains the most complex animals that have ever lived on this earth. This phylum has four subphyla. The largest and most important subphylum is the Vertebrata. This subphylum includes fish, amphibians, reptiles, birds, and mammals.

Three factors make chordates different from all other animals.

* **All chordate embryos have a rod of connective tissue along the length of the dorsal side of their bodies.** This rod is called a notochord. Primitive chordates have a notochord their entire lives. So do some lower vertebrates, such as the lamprey. But the notochord of the lamprey becomes surrounded by cartilage parts of the spinal column. In other vertebrates, the notochord appears only in the embryo. But early in life, it changes into the *vertebral* column, or backbone.
* **All chordates have a tubular nerve cord.** It lies just above the notochord on the dorsal side. The anterior end of this nerve cord develops into a brain. The remaining part becomes the spinal cord. Together, the brain and the spinal cord make up the *central nervous system*.
* **All chordata have paired gill slits at some time in their lives.** These gill slits form openings in the throat. Fish and the more primitive vertebrates have gill slits throughout life. The higher vertebrates, including reptiles, birds, and mammals, lose their gill slits very early in life.

Try reading the first version of the passage. You probably find it much more difficult to read and understand than the second version of the passage. You probably use the headings and other signals in the second passage to help you organize your understanding of the passage. Without headings and other cues to text structure, the passage on the right is much harder to read.

Effective learners can be expected to learn a lot more from the passage with cues to text structure than passage without these cues. Ineffective readers on the other hand, learn relatively little from either passage, and they may learn no more from the passage with text cues than the passage without text cues. Ineffective readers do not pick up on cues to text structure (Meyer & Rice, 1984). By teaching poor readers how to use text structure to help guide their understanding, teachers can enable students these students to improve their reading comprehension (L. K. Cook & Mayer, 1988; Meyer et al., 1980; Taylor & Beach, 1984; Williams, 2005).

Cues to text structure also alert readers to the overall *rhetorical structure* of the text (Deane, Sheehan, Sabatini, Futagi, & Kostin, 2006). **Rhetorical structure** refers to the overall organizational pattern of a text, such as the pattern of comparing and contrasting or the pattern of presenting a persuasive claim with supporting arguments. Commonly used rhetorical structures are presented in Figure 7.5. Researchers have found that even college students can benefit by being taught common rhetorical structures. For example, college students who are explicitly taught how research reports are structured (see Figure 7.5) learn more from reading research reports than students who have not been given explicit instruction (Dansereau, 1985).

Figure 7.5:
Common Patterns of Organization

Comparing and contrasting

Main idea and details

Narrative (events in a time sequence)

Persuasion (claims and arguments)

Showing steps in a process

Research report (introduction, research questions, method, results, conclusion)

Summarizing. Summarization involves selecting the important ideas from a text and then generating a statement or a set of statements that captures in shortened form what the central meaning of the text is (Dole et al., 1991). The summary of a 150-word paragraph might be a 20-word sentence. A summary of a 50-page chapter might be a 2-page outline.

Summarization is a difficult strategy for many students (Cordero-Ponce, 2000; Johnston & Afflerbach, 1985). Good readers are better at summarizing texts than poor readers are (Winograd, 1984). Poor readers are more likely to include less important information in their summaries, and they are more likely than good readers to include sentences with vivid, detailed information, rather than central ideas. Good readers are also better able to generate a good statement of what the main idea of the passage is when the main idea isn't explicitly stated in the text (Winograd, 1984).

Elaborating. In Chapter 2, you learned that elaboration involves connecting new information with information from long-term memory. Students elaborate when they take the ideas that they are reading and associate them with other things that they already know. Elaboration has positive effects on learning in that students who elaborate learn much more than students who do not.

Ellen Gagné and her colleagues (1984) conducted a study in which they taught seventh graders the strategy of elaboration. Students in some classes were taught to elaborate in the following way:

* John reads, "Columbus was a Spaniard. He sailed to America in 1492." He wants to remember this information, so he thinks, "Columbus most likely sailed West to America because the shortest way to get to America from Spain is to go West."

Notice that John is taking information in the text and linking it with other things that he knows. In Gagné's study, students who learned to elaborate showed much better text comprehension and recall than those who did not. Elaboration is more than just **paraphrasing**. Paraphrasing is saying the same ideas in the text in one's own words. When a student just paraphrases what is in a text, there is relatively little old information being brought to bear. Elaboration goes beyond paraphrasing to make substantial connections to prior knowledge.

In the Reflection at the beginning of this chapter, some of the students did not engage in any elaboration at all. Those students who did not elaborate tended to learn less than those who elaborated more. You may find it helpful to go back to examine the Reflection and consider how each student is elaborating the sentence being read.

Problem 7.4. Understanding students' thinking: Elaborations

Now try your hand at evaluating students' elaborations. Here are two middle school students whose teacher has asked them to use the strategy of elaboration in response to the text below. Does each response display elaboration?

Text: Jackson was the first president to use the veto extensively. Earlier presidents had used the veto very rarely, and only when they believed that a bill that Congress had passed was unconstitutional. Jackson used the veto as a weapon of policy.

Nate. "Earlier presidents didn't use the veto much, but Jackson used it a lot. Earlier presidents didn't veto a bill unless they believed it was unconstitutional. But Jackson was different."

Julien. "Most presidents today use vetoes a lot, so it looks like Jackson started something that has continued for almost 200 years."

Response: *Nate does not elaborate. This is a paraphrase, a lengthy one, but still a paraphrase. There are no substantial ideas mentioned that were not already in the original text. Julien does elaborate. He connects what he is reading to his knowledge of contemporary presidencies.*

Explaining. When **explaining** ideas to themselves, learners ask themselves "Why" questions about material in the text, and then they try to answer these questions. For instance, as a student reads a biographical sketch of Edgar Allan Poe, she could try to explain why Poe did the things he did in his life. Or a student studying a worked mathematics problem could try to explain to himself why each step is important in reaching a final solution. The study you read earlier in the chapter by Chi et al. (1989) about physics learners showed that it is very important for physics learners to carefully explain to themselves why each step in the example problems are taken. Effective learners explain things to themselves more than ineffective learners do (Bielaczyc, Pirolli, & Brown, 1995; Roy & Chi, 2005).

To investigate whether explaining ideas in a text improves learning, the role of explanation among students, cognitive psychologist Michelene Chi and her colleagues (1994) performed an experiment in which eighth graders read a textbook passage on the circulatory system. Students participated individually. Students in the *no-explanation* group read the text twice. Students in the *explanation group* read the text once but paused after each sentence to explain aloud what the sentence meant. After reading the text in one of these two ways, all students answered an extensive battery of questions about the circulatory system before and after reading the text. These questions were divided into *lower- level* and *higher-level* questions. The lower-level questions could be answered using information directly written in the text passages. The higher-level questions required inferences that required a good understanding of the circulation system. The researchers found that the students who explained the ideas learned more than those who only read the text two times. The difference was especially large for the higher-level questions. In addition, the researchers found that the more explanations that students in the explanation group provided, the more they learned. Students in the explanation group who generated many explanations were particularly successful at developing an accurate model of how blood goes from the heart to the lungs, back to the heart, and then to the rest of the body.

An important characteristic of the explanations of students in the explanation group was that their explanations often enabled them to infer the function of body structures. Here is an example:

> TEXT: The septum divides the heart lengthwise into two sides. The right side pumps blood to the lungs, and the left side pumps blood to the other parts of the body.
>
> STUDENT EXPLANATION: So the septum is a divider *so that the blood doesn't get mixed up.* So the right side is to the lungs, and the left side is to the body. So the *septum is like a wall* that divides the heart into two parts . . . it kind of like *separates* it so *that the blood doesn't get mixed up.* (Chi et al., 1994, p. 454)

Note that the parts of the explanations in italics are inferences that the student makes about the function of the septum; the septum's function to keep blood separate is not explicitly mentioned. By generating explanations, the students develop a better understanding of what the text says because they add important information that was not explicitly stated in the text.

Based on this study, the researchers concluded that generating explanations is an highly effective means of learning. Many other studies also support the usefulness of explanations in learning (Bielaczyc et al., 1995; Ferguson-Hessler & de Jong, 1990; Mevarech & Kramarski, 2003; Ozgungor & Guthrie, 2004; Rittle-Johnson, 2006). Hence, explanations appear to be a particularly powerful comprehension strategy to teach to students.

Problem 7.5
Understanding students' thinking: Explanations

I have found that my educational psychology students often have difficulty diagnosing whether students are self-explaining or not. Consider the following example:

A high school mathematics teacher has assigned students to work in pairs to solve rate problems. Each student in the class has exhibited some difficulties in solving these problems correctly. The teacher has instructed students to explain answers to each other as they work together. As the teacher walks by the different groups, she listens to what students are saying. Put yourself in the teacher's position and evaluate whether the students in each example have given a good explanation.

1. *Word problem.* Samantha drives an average of 20 miles per hour to go to a movie. The movie theater is 5 miles from her house. How long did it take Samantha to get there?

Student 1: I always get confused on these rate problems.

Student 2: I think we have to use the definition of rate.

Student 1: Oh yeah. So, rate equals distance divided by time. OK, so that means that, let's see, 20 equals 5 divided by time. I forget how to get rid of the time exactly. I guess it's a matter of flipping both sides over. OK, so that's time divided by 3 equals 1 over 20. So the answer is 3/20 of the time.

2. *Word problem.* Kramer swims 1 mile along the East River in 30 minutes. How fast is he swimming?

Student 3: Do you know how to do this?

Student 4: Not really. But I remember that I should start with the meaning of rate. Rate is defined as how far you go divided by how long it takes.

Student 3: That makes sense because if you go 40 miles per hour, you're going 40 miles divided by 1 hour.

Student 4: Right, so in this case, rate is just equal to how far over how long, which is 1 divided by 30. So that's 1/30 miles per hour. Oh – wait a minute, that can't be right, because 30 is minutes, not hours. It doesn't make sense because that would mean that in 1 hour, he would only go 2/30 miles, and it said that Kramer goes 1 mile in just half an hour, which is more. So it must 1/30 miles per minute, and in 60 minutes, that would be 2 miles, so 2 miles in an hour.

Response:

1. The students don't use self-explanation. Student 1 is just describing the algorithm used to answer the question. There is no attempt to explain why any of the steps are taken.

2. This example shows effective self-explanation by the two students. What we see is that the students don't really understand very well, but by trying to explain each step, they get better as they goes along. They don't just repeat the formula; student 3 tries to explain why it makes sense: "That makes sense because . . . ." Student 4 checks to see whether her results make sense when she realizes that their initial answer is inconsistent with the information given in the problem. Even though the students have imperfect understanding, the explanations are good because in the process of explaining, they are improving their understanding.

Formulating problems. The Reflection at the beginning of this chapter comes from a study of elementary school students by educational psychologist Carol Chan and her colleagues (1992). Chan and her colleagues found that the students who understood and remembered the passages the best were those who formulated problems based on what they read in the text. Examples include these two students' think alouds in response to this text:

TEXT: **Harmful germs can get into your body in three ways, through your nose, your mouth, and by cuts and scratches in your skin.**

Student 1: They get in through your mouth and nose, and um . . . cut . . . what I am thinking is, how can they get in because the cut is so little . . . but maybe it really got in through your skin . . . so it might not be getting exactly right in.

Student 2: Why do they get in only through your nose and your moth and scratches? Can they get in through your ears or something . . . because your ears sort of have holds . . . maybe the eardrums block it or something.

In each case, the students talked about something that puzzled them in response to the text. You may also want to revisit your response to the Reflection at the beginning of the chapter in the light of this information.

A study by Bereiter and Bird (1985) points to the usefulness of formulating problems to enhance understanding problem formulation. An example from their study comes from a proficient adult reader who was reading a narrative passage and became puzzled by the statement that a character was lazy:

Reader: But how could he say she's lazy when she works so hard? Maybe she's lazy when it comes to other things?

Asking questions like this when one is puzzled by the text and setting these puzzles as a problem to be solved can be very productive for learning. Notice that this process overlaps a great deal with monitoring in that the reader is actively seeking points in the text that are not understood and then formulating questions about them.

Comprehension strategies and self-regulated learning. These comprehension strategies fit nicely into a self-regulated learning framework. If students set a *goal* of learning and understanding the text, then they have a range of useful *strategies* that can employ to help them achieve their goal—using text structure, summarizing, elaborating, and explanation. While carrying out these strategies, the learner should *monitor understanding*. When failures to understand are detected, the learner formulates problems and then sets new goals to repair comprehension. Thus, all of the comprehension strategies we have discussed in this section can be viewed as part of the process of setting goals, choosing strategies to meet goals, monitoring progress, and making adjustments as needed.

In the next section, we will turn to a different group of strategies. These strategies are useful for solving a variety of problems, including math problems and science problems as well as problems encountered in fields such as business or public policy making.

Problem Solving Strategies

Problems occur in almost every area of human endeavor. This includes fields ranging from mathematics (e.g., finding the area under a curve) and chemistry (e.g., determining how much alkaline must be added to an acidic solution to neutralize it) to business (e.g., working out a marketing plan), foreign policy (developing recommendations for how to deal with Mideast conflicts), and computer programming (e.g., developing a better interface for a word processing program). **Problems** occur when a person has a goal that cannot be achieved immediately, so that the person must devise and carry out a series of steps to solve the problem. The steps may be easily carried out, as when a physics professor quickly solves an end-of-chapter physics problem in a high school textbook. Or the steps may be difficult to carry out, as when the same physics professor attempts to invent a new instrument to detect asteroids or comets whose orbits could bring them close to the earth. **Problem solving strategies** are strategies that generally help problem solvers solve problems more effectively.

Much of the work on problem solving strategies has been inspired by George Polya's (1945) classic work on mathematical problem solving. Polya was a mathematician who took an interest in helping people learn to solve mathematical problems more effectively. He discussed four strategies that can help problem solvers solve problems more effectively (cf. Bransford & Stein, 1984). These strategies are illustrated in Figure 7.6.

Figure 7.6:
Polya's Problem Solving Strategies

[Description of figure 7.6. This is a four-panel drawing. In each panel, the reader is looking over the shoulder of a girl so that the readers can look at the paper that she is writing on. On the paper, there will be a math problem and then the girl's solution. Here is the problem: *The circumference of a circle is 16. Find the area.*]

Figure 7.6a *Understand the problem.*

The girl has drawn a circle, writes C=16, draws the radius and labels it 'r'.

Figure 7.6b *Develop a plan for solution.*

The girl has written: Solve for r using $C=2\pi r$.
Then solve for A using $A = \pi r^2$

Figure 7.6c *Carry out the plan.*

The girl has written: $C = 2\pi r$
$16 = 2\pi r$, $r = 8/\pi$
$A = \pi r^2 = \pi\ 64/\pi^2$
$A = 64/\pi$

Figure 7.6d *Look back to see what can be learned from this process.*

The girl is shown thinking to her self: "In any problem when the circumference is given, you can always find the radius and then the area."

1. *Understand the problem*. Effective problem solvers take time to think about all the given information and how the information is related until they understand the problem thoroughly.

2. *Develop a plan for solution*. When the problem is understood, the problem solver can work out a plan to solve the problem.

3. *Carry out the plan*. Once a plan is worked out, the problem solver carries out the steps in the plan.

4. *Look back to see what can be learned from this process*. An effective problem solver does not stop once the problem is solved.

Polya's four strategies are not always carried out in a straightforward sequence. For example, a problem solver might discover while developing a solution plan or while carrying out the solution steps that he had made a mistake because of a failure to understand the problem properly. This would lead him to cycle back and redevelop a new understanding of the problem before continuing again with the other steps.

In addition to Polya's strategies, psychologists have investigated other strategies for solving problems in a variety of fields, including but not limited to mathematics. In this section we will discuss four strategies that can help ineffective problem solvers become more effective. As we will discuss, some of these strategies are specific ways of implementing Polya's general strategies.

Representing problems. When trying to understand the problem (Polya's first strategy), an important step is construct a representation of the problem. **Representing the problem** (also called **problem representation**) means developing a clear "picture" of what one knows about the problem and what one needs to find out. The picture can be literally a physical drawing or diagram, or it can be a mental model of the situation. An example of a student drawing an actual physical diagram is a mathematics student who draws a diagram that captures all the information given in the problem (see Figure 7.6a). An example of a student constructing a mental model is a high school economics student solving a test problem regarding effects of inflation on international balances of payments. The student does not draw a diagram but spends several minutes carefully reflecting on the relevant factors and how they are interrelated.

Effective problem solvers construct complete, meaningful representations of problems before solving them; ineffective problem solvers often do not (Novick & Bassok, 2005; Pretz, Naples, & Sternberg, 2003). The following simple example illustrates the difference. First and second graders were given this word problem to solve: "There are 26 sheep and 10 goats on a ship. How old is the captain?" Of 97 children, 76 answered "36" (Reusser, 1988). Only a few students correctly answered that the question did not provide any information to answer the question; they had taken the time to envision the situation and realized that the numbers 26 and 10 were irrelevant to the captain's age. The students who answered 36 simply added the numbers without ever generating a complete representation of what the problem was asking. They did not pay attention to what the problem was actually about. Clearly, these students were making no attempt to understand the problem by constructing a meaningful understanding of it; instead, they were undoubtedly processing the problem very superficially, without paying attention to what the problem was actually about.

Three characteristics of good problem representations is that they are (a) complete, (b) include inferences, and (c) exclude irrelevant information. We briefly discuss each of these below.

One key to good problem representations is to make sure that the problem representations are *complete*. For complex problems, the amount of information that should be included in the problem representation will often be more than working memory can hold; hence, written diagrams or notes are often necessary to make sure that important information is not forgotten. But whether students draw diagrams, take notes, or carefully envision the situation in their minds, effective problem solvers take the time to thoroughly represent what they know about the problem before attempting a solution (Voss, Greene, Post, & Penner, 1983).

Problem 7.6
Understanding students' thinking: Problem representation

Two high school juniors are solving a practice math problem for the SAT. Each creates a problem representation. Evaluate the quality of each representation.

Problem:

> Donna has three kinds of pets – cats, dogs, and hamsters. She has one more hamster than she has cats. She has three times as many dogs as hamsters. Of the following, which could be the total number of these pets?

A) 15
B) 16
C) 17
D) 18
E) 19

Haruka's Reponse:

```
One more hamster than cat:
H = 1 + c

Three times as many dogs as hamsters:
3h = d

3 variables, 2 equations, can't
solve . So try one number at a time.
```

Amber's Reponse:

H,*d*,*c*

Response. Haruka has created a complete problem representation that captures the two needed equations and explicitly notes that there is no unique solution for 2 equations with 3 variables. Amber does not clearly set out a problem representation. Amber has merely written down three variable labels. This is not a complete response.

Good problem representations often include *inferences* that go beyond the information that is initially given. For example, one researcher asked history professors and high school students to analyze eight documents. Some documents provided testimony by eyewitnesses about who fired the first shot of the American Revolution at Lexington Green in 1775 (Wineburg, 1991). When reading these documents, the history professors developed more elaborated mental representations of the situation than the high school students did. This required drawing inferences that went beyond the information given in the eight documents. One historian said,

> One has to try to put themselves in the minds and the bodies of the British. They're starting out early in the morning, they must be walking quickly; I'd have to figure out how many miles between the barracks where

> [the British commander] and his troops left and how fast they were walking, because that . . . might help explain if they were really fatigued, and then the adrenaline started to flow in the battle, that they may have lost control. They may have been angry—a whole range of other kinds of things. So the physical dimensions of when they left, the fact that they had to go through a river up to the middles of their bodies meant that they were wet, I suppose, the entire time. . . . (Wineburg, 1991, pp. 82-83)

This highly elaborated problem representation with extensive inference helped the historian develop a better solution to the question of whether the British or the colonial soldiers fired the first shot.

Effective problem representation requires the problem solver to determine the relevance of information and *exclude irrelevant information* (J. L. Cook, 2006; Littlefield Cook & Rieser, 2005). This requires the problem solver to decide what information is needed to solve a problem and what can be ignored (B. J. Barron et al., 1998). Consider this problem: "Susan and Pedro got married 5 years ago, and now they have two children, ages 4 and 2. Assuming that the children make typical progress through school, in what year will the younger child legally become an adult?" To answer this question, students must recognize that only one of the three numbers provided is relevant, the age of the younger child. The child's normal progress through school is also irrelevant. Students must also bring in two numbers that are not explicitly included in the problem statement: the current year and the age at which children become adults. Students are often unskilled at determining the relevance of information, in part because they have too few opportunities in school to grapple with such problems.

Identifying subgoals. Most real-world problems are complex rather than simple, and as problem solvers formulate solution plans (Polya's second strategy in problem solving), the solution plans often include many steps. These steps mean that in order to achieve the final goal, problem solvers must work out a series of subgoals along the way that will help them get to their final goal, step by step (Thevenot & Oakhill, 2006). Hence, effective problem solvers identify subgoals that they can achieve on the way to the final goal.

As an example of a problem that requires problem solvers to set subgoals in order to achieve a final goal, consider this authentic problem that was posed to seventh graders in a recent project (Malhotra, 2006). The problem was to figure out how large a drainage trench on school grounds would need to be to hold the runoff from an average heavy rain storm. The students' results were used to plan the actual digging of a drainage ditch. To solve the problem, students had to break it down into a series of steps. Each step had a subgoal that needed to be achieved on the way to achieving the overall goal. Some of these subgoals were:

- determine how much rain falls during a typical heavy rain storm
- determine the area of the school grounds
- determine what volume of water can be expected to run off (vs. percolate into the soil) in the direction of the ditch
- determine the dimensions of a ditch that can hold the volume of water that would run off

Effective problem solvers learn to set subgoals when solving multi-step problems (B. Barron, 2000).

Even relatively simple multi-step problems can present a challenge to younger (and some older) children. Consider this problem from a study by J. Taylor and Cox (1997, p. 191): "At the June Fair, lemonade costs $0.60 for a small glass and $0.80 for a large glass. Chocolate chip cookies are $0.25 each. How much will 8 small glasses of lemonade and 3 cookies cost?" Solving this problems (without using algebra) involves three subgoals: Students must determine the cost of the 8 small lemonades using multiplication (subgoal #1), the cost of the 3 cookies (subgoal #2), and the total cost by adding the results of the previous two subgoals (subgoal #3). Without specially designed instruction, few fourth graders were able to solve these problems.

Monitoring for sense. Effective problem solvers check to be sure that their initial problem solutions make sense (Van Haneghan, 1990). Consider a student who is asked to solve this problem on a test: "A cyclist is riding at 15 miles per hour. How long will it take to get to Dallas, which is 30 miles away." Although the student sets the problem up correctly, he accidentally hits the multiply key instead of the division key, arriving at the answer 450 hours, which he writes on his test paper. If the student had checked his work, he would have realized that this answer is so far from being reasonable that it must be a mistake. But he did not check to see whether the answer made sense.

Noticing commonalities and differences. Polya's last step directs problem solvers to reflect on what they can learn from the problem they have solved. Learning from problems is enhanced when problem solvers construct general schemas for how to do problems (Reeves & Weisberg, 1994). One way to build general schemas is to reflect on the current problem and compare it with other problems that have been encountered (Novick & Bassok, 2005). Suppose a child is learning to solve word problems that involve addition and he encounters two word problems:

1. Ellen has 3 nickels, and Miranda has 5 nickels. How many nickels do they have together?
2. Gina has 5 baseball cards, and Caleb gives her 4 more. How many baseball cards does she have now?

It would be useful if the child compares these problems and notices what they have in common at a general level: in both cases, the problem statement describes objects being combined or put together, and then the problem asks how many objects there are after they are put together. The child might notice that the two problems have different wordings, and therefore that both wordings signal that objects are being combined and that addition is called for. When students construct general schemas that can be used to describe different problems within the same general category, students are better able to solve related problems in the future (Gick & Holyoak, 1983).

Problem 7.7
Understanding students' thinking: Problem solving strategies
A group of seventh graders are working on the following algebra problem: "Rachel is 2/3 as tall as Mario, who is 6 feet tall. Mario weighs 142 pounds, which is 53 pounds more than Rachel. How tall is Rachel?" Here is an excerpt from their conversation:

Student 1: I think this is one of those fraction multiplication problems.
Student 3: Yeah, like the one yesterday with the guy who was half as tall as his father.
Student 2: So in these problems, we're supposed to make an equation with the fraction. And we can forget about the weight. Weight doesn't matter to find the height.
Student 4: [after a pause as everyone worked on the equation] What did you get?
Student 3: I used m for Mario's height, and r for Rachel's height, and I got 2/3r = m.
Student 2: But that would mean that Mario is two thirds as tall as Rachel. And that would mean Rachel is 9 feet tall.
Student 1: Rachel has to be shorter than Mario.
Student 3: I see, so it has to be the other way. r = 2/3 m. So when you see two-thirds <u>of</u> something, you multiply the number by two thirds.
Student 2: [after a pause as they quickly solve the equation] So Rachel is 4 feet tall. Right?
Student 4: That's what I got. And 4 is two thirds of 6. So it works.

Evaluate the students' problem-solving strategies?

Response: *This conversation displays good use of several strategies:*

- *Problem representation (when the students work on setting up the correct equation, and explaining to themselves how the equation should be set up, and when Student 2 notes that weight can be excluded from their problem representation)*
- *Noticing commonalities and differences (when Student 3 notices that it is like a problem*

encountered yesterday, and Student 1 labels these "faction multiplication problems." Then, it appears that Student 2 compares the wrong equation, m=2/3r, with the correct equation, r=2/3m, and then generalizes a rule from this comparison.
- *Monitoring for sense (when Student 2 notes that Rachel can't be 9 feet tall, and Student 4 notes that the answer makes sense)*

In this section, we have examined problem solving strategies (problem representation, identifying subgoals, monitoring for sense, and noticing commonalities and differences) that help students learn to solve a wide variety of problems more effectively. All of these are strategies that self-regulated problem solvers use to tackle problems and check how well they are doing as they work on the problems. In the next section, we will turn to strategies that can help students become better writers.

Writing Strategies

Writing can be viewed as a very difficult kind of problem in which there are *many* possible solutions but no definitive criteria for defining what makes for a good solution. For example, consider a student who is asked to write a persuasive newspaper column on what should be done about global warming. There is no single best way to write this editorial, and people disagree on what makes for a well-written editorial on this topic. Thus, writing is an example of an *ill-structured problem*, which we discussed in Chapter 1. Writing stands in sharp contrast with well-structured problems that have a clear solution that can be readily agreed upon (Spiro et al., 1987).

In this section, we will discuss several strategies that distinguish effective from ineffective writers. Much of the current work on writing strategies has been strongly influenced by a model of writing developed by psychologists John Hayes and Linda Flower (Hayes & Flower, 1986). There are three basic writing processes: planning, sentence generation, and revising. **Planning** refers to generating ideas to write about and thinking about how to organize these ideas before actually beginning to write the essay. **Sentence generation** is the actual writing down of sentences. **Revising** refers to changes that are made once a draft of a passage has been written. Planning, sentence generation, and revising are guided by goals, which in skilled writers are strongly influenced by the writer's anticipation of how the expected audience will react. Among these processes, planning, revising, and considering the audience strongly distinguish better from worse writers. We will focus on these strategies in this section. Throughout this section, the term writers refers to anyone who writes. We are especially interested, of course, in student writers.

Planning. Effective and ineffective writers differ in how they approach planning. As an example, consider a study by psychologist Ronald Kellogg (1988). Kellogg had undergraduates write a formal letter in which they were to argue in favor of a particular system of busing, after they had read details about several possible systems. Some undergraduates were directed to construct outlines; outlining is one way to plan before writing. Other undergraduates were given no specific directions. The undergraduates in both conditions could spend as much time as they chose to write the letters. The average student took less than 30 minutes from start to finish.

Before you read further, think about what you would predict about the results of this study. How many minutes do you think the students who were not asked to write outlines spent planning their letter before they began writing? In other words, how long did they spend thinking about what they would write (perhaps jotting down notes of some kind) before they began writing their letter? The answer is that they spent an average of zero minutes planning before they started writing. Students directed to write outlines before they began writing the letter spent an average of 8 minutes planning. Judges who were blind to experimental condition judged the quality of the letters. The students in the outline group wrote letters that the raters judged superior to the letters written by students in the no-outline group.

As this study illustrates, more effective writers plan at the outset of their work, often by outlining or jotting down ideas in some other way (R. T. Kellogg, 1994; Ronald T. Kellogg, 2006; McCutchen, 2000). Planning includes both *generating* ideas and *organizing* those ideas (Hayes & Flower, 1986; R. T. Kellogg, 1994). **Generating** ideas refers to coming up with ideas that could be included in the written document. When generating ideas, effective writers typically generate more ideas than they will actually use, so that they have a pool of ideas from which to select. When generating ideas on a persuasive column on global warming, the learner may begin brainstorm by writing down everything that comes to mind. She might also consult other sources such as the Internet or magazine articles to generate further ideas. **Organization** is the process of deciding which ideas to include in the final paper and working out how to arrange them. The student writing on global warming decides which arguments to include, what evidence is most persuasive, and what order to put them in. Planning can suffer either from generating too few ideas to work with or from failing to fashion these ideas into a coherent whole.

Highly effective writers spend a substantial amount of time planning before they begin to write (Ronald T. Kellogg, 2006). Before writing, they may spend significant time thinking about the problem, mulling it over, and trying out different possible ways of writing the paper (Hayes & Flower, 1986). Ineffective writers tend to start right in with their first or second idea and follow this idea to completion.

Expert writers often start out by developing some very general plans. They don't get detailed at the beginning of the process. Instead of focusing on the details, they start off making general plans, fully aware that they may revise these plans. They realize that there is no point in spending a great deal of time on details when they may change their overall plan later on. Thus, effective writers are also open to changing the overall plan for the paper even after they begin writing it (Bryson et al., 1991, p. 61).

Planning among younger writers. The research we have discussed so far concerns planning with secondary and postsecondary student writers. Bereiter and Scardamalia (1987) examined the typical writing of younger students. Table 7.3 illustrates two approaches to planning for writing. Both writers were writing about the influence of TV programs on children. They were thinking aloud as they were planning their essays. The expert writer was an adult. The novice writer was a sixth grader. Before you read on, think about how you would characterize the differences between these two writers' planning.

Table 7.3:
Excerpts from Think Aloud Protocols of Two Writers

An expert writer	A novice writer (a sixth grader)
--So, I'm looking for examples of programs that could be argued . . . that could be argued were good influences on children. --Now I know I already don't believe this, but Sesame Street comes to mind a s a possible good influence, --And I find myself trying to work it out. --So I'm going to say . . . --I'm making up two columns here . . . and just trying to respond to my own through processes. --So I guess what I need is three columns here . . . I need a column just for the specific and the examples. And I can work back and forth between columns. --Sesame Street is good because it could be argued that it educates. --And educates in a specific way . . . giving children basic information, ABC's etceteras. --But immediately when I say it's a good influence, I have reservations about it. --Now I'm just trying to clarify for myself the reservations about . . . (Bryson et al., 1991, p. 72)	--I think it is good and bad for children to watch television because I like the cartoons and some said movies. --But I like good movies that come on TV because they are good to watch. --But usually it is good to watch comedy shows because they are very funny. --They keep you laughing almost every time you watch them. --It is good to watch interesting movies. --Interesting shows like Young and the Restless, All My Children, and General Hospital . . . because it's sometimes exciting. --But pay TV has some very good movies like Splash, Police Academy, Romancing the Stone. --But sometimes I watch sports. --My favorite sport is baseball. --I like football, but not that much. --I hate golf and tennis and all the other stuff except soccer. --but I usually watch wrestling at my friend's house because it's kind of exciting and I like the way they fight. (Bryson et al., 1991, pp. 72-75)

According to Bereiter and Scardamalia's analysis, students who are effective writers engage in a process of **knowledge transformation**, which means that they rework their ideas into new thoughts and organizational patterns (Galbraith, Ford, Walker, & Ford, 2005). In the first protocol, you can see the expert writer working through ideas, trying to reorganize them and think of new things to say. The expert writer was engaged in knowledge transformation. In contrast, the sixth grade student in Table 7.3 was engaging in a process called **knowledge telling** (McCutchen, 2006). Knowledge tellers do not rethink or rework their ideas. Instead, they think of ideas in whatever order they come to mind, and they generally write these ideas down on paper as they think of them without any thought about how the ideas will fit into an overall structure. These students don't plan their writing because they write what they are thinking in the exact order that they are thinking it.

Younger students tend to be knowledge tellers when writing. During the elementary school years, some begin to shift to a knowledge transforming model of writing. Teachers of elementary school children should help students move from the knowledge telling strategy to the knowledge transforming strategy.

Revision. After a draft is written, the next step in the writing process is revision. Revision can range from rewriting a whole draft with a new organization pattern to making minor changes in spelling. Good writers spend more time revising than poor writers do (Beach & Friedrich, 2006; Hayes & Flower, 1986; Pianco, 1979). But it is not just the *amount* of revising that differentiates effective from ineffective writers. The type of revision varies as well.

Effective writers' revisions are more global (Hayes & Flower, 1986). That is, effective writers are more likely to make major changes affecting the overall structure of the paper. Students who are effective writers not only plan more extensively; they also make more substantial changes after they have begun writing. As they write, they may change their overall plan, which requires them to go back and rewrite earlier sections. Effective writers are thus more likely to completely rewrite a major section, and they are more likely to revise the overall organization of the paper. In contrast, to the extent that ineffective writers do revise, their revisions are minor changes to words or phrases (Hayes & Flower, 1986; Kellogg, 1994). They may correct a spelling error or add a comma, but they are unlikely to rewrite a whole paragraph to make it more understandable or more coherent.

Problem 7.8. A researcher collected think aloud protocols from six eighth graders as they were revising a paper in which they had written a movie review of a movie of their choice. Which of these statements are likely to be made by effective writers but not by ineffective writers?

A. "I think I should break this long sentence into two sentences."
B. "Oh. This should be *too* with two O's rather than with one O."
C. "I don't think people will understand this part where I explained the basic plot. I'd better do this part again."
D. "I don't think this second reason for hating the movie makes very much sense. Maybe I should take it out and talk instead about how the plot doesn't make sense, and give two or three examples."
E. "If I say, 'Everyone in the theater was laughing,' people might not know whether I mean because the movie was funny, or because it was dumb."

Response: Statements A, B, and E are all primarily about a single word or sentence in the student's essay. Even E—which shows admirable awareness that readers might find a sentence ambiguous—is focused on a single sentence in the essay. Therefore, these statements are all local revisions, and they could be made by ineffective as well as effective writers. Statements C and D reflect an intent to make more global revisions. In statement C, the student demonstrates a willingness to rewrite a whole section because readers might find it hard to understand. Statement D shows the student considering taking out one argument for disliking the movie and replacing with an entirely new argument, which would require substantial new writing. Thus, Statements C and D exhibit an interest in more global revisions that are most likely to be associated with students who write effectively.

Writing for the audience. Writing for the audience refers to an ability to take readers' knowledge and perspectives into account when writing. An effective high school writer will write an analysis of causes of World War I differently if the audience is her history teacher than if the audience is a fifth grade history class. Similarly, an effective writer will write a persuasive essay arguing for higher taxes to support schools differently if readers are likely to be hostile to the idea than if readers are willing to be more receptive. Writing for the audience is difficult because people find it very difficult to take other people's perspectives into account (Cutting & Chinn, 2006; Gehlbach, 2004)

More effective writers attend more to their audience than novices do, and the ability to take audiences into consideration develops with age (Kellogg, 1994). Fourth and eighth graders do not make adjustments to their essays when they are given information about the audience; twelfth graders do (Bracewell, Scardamalia, & Bereiter, 1978).

Problem 7.9.
Understanding students' thinking: Writing strategies

A fifth grader is writing about the causes of the American Revolution for a class history book that his class is putting together. Before he begins writing the paper, he spends 5 minutes writing the following on scratch paper.

Main causes:

~~2~~ 3	soldiers stay in people's houses	
~~1~~ 2	be free	
~~3~~	~~too many taxes~~	
~~3~~ 1	taxes without representation	Boston Tea Party

His final paragraph is as follows:

There were three main causes of the American Revvolution. They didn't like taxes without representation, so they had the Boston Tea Party. They wanted to be free. And they got mad when soldiers were staying in their house.

Evaluate the strategy use that is evidenced in his prewriting and writing.

Response: The student has done some planning, as is evident in his outline. And there is a small amount of revision, as the student crosses out one idea and replaces with another, and also reorders the ideas slightly. But overall, the idea generation is minimal, and there is no generation of supporting ideas. So this is, overall, unsatisfactory planning. It appears that he undertakes no revision once he begins writing. His lack of awareness of the audience is evident in that he doesn't provide any surrounding context, and he leaves the reader to wonder what his pronouns (they) refer to.

We have now examined general self-regulation strategies, comprehension strategies, problem solving strategies, and writing strategies. The writing strategies we have discussed in this section—planning, revising, and writing for the audience—are broadly applicable to students of all ages. By helping your students learn to carry out these strategies, you will enable them to become self-regulated writers who can plan, execute, and revise their writing on their own. In the next section we will turn to our final set of strategies that can help students become more effective learners and thinkers: strategies for reasoning.

Reasoning Strategies

Reasoning strategies help us decide what ideas about the world are true or false. For example, economists use reasoning strategies to try to understand the effects of monetary policy on the health of the economy. Geologists use reasoning strategies to develop and test theories of why earthquakes occur. Teachers use reasoning strategies to decide whether rewards such as stickers are likely to increase or decrease their students' motivation. We will discuss several useful reasoning strategies in this section of the chapter: generating arguments and counterarguments, fair-mindedness in evaluating evidence, estimating frequencies and probabilities, considering sample size, considering control or comparison groups, sourcing, and seeking corroboration.

Much of the research on reasoning strategies has examined the reasoning of adults (undergraduates as well as other adults). This research indicates that adults are not proficient in using many reasoning strategies, including the strategies discussed in this section. This strongly suggests that K-12 schools have not done a good job of preparing students to be good reasoners. In later chapters, you will learn about instructional methods to improve students' reasoning. The focus of this section is to discuss common flaws in reasoning as well as more effective reasoning strategies so that you will gain a good understanding of the problems that instruction in reasoning needs to address.

Generating *arguments and counterarguments.* In a number of studies, participants have been asked questions such as these:

> Do you support or oppose increased taxes for funding education? List all the arguments in support of your position that you can think of. Now list all the arguments against your position that you can think of.

How many arguments can you come up with?

While some students are capable of generating many arguments on multiple sides of an issue, other students generate fewer arguments, and are only capable of generating arguments in support of their own position. Were you able to think of as many arguments *against* your position as *for* your position? If so, you are unusual. Most adults and adolescents can think of two or three times more arguments for their own position than against it (Kuhn, 1991). In addition, researchers have consistently found that most people do not generate very many arguments at all, perhaps two or three arguments for their position and one argument against (e.g., Kuhn, Shaw, & Felton, 1997; Perkins, Allen, & Hafner, 1983).

Thus, a basic failing of human reasoning is that people generally fail to consider sufficient arguments, especially arguments for the opposing position. This suggests that one focus of instruction should be to help students learn to generate more arguments on both sides of questions as they are considering an issue. However, as we will see as we look at the next strategy—fair-mindedness in evaluating evidence—it is not enough simply to generate arguments on both sides of a question. Effective reasoners also evaluate arguments on both sides fairly.

Evaluating evidence fairly. Think about a capital punishment supporter who reads the following study:

> Palmer and Crandall compared murder rates in 10 pairs of neighboring states with different capital punishment laws. In 8 of the 10 pairs, murder rates were *lower* in the state *with* capital punishment. This research supports the deterrent effect of the death penalty.

How do you think the capital punishment supporter would respond? Two representative responses were:

> It shows a good direct comparison between contrasting death penalty effectiveness. Using neighboring states helps to make the experiment more accurate by using similar locations.
>
> It seems that the researchers studied a carefully selected group of states and that they were careful in interpreting their results.

Now—how would capital punishment supporters respond to the exact same study if the results were the opposite, as shown here:

> Palmer and Crandall compared murder rates in 10 pairs of neighboring states with different capital punishment laws. In 8 of the 10 pairs, murder rates were *higher* in the state *with* capital punishment. This research opposes the deterrent effect of the death penalty.

Here are two representative responses by capital punishment supporters to *this version* of the study:

> The evidence given is relatively meaningless without data about how the overall crime rate went up in those years.
>
> There were too many flaws in the picking of the states and too many variables involved in the experiment as a whole to change my opinion.

The method of the study was unchanged. Only the results were different. And yet the responses were totally different. Students found great fault with the study that opposed their views but found no problems with the study that supported their views. The same pattern held for opponents of the death penalty: They found flaws in the study when the results supported the death penalty and found no flaws in the study when the results opposed the death penalty.

As this study illustrates, most people look hard for flaws in evidence that contradict their beliefs, but they don't look hard at all for flaws in evidence that support their beliefs (P. A. Klaczynski, 2000; Paul A. Klaczynski, Schuneman, & Daniel, 2004; Kunda, 1990). In this way, their reasoning is biased rather than fair-minded. Poor reasoners are biased in their evaluation of evidence. Good reasoners, on the other hand, attempt to be more fair-minded in evaluating evidence (Chinn & Brewer, 1993).

Recall from Chapter 5 (prior conceptions), you learned about the various ways in which people discount evidence that contradicts their beliefs. In doing this, people do not always evaluate evidence fair-mindedly. Instead, they may evaluate evidence that contradicts their current beliefs with skepticism and they may gloss over any possible flaws in evidence that supports their beliefs. As a teacher preparing students to reason in the real world, one of your goals should be to promote more fair-minded reasoning. The goal is for students to be able and willing to notice flaws in arguments that support their positions as well as to avoid being too harsh in evaluating arguments against their positions.

Problem 7.10
Understanding students' thinking: Students' arguments

Here is an essay written by a sixth grader on the topic of whether research that harms animals should be illegal. The essay was not to be merely a persuasive essay arguing for one side of the question. It was supposed to be an essay that explored multiple sides of an issue. Here is one student's essay. Evaluate the quality of her essay.

I don't think that animals should be used in research because it's not fair to the animals. Animals have rights too. Even if they're not just like humans, they are still living creatures so we have to treat them kindly. How would you feel if someone wanted to take your pet dog or even your pet hamster and use it for medical research and how would you feel if the pet died? Even if these animals that are being used in research aren't someone's pets, they should still be treated the same as if they were someone's pets. I know that maybe the animals can be useful in medical research, but I haven't heard of any big discoveries being made from using animals. It's usually for stuff like make-up and it's not fair to use animals in research to test the safety of make-up.

Response: This is a very one-sided essay that shows little evidence of fairly considering the evidence on multiple sides. The student barely mentions arguments for using animals in research and discounts the possibility that useful discoveries have been made on the basis of research with animals by saying that she hasn't heard of any such discoveries. But there's no indication that she searched for whether there were any such discoveries. The claims she does make (such as the claim that animal research is usually used to test make-up) are not supported by any specific evidence. She does not critically evaluate her own claims.

Considering sample size. Suppose that Lexie, a high school student, is writing a paper on whether a new fad diet is effective and safe. She reads a scientific study with over 1000 people that shows a slight average weight gain among those following the diet and also demonstrates harmful side-effects of the diet. She also reads the testimony of a single dieter in a magazine who describes how the diet has helped her lose weight and turn her life around. To which piece of evidence should Lexie give more credence? Scientists and social scientists would argue strongly that the study with 1000 people should be given more weight. Other things being equal, evidence based on large samples (i.e., large numbers of people, animals, or other objects of study) is more credible than evidence based on small samples or just a single case. C**onsidering sample size** refers to taking the number of objects of study into account when drawing conclusions.

Effective reasoners prefer evidence based on larger sample sizes (Jacobs & Narloch, 2001; Watson & Moritz, 2000). Ineffective reasoners do not pay attention to sample size, and indeed they often find stories or vivid examples more persuasive than better data based on larger samples (Chinn, 2006; Nisbett & Ross, 1980). As an example, consider this problem adapted from Fong, Krantz, and Nisbett (1986).

> The Caldwells had long ago decided that when it was time to replace their car, they would get what they called "one of those solid, safety-conscious, built-to-last Swedish cars"—either a Volvo or a Saab. As luck would have it, their old car gave up the ghost on the last day of the closeout sale for the model year both for the Volvo and the Saab. They quickly got out their *Consumer Reports* where they found that the consensus of the experts was that both cars were very sound mechanically, although the Volvo was felt to be slightly superior on some

> dimensions. They also found that the many readers of *Consumer Reports* who owned a Volvo reported having fewer mechanical problems than the many readers who were owners of Saabs. They were about to go and strike a bargain with the Volvo dealer when Mr. Caldwell remembered that they had a friend who owned a Saab and one who owned a Volvo. Mr. Caldwell called up the friends. The Saab owner reported having had a few mechanical problems but nothing major. The Volvo owner exploded when asked how he liked this car. "First that fancy fuel injection computer thing went out: 250 bucks. Next I started having trouble with the rear end. Had to replace it. Then the transmission and the clutch. I finally sold it after 3 years for junk."

Given that the Caldwells are going to buy either a Volvo or a Saab today, which do you think they should buy? Why? Good reasoners will realize that if the Caldwell's goal is reliability, the Volvo is the better choice. The experiences of many Volvo owners (reported in *Consumer Reports*) is a better predictor of whether a new car will be reliable than one owner's experience. It's more helpful to look at the maintenance records of thousands of Saabs and Volvos than of 1 Saab and 1 Volvo. But many people who read this story do not reason in this way and instead recommend that the Caldwell's choose the Saab, based on this single vivid story. When making a decision then, students who understand the value of statistics will make more informed choices.

These two examples (diets and choice of cars) illustrate the importance of considering sample size in everyday decision making. The implication for teachers is that students should learn to give greater weight to evidence based on larger rather than smaller samples. In later chapters, we will examine ways to help students learn to reason about sample size as well as about other issues.

Figure 7.7: The SAT Problem
Does Doxymillin work?

Scientists have been trying to find out how nutrition affects learning. They studied 30 high school juniors in a New Jersey school. The students agreed to eat a very healthy diet. They ate many fewer fatty foods and junk foods. They cut way back on foods with processed sugar. Then they checked on how the students did on tests that they took for college, such as the SAT test.

They found that the students got an average SAT score of 1195, which is much higher than the average SAT score of students in New Jersey.

What should the scientists conclude from this study? Explain your answer as much as you can.

Considering comparison groups. Read the problem in Figure 7.7. How would you answer the question posed in the figure? Nearly all middle school students as well as most high school students and even many undergraduates respond that the scientists can conclude that those who eat healthy diets get high SAT test scores, or a conclusion similar to this . However, there is a crucial piece of information missing from this problem: The SAT scores of other students in the same high school who did *not* eat the very healthy diet. Without this information, it is not possible to draw any conclusion about diet. Suppose that this was a high school with very high SAT scores on average. In fact, suppose that if all juniors took the SAT, their average test score would be 1197. Then an average SAT score of 1195 for students eating a healthy diet would be just about at the average of the whole school. Without knowing the SAT scores of other students in the same high school, no conclusion at all can be drawn from the study.

When effective reasoners see problems like the one in Figure 7.7, they notice that there is a need to consider a relevant *comparison group*, in this case students in the *same high school* who ate a less healthy diet; ineffective reasoners are more likely to draw conclusions from insufficient information (Klaczynski, 1997; Stanovich & West, 1998). This brings us back to an idea we discussed in Chapter 1: the importance of comparison groups in experimental research. As you learned in Chapter 1, a relevant *comparison group* is a group that is similar to the *treatment group* in as many respects as possible except for the treatment. In experiments with random assignment, the comparison group is a *control* group. In situations where random assignment is not carried out, one can still try to identify relevant comparison groups that are as similar as possible to the group of interest. Without such comparison groups, meaningful conclusions are often impossible.

Here is another example. A teacher is trying to figure out why seven of his fourth grade students are doing poorly. The teacher thinks that the cause may be that the students are spending too much time watching TV. Therefore, the teacher interviews each student and finds out that all 7 students watch TV for at least 2 and a half hours a day. He concludes that too much TV is the cause of the problem. Has the teacher drawn a valid conclusion? The answer is no, because the teacher has not compared these students with students who are doing well. In fact, most American children watch from 3 to 5 hours of TV per day (Christakis, 2007). It is likely that the children doing well watch many hours of TV per day, as well. If so, this cannot be the factor causing the seven children to do poorly. Faulty conclusions arise from not thinking comparatively.

Problem 7.11
Understanding students' thinking: Evaluating students' use of evidence

A student thinks that laziness causes school failure. The teacher asks, "Why do you think so?" The student replies, "Because I see it around me, you know. I have friends who fail. They figure it's the right thing to do, and, you know, they just get lazy or want to hang out with their friends. And I read someone say the same thing on some blog on the internet." Evaluate this student's reasoning. (adapted from data in Kuhn, 1991)

Response: *In terms of the strategies discussed in this chapter, the student's reasoning is flawed in several respects. The student is considering only a small sample (a few friends). The student also fails to consider appropriate comparison groups, such as students who do not fail; do those students also like to hang out with their friends? You could also say that the student has not tried to generate possible evidence on the other side of the question. And the student does not employ the strategy of sourcing with respect to the information read on the blog. Whose blog is this? Is the blog trustworthy? The student does not attend to these issues.*

Sourcing. **Sourcing** refers to carefully considering the source of evidence and how credible the source is when evaluating evidence. For example, if you are a juror hearing eyewitness testimony in a murder trial, you will be most confident in the testimony if the eyewitness has no reason to be biased, if the eyewitness had a clear view of the event, and if there is no reason to suspect that the eyewitness has distorted memories of the event (cf. Ennis, 1987). If an eyewitness stands to profit financially from the defendant's conviction, you are likely to treat the testimony more skeptically than if the eyewitness is a neutral observer who did not previously know the defendant. Studies indicate that students often fail to consider the source of evidence when they weigh the evidence (Britt & Aglinskas, 2002; De La Paz, 2005; Wiley & Bailey, 2006). Some characteristics of trustworthy sources are in Table 7.4

Table 7.4:
Characteristics of trustworthy sources

Characteristic	Definition	Example
Position	Occupation or credentials	A general is better placed to give a trustworthy account of troop movements than a medical aid who knows nothing about strategy.
Motivation	Reason for the author writing the document	A political opponent of Lincoln is less trustworthy source about Lincoln's motivations than a neutral source.
Participation	How the author came to know about the events that are described	A nurse who served in battlefield hospitals is a more trustworthy source of hospital conditions than a nurse who was never there.
Date	Time period in which the document was written	An eye witness report written immediately after a battle is more trustworthy than an eye witness report written fifty years later.
Document type	The kind of document such as personal letter, official record, formal treaty, tabloid article, etc.	A *New York Times* article is likely to be more trustworthy than an article in a sensational weekly tabloid.

adapted from Britt & Aglinskas (2002)

Recall from earlier in the chapter, educator Sam Wineburg (1991) gave high school history students and historians a set of one-paragraph documents about whether the colonials or the British fired the first shot on Lexington Green in 1775 to start the American Revolutionary War. When reflecting on documents, historians considered the source of the document 98% of the time; high school students considered the source of the document only 31% of the time. One student was reading an excerpt from a British officer's diary, and when she got to the end, where the source was listed, she suddenly exclaimed "Oh my God, it's British" (Wineburg, 1991, p. 79). Historians, in contrast, regularly checked the source first before reading the document.

Sourcing has become particularly important in the age of the Internet, where there are many untrustworthy sources that put information on the web (Wiley & Bailey, 2006). When looking for information on AIDS, an American Medical Association website is likely to be more credible than a website published by a person making wild claims about contagion that are not supported by any scientific evidence. But elementary, middle, and high school students may have difficulty discriminating trustworthy from untrustworthy sites.

The examples in this section point both to the importance of helping students learn to check sources of documents regularly and to the importance of learning what makes a source trustworthy. In later chapters, we will examine instructional methods that can help students learn about strategies such as sourcing.

Seeking corroboration. **Corroboration** refers to checking "important details against each other before accepting them as plausible or likely" (Wineburg, 1991, p. 77). As Wineburg (1991) found in his study of historians and high school students, historians sought to corroborate details from one document with other documents; high school students did not. When reading a textbook account of the battle at Lexington Green that said that the rebels were ordered to disperse but stood their ground, one historian said, "It's not clear that they were ordered to disperse, the depositions don't indicate that, the British accounts do indicate that. Let me check back to Barker [the author of another document] for a second--yeah, Barker doesn't even say there was any dispersal." Thus, the historian was trying to use the different available historical documents to corroborate each other as well as to corroborate what the textbook said. In contrast, a high school student said in response to the same document, "It seems in a way [to be] just reporting the facts, 'The rebels were ordered to disperse. They stood their ground,' just concise, journalistic in a way, just saying what happened there" (Wineburg, 1991, p. 81). The student did not notice that there were historical documents that did not corroborate the textbook account, nor did the student seem at all disposed to search for corroboration.

By seeking corroboration for evidence, students are more likely to arrive at an accurate picture of events (Brem, Russell, & Weems, 2001; Britt & Aglinskas, 2002). If multiple sources agree on a claim, that claim is more likely to be true. In a jury trial, three eyewitnesses who agree that they saw a person rob a store is more credible than a single eyewitnesses, because the eyewitness corroborate each other. Finding fingerprint evidence at the scene of the crime provides further corroboration. The more corroboration there is for a claim, the more trustworthy the claim is. Thus, an important goal of teaching is to help students to appreciate the value of corroboration and to actively seek corroboration for claims.

Problem 7.12.
Evaluating teaching: A teacher-constructed questionnaire

A teacher gives out a questionnaire to his high school history students. Here is the questionnaire and one student's responses. Evaluate the questionnaire; does it do a good job of determining what strategies students use to study for tests? Then evaluate what you can learn from the student's responses.

Name: Jarrod Williams Period: 3

Think about how you studied for your last history test.
Rate your agreement with each statement. Circle one number.
1 = you completely disagree
5 = you completely agree

1. I studied a lot.	1	2	3	4	(5)
2. I reviewed the textbook.	1	2	3	4	(5)
3. I reviewed my notes.	1	2	3	4	(5)
4. I asked myself questions as I studied.	1	(2)	3	4	5

Now describe your approach to studying for the test.

I studied my textbook in the evening, and I reviewed my notes during study hall before class.

Response: At least three of the four questions with ratings are very ambiguous. What does it mean to study a lot? Different students will interpret "a lot" very differently, so it is difficult to *interpret students' answers without knowing exactly how much they studied. Did Jarrod study 30 minutes in the evening and 40 minutes during study hall and think that this is a lot of studying? How much is a lot? The two questions about reviewing the textbook and the notes do a poor job of getting at exactly what strategies the students are using. "Reviewing" could include simply rereading the text or studying it much more actively using elaboration or explanations. The fourth question is better, in that it is clearer about a specific strategy (asking questions about the text) that the students might use. Asking oneself questions is a way to stimulate one's own elaboration or explanations of the text.*

Although the ambiguity of the first four questions makes definitive interpretation of Jarrod's responses impossible, his responses suggest that he may not have studied using active comprehension strategies. He said that he did not use the one active strategy listed—asking himself questions about the text. His reviewing may have been limited to rereading the text and his notes.

The open-ended question at the end is one that allows students to show the extent to which they have metaawareness of the effective or ineffective strategies that they are using. Jarrod uses very general verbs ("studied" and "reviewed"). Either he lacks the motivation to tell more about the specific strategies he is using, or he lacks the metacognitive awareness needed to say more precisely the strategies he is using.

In this section we have examined six reasoning strategies that can help students become more effective reasoners: generating arguments and counterarguments, fair-mindedness in evaluating evidence, considering sample size, considering comparison groups, sourcing, and corroboration. All of these strategies can help students learn to think critically and fairly about evidence and to use evidence effectively to reach well-founded conclusions. These reasoning strategies can be emphasized across subjects and ages. We will explore instructional strategies more thoroughly in later chapters.

HOW TO EVALUATE STUDENTS' STRATEGY USE

In this chapter, you have now learned many strategies that you can productively teach your students. You have seen that it is possible to help students become much more effective learners and thinkers if you teach them more effective cognitive strategies. In the *Understanding Students' Thinking* problems you have encountered so far, you have also begun to gain experience in evaluating students' strategy use based on their talk in individual think alouds and their talk in group work. As a teacher, you will need to be skilled at diagnosing what strategies students are (and are not) using.

There are two basic methods you can use to identify the cognitive strategies your students are using to evaluate how well they are using them: (1) Administer self-report assessments to find out what kinds of strategies your students say that they use. (2) Pay attention to what students say when they talk (in individual think alouds, in group work, and in class discussions) and to what they write in their written work.

Administering Self-Report Assessments

A **self-report assessment** is an assessment that asks students questions about their own personal characteristics, such as the strategies that they use when they study. One way to find out what strategies your students use is simply to ask them. You could, for example, ask a student after school how he studies for a test. By asking follow up questions, you could prompt him to be specific about the strategies that he uses. Or at the beginning of class near the beginning of the term, you could also ask all of your students to write down for you the typical strategies they use on a particular task (such as studying vocabulary words).

One type of self-report is called the **cognitive strategy questionnaire**, a questionnaire which asks questions about students' strategy use. One widely used questionnaire to assess cognitive strategies is the *Motivated Strategies for Learning Questionnaire (MSLQ)*, which includes motivational items (discussed in Chapter 7, Motivation and Core Beliefs) as well as items used to assess learning strategies. Figure 7.8 presents several MSLQ items from a version of the MSLQ reported by Pintrich and De Groot (1990). It is in a form that you could hand out to students to answer. The first set of items is designed to assess use of several cognitive strategies. The second set of items assesses self-regulation.

Figure 7.8: Items from the MSLQ

Rate each of these statements on a scale from 1 (not at all true of me) to 5 (very true of me).

Cognitive strategy use:	not at all true				very true
1. When I study for a test, I try to put together the information from class and from the book.	1	2	3	4	5
2. It is hard for me to decide what the main ideas are in what I read. (reversed)	1	2	3	4	5
3. When I study, I put important ideas into my own words.	1	2	3	4	5
4. I always try to understand what the teacher is saying even if it doesn't make sense.	1	2	3	4	5
5. I use what I have learned from old homework assignments and the textbook to do new assignments.	1	2	3	4	5
6. When I am studying a topic, I try to make everything fit together.	1	2	3	4	5
7. I outline the chapters in my book to help me study.	1	2	3	4	5
8. When reading I try to connect the things I am reading about with what I already know.	1	2	3	4	5
Self-regulation					
1. I ask myself questions to make sure I know the material I have been studying.	1	2	3	4	5
2. When work is hard I either give up or study only the easy parts.	1	2	3	4	5
3. I work on practice exercises and answer end of chapter questions even when I don't have to.	1	2	3	4	5
4. Even when study materials are dull and uninteresting, I keep working until I finish.	1	2	3	4	5
5. Before I begin studying, I think about the things I will need to do in order to learn.	1	2	3	4	5
6. I often find that I have been reading for class but don't know what it is all about. (reversed)	1	2	3	4	5
7. I find that when the teacher is talking I think of other things and don't really listen to what is being said. (reversed)	1	2	3	4	5
8. When I'm reading, I stop once in a while and go over what I have read.	1	2	3	4	5

NOTE: On most items, a higher score indicates better strategy use; on "reversed" items, a lower score indicates more sophisticated strategy use.

By giving a questionnaire such as this one, you can learn a great deal about your students' strategy use. There are currently websites that allow students to take different versions of the MSLQ online. Other questionnaires, such as the Learning and Study Strategies Inventory (LASSI) (Weinstein, Zimmermann, & Palmer, 1988), can be purchased and administered to students. Research with questionnaires such as the MSLQ and the LASSI has usually found small but statistically significant correlations between reported strategy use and measures of achievement such as course grades or GPA (e.g., Karabenick & Sharma, 1994; Pokay & Blumenfeld, 1990). If you cannot use a professionally developed questionnaire, or if you want to assess use of a strategy not covered by existing questionnaire, you could construct your own questionnaire with items like the ones above to gain insights into your students' thinking.

Problem 7.13. Understanding students' thinking: Elaborations

Now try your hand at evaluating students' elaborations. Here are two middle school students whose teacher has asked them to use the strategy of elaboration in response to the text below. Does each response display elaboration?

Text: Jackson was the first president to use the veto extensively. Earlier presidents had used the veto very rarely, and only when they believed that a bill that Congress had passed was unconstitutional. Jackson used the veto as a weapon of policy.

Nate. "Earlier presidents didn't use the veto much, but Jackson used it a lot. Earlier presidents didn't veto a bill unless they believed it was unconstitutional. But Jackson was different."

Julien. "Most presidents today use vetoes a lot, so it looks like Jackson started something that has continued for almost 200 years."

Response: Nate does not elaborate. This is a paraphrase, a lengthy one, but still a paraphrase. There are no substantial ideas mentioned that were not already in the original text. Julien does elaborate. He connects what he is reading to his knowledge of contemporary presidencies.

One obvious problem with self-report measures of strategy use is that students may not truthfully tell you what strategies they actually use, or they may not interpret the items in the way that you intend. For instance, when a student reports that she usually "carefully studies each step in the example problems," she may think that this means that she reads every word in the example problems, not that she actually tries to explain each step. Self-report measures also require students to have metacognitive knowledge about the strategies they use; many students, however, may use effective or ineffective strategies but be unable to tell you what they are.

Listening to students' talk and reflecting on their written work. You have already had practice evaluating students' strategy use in the application problems. As these problems indicate, there are several different ways to find out about your students' strategy use. One excellent way is to really listen to them and reflect on their strategy use when they are talking in groups or in class discussions. (I'll discuss this more in later chapters on discussions and collaborative learning.) You can also examine students' written work to see what strategies they seem to be using, as you have done in earlier application problems in this chapter.

You can also elicit think alouds when you are working one on one with students, perhaps before or after school. It is quite easy to get students to think aloud as they are reading or solving a problem. You can use instructions such as those in Figure 7.9 to get students started (see Chan et al., 1992; Chi, de Leeuw, Chiu, & LaVancher, 1994). As you carefully listen to what your students say as they are thinking aloud, you will gain insights into which strategies they are using and how well they are using these strategies. You will have a chance to develop your skill evaluating students strategy use from think alouds in the problem sets at the end of the chapter.

Figure 7.9:
Instructions to help students think aloud

Example of instructions for older students (upper elementary)

"When you think out loud, you read a short section, and then you pause and say anything at all that comes to mind as you read the sentences. These questions might give you some ideas of what to say:

--What does this mean?
--Is there anything I don't understand? Is there anything I wonder about now?
--Is anything different from what I thought before?
--How do the new ideas tie in to things I've learned before?"

Example of instructions for younger students (early elementary)

When you think out loud, you read these sentences, and then you stop and say anything you are thinking.

-- You can talk about what the sentences mean.
-- You can talk about something you don't understand in the sentences.
-- You can talk about any new ideas you have when you're reading.

STRATEGY INSTRUCTION: MAKING THINKING PUBLIC

In later chapters, you will learn how to teach cognitive strategies to your students. Right now, we will foreshadow one important point about teaching cognitive strategies. An important component of instruction that promotes strategy development is *making thinking public,* or *making thinking visible* (Collins, Brown, & Newman, 1989). Making thinking public refers to explaining one's thinking in group and class discussions.

To illustrate the importance of making thinking public, let's consider the following hypothetical example of a discussion in a fifth grade social studies class. One of the teacher's goals is to help students infer the meaning of unknown words. In the following passage, the word *cargo* is unfamiliar to many students. They read: "Did Sam Adams organize the Boston Tea Party? Although he never said so publicly, he very likely knew that it was planned. Whoever led the tea party, however, made sure that the protest was orderly. Only tea was destroyed. No other cargo was touched. The Boston Tea Party was meant to show Britain that the colonist would act firmly."

Teacher: What do you think cargo means?
Rafael: I think it means something like products.
Teacher: That's very close. We could say that cargo is the products that are carried by a ship.

If the teacher's goal is to help students learn how to infer the meaning of unknown words, did the teacher succeed? Has Rafael inferred the meaning of a new word, or did he already know this word, or did he just make a lucky guess? The teacher simply doesn't know because he hasn't asked Rafael to explain how he arrived at this definition. In addition, suppose that there are 14 students in the room who do *not* know how to infer the meaning of this word. They might have learned the meaning of *cargo*, but they have not learned anything about how to derive the meaning of a word from context.

In contrast, consider this exchange:

Teacher: What do you think cargo means?
Rafael: I think it means something like products.
Teacher: How did you come up with that answer?
Rafael: Well, I looked at those two sentences. One sentence says that only tea was destroyed. The next sentence says that no *other* cargo was touched. So I was thinking that cargo is something on the ship that *could* have been have been destroyed. Cargo could be things carried on the ship, like products being taken from one place to another.

This time the teacher followed up on Rafael's answer by asking him to explain his thinking. From Rafael's answer, the teacher knows that Rafael did know how to infer the meaning of this word from its context. Because Rafael explained his thought process, those 14 students who did not know how to infer the meaning of the word *cargo* have a chance to learn something about how to do it from Rafael's explanation. By listening to Rafael explain his thinking (i.e., from Rafael making his thinking public), these students might learn that they should consider adjacent sentences, and that words like *other* can be a good clue.

Figure 7.10:
Showing cognitive work

[This is a two panel drawing.

The panel on the left shows a girl about 11 years old saying "I think the paragraph summary is that Hawaii has people from many different backgrounds."

The label under this drawing says "Doesn't show cognitive work."

The panel on the right shows the same girl saying, "I think the paragraph summary is that Hawaii has people from many different backgrounds. I got this idea because each of the sentences in this paragraph talks about people from different backgrounds, like Japanese, Chinese, Polynesian, and European. Even though there isn't any topic sentence, I can figure the topic out because all the sentences are about this one idea."

The label under this drawing says "Shows cognitive work."]

Making thinking public is analogous to "showing your work" on a math problem. Most of you probably had a math teacher who would not accept homework or tests that only showed the answers to a problem, you had to show all the steps you followed to answer the question. Making your thinking public is a verbal form of showing your work, as illustrated in Figure 7.10. The girl on the left of Figure 7.10 simply gives a summary of a paragraph without explaining how she got the answer. On the right side of Figure 7.10, she does explain how she came up with her summary, thus showing her cognitive work.

How can teachers encourage students to make their thinking public? Asking the questions as our hypothetical teacher did can elicit students to reveal their thought processes. Additional questions and statements that teachers use to help students verbalize their thoughts are illustrated in the transcript presented below. This transcript, based on research by Taylor and Cox (1997) shows a teacher (T) working with fourth graders (J, R, L) solving relatively complex math problems. In the transcript, the students are working on this math problem: Amy has $28. She plans to save $3 each week. In how many weeks will she have enough money to buy a telescope that costs $49? Notice what the teacher says to elicit students' public thinking.

Dialogue		Analysis
T:	OK, how's his math? Everything OK up there [on the whiteboard where the student has written his answer]?	← The teacher asks other students to evaluate one student's work.
J, R:	[together] Yeah.	
L:	I don't know yet.	← The teacher asks the student to explain why she doesn't know. Then the students try to explain their thinking in the next several turns.
T:	What do you mean, we don't know yet?	
L:	Well, it could be wrong. We didn't check it yet.	
T:	We didn't check it yet, but as for his division, 21 divided by 3, is that correct?	
L:	Yeah.	
T:	What about the subtraction 49 minus 28?	
L:	Well, we only gotta go 7, minus 14, minus 28 to check it.	
T:	Well, we're not up there yet are we? So, what's the answer to our question so far?	
L, J, R:	[together] Seven.	
T:	OK, Linda, you can go up there [to the whiteboard **] and give it a good ol' try. Talk to us. Tell us what you're doing while you check it.	← Here the teacher gives explicit instructions asking Linda to make her thinking public by telling what she is doing as she works at the board.
L:	7 times 3, so if it's 21, then we know it's the answer. And it *is* 21!	
T:	OK, but how do you know?	
		← The teacher prompts the student to explain her thinking even more.
L:	Because 7 plus 7 is 14, and then you add another 7 and it's 21.	
T:	Right, but how do you know she has enough money?	← The teacher wants more elaboration and therefore prompts the student to explain further.
L:	Well ….	
(The teacher continues working with the students to understand why they have come up with this answer.)		
Taylor and Cox (1997, pp. 209-210, underlining added)		

The teacher encourages students to make their thinking public in several ways:

- by generally asking students to show their thinking out loud
- by asking for further clarification of their ideas ("What do you mean?)
- by having students explain their thinking while working out the problem on the board ("tell us what you're doing while you check it")
- by insisting that the students come up with explanations for their answers ("but how do you know….")

As the students explain their thinking, the teacher learns about her students' mathematical problem solving strategies. In addition, the students are learning more because now they are engaged in active explanation.

Problem 7.14.
Evaluating teaching: Encouraging students to make their thinking public

Sharon Gettis is a third grade teacher who has recently learned about the idea of encouraging students to make their thinking public, and she has decided to begin trying to do this during her lessons. Here is a reading lesson in which the students are discussing a story about a girl named Lauren who is not a good soccer player but still contributes to her team by being very supportive of her teammates. As Sharon talks with her students about the story, she wants to have her students not just answer her questions but explain how they came up with the answers to her questions. Evaluate how well she accomplishes her goal in this exchange. If you think she could have done better, identify what she could have said instead.

Several minutes into the discussion, Sharon asks a new question.

Sharon: We've been talking about the mistakes Lauren made on the soccer team. Why did Lauren's teammates like her so much? Colby?

Colby: Because she gave them presents and things. [This is an idea that is not very well supported by the story.]

Sharon: OK. That's one possibility. How about any other reasons? Noemi?

Noemi: Because she really helped her teammates play better.

Sharon: Why do you think that?

Noemi: Well, because in the story it said that, like, her friend Savannah heard Lauren cheering for her, so she ran as fast as she could.

Response: *With Noemi, Sharon asks a question that does prompt Noemi to explain her thinking. When Sharon asks why she thinks that, Noemi explains the textual evidence that she used to support her position. However, Sharon does not do as well with Colby. Perhaps because Colby got what she viewed as a less acceptable answer, she decided not to ask him to explain his thinking. But teachers can ask students to make their thinking public even if answers are not right. In fact, by following up on a less acceptable answer with Colby, Sharon could have helped Colby see why the answer was less acceptable. If Colby had not been able to find any textual evidence for his idea, then he would learn that his ideas need to be more closely tied to textual evidence. If he had offered some support for his idea, the teacher could have continued the conversation to help the students understand why some ideas are better supported by the text than others.*

EXTENSIONS

In this section we examine how strategy use by students varies across different kinds of students. We first examine developmental changes in strategy use. We then explore strategy use in students of other cultures as well as ESL students. Finally, we consider strategy use by special education students.

Developmental Changes

In Chapter 3, you learned that there are theories about major developmental changes in children's minds as they grow older. An important aspect of cognitive development is the changes in strategy use that occur as children grow older. As students gain a greater understanding of their own minds, their understanding of learning strategies that are available to them increases, and their strategy use grows more sophisticated. For instance, older learners are more proficient at using strategies such as summarization, elaboration, explanation, and monitoring than younger learners are (A. L. Brown et al., 1983).

Similarly, as elementary school children move into middle school and then high school, their understanding of the distinction between theories and evidence improves. At this point, they better understand the role of evidence in supporting theories and that evidence can either support or contradict their current theory (Kuhn, in press). This ability lays the groundwork for improved use of the reasoning strategies that you have learned about in this chapter.

Researchers have found that even many adult learners fall short of proficiency on most of the strategies that you have learned about in this chapter. Moreover, even early elementary school students can begin learning most of the strategies in this chapter at a basic level (A. L. Brown et al., 1983). Research has shown that young children can learn sophisticated scientific and mathematical strategies that until more recently, were thought to develop only in early adolescence (Lehrer & Schauble, 2002; Metz, 1995). This research indicates that most—if not all—of the strategies in this chapter should be introduced in early grades and revisited in more complex ways as students move into higher grades.

Students' use of each of the strategies discussed in this chapter will become more sophisticated over time, as well as other strategies they learn, as they continue to use them throughout their school years. Table 7.6 presents six dimensions of change in strategy mastery, using the strategy of summarization as an example. Instruction should focus on helping students gain sophistication in strategy use along these six dimensions.

Cultural and Linguistic Diversity

There is some evidence that students from different cultures may use different cognitive strategies for learning. In a comparison of Australian and Japanese high school students, Japanese students reported more rehearsing and memorizing and more reviewing of textbooks, whereas Australian students reported more goal setting, more use of self-rewards, and they were more likely to seek teacher or adult assistance. They also tended to review notes and tests (Purdie, Hattie, & Douglas, 1996). In a study of U.S. students, Stevens and Tallent-Runnels (2004) found that the Hispanic and Anglo students seemed to interpret questionnaire items differently, which made it difficult to compare strategy use across the two groups.

Nisbett and his colleagues (2001) have reported on a broad range of differences in reasoning strategies between European Americans and East Asians. For instance, East Asians are more likely than European Americans to consider the surrounding context when explaining events. In one study, Koreans reported a much stronger belief than European Americans that people's behavior is determined by the situation in which they find themselves. When asked to explain people's behaviors, East Asians are more likely to take the situation into account when making attributions. In explaining a murder case, an East Asian might say "he became ambitious because he had grown up in a small town," whereas a European American is more likely to say simply that "he became ambitious" (Choi, Nisbett, & Norenzayan, 1999, p. 58). Thus, the East Asian explains the murder partly in terms of the situation in which the individual lived, whereas the European American tends to explain the murder strictly in terms of the internal characteristics of the individual.

These differences in strategy use may very well arise from larger differences in cultural norms and values. Niles (1995) found that Australian university students tended to report competition as a central driving force that influenced how they approach learning, whereas Asian students studying at Australian universities reported social approval as an important factor. Nisbett et al. (2001) argued that differences in reasoning between East Asians and European Americans arise from a general collectivist orientation in East Asian countries, which contrasts with a more individualistic orientation in Western countries.

There is a danger, however, in assuming that students of a particular background will employ particular kinds of strategies. Niles (1996) found that in contradiction to a stereotype that Sri Lankan students prefer rote memory strategies, these students actually preferred complex learning strategies. What should you, as a prospective teacher, take away from this? Regardless of your students' cultural backgrounds, there is likely to be wide variation in your students' strategy use, as well as in the underlying theories of learning and epistemology that guide their choice of strategies. Your task, as a teacher, is to find out the various strategies that your students are using and then to help students who need to use more effective strategies.

Capitalizing on students' strategic knowledge. There is limited research on transfer of strategies from one language to another. Spanish speakers who are successful in English reading are able to transfer strategies used in Spanish to learning in English (Jimenez, Garcia, & Pearson, 1995, 1996). Successful bilingual learners are also explicitly aware of relationships between English and their native language. Thus, teachers of bilingual students can capitalize on strategies that students can deploy in their first language and help them learn to use these strategies in English, as well.

Students with Learning Disabilities

Without instruction, students with learning disabilities typically show limited use of the strategies discussed in this chapter (Butler, 1998; Graham et al., 1998). For example, LD students exhibit these characteristics:

- They fail to monitor their comprehension when they are reading (Swanson, 1991).
- They are poor at identifying important information and using text structure signals (Alexander, Garner et al., 1998).
- They have difficulty summarizing and asking meaningful questions of texts (Palincsar & Brown, 1984).
- They fail to engage in adequate planning and idea generation when they are writing (Graham, 1990; Page-Voth & Graham, 1999).
- They do not engage in meaningful revision of their writing (Graham, 1997).

It is not only that LD students do not use useful strategies; they may also have less metacognitive control over their strategy use (Butler, 1998; Wong, 1985). This suggests that making thinking public may have particular value for LD students so that they can gain practice at talking and thinking about strategy use (cf. Palincsar & Brown, 1984).

LD students profit from instruction in many of the strategies presented in this chapter (Baker, Gersten, & Graham, 2003; Page-Voth & Graham, 1999; Palincsar & Brown, 1984). Indeed, it appears that a particularly effective technique for working with LD students is to identify strategies that they need to learn and provide instruction in these strategies. Because many non-LD students in the class will profit from learning the same strategies, it is often a good idea to teach the same strategies to all students. LD students may especially benefit from the instruction.

An important question is why LD students demonstrate difficulties with metacognition and strategy use. As we discussed in Chapter 4 (individual differences), one possible explanation is that LD students have less working memory capacity. Another is that poor strategy use is responsible for differences in performance on memory and other tasks. Consider a child who can recall only 5 digits on a digit span task, in comparison with a non-LD student who can recall the more typical 7 digits. Even on a simple task such as this, it is possible that more proficient performers use some memory tricks to try to remember an extra digit or two, whereas LD students fail to use any such strategies. This could at least partly account for differences in performance on short-term memory tasks.

It is important to keep in mind that even if LD students learn more effective strategies, they may still have more difficulty learning than other students. One reason is that prior knowledge is also an important factor that influences learning, and if a student has used inefficient strategies for many years, that student will have a much smaller knowledge base to draw from to understand new information. Learning better strategies should help student enrich their knowledge base, but it may be difficult to catch up.

To the extent that some LD children's difficulties are caused by physical differences in the size of short-term memory, these students will likely have more difficulty with some of the strategies. For instance, elaboration is a strategy that makes heavy demands on short-term memory, as the learner combines new information with elements of prior knowledge in short-term memory to construct new memory structures. Indeed, most of the strategies outlined in this chapter pose demands on working memory, and LD students with restricted working memory space may find it harder to use these strategies and may profit less from them. Nonetheless, strategy instruction has proven to be a valuable intervention with LD students. In Chapter 16 (strategy instruction), you will also learn about ways to adapt instruction to students with learning disabilities.

CHAPTER 8 Assessment

Chapter Outline

INSTRUTIONAL GOALS AND THE INSTRUTIONAL CYCLE
- **The instructional cycle**
- **Instructional goals**
- **Behavioral objectives**

ASSESSING UNDERSTANDING

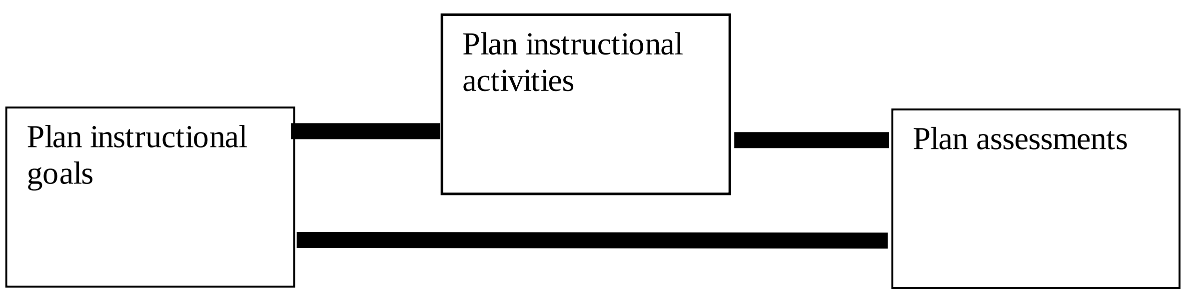
ASSESSING TRANSFER
- **The difficulty of achieving transfer**
- **Assessing for transfer**

INSTRUTIONAL GOALS AND THE INSTRUTIONAL CYCLE

The Instructional Cycle

There are three central parts of instructional planning in Figure 8.1 (cf. Smith & De Lisi, 19xx):

Figure 8.1: Instructional planning



There is no particular order in which these planning activities need to be performed. Most commonly, you would start with instructional goals. But however you proceed, it is crucial that goals, activities, and assessments are in tight alignment.

Serious problems can arise when goals, activities, and assessments are not in alignment. Here are some examples, all taken from undergraduate classes.

Example 1. An educational psychology professor has student groups act out a series of skits in which the undergraduates in the class act out the role of K-12 students of various ages interacting on an assigned task.. After each skit, there is a discussion about "how effective" the collaborative learning was in each acted out group. Afterwards, the students leave the class thinking that the class went quickly, but they really don't know what they were supposed to "get" from this.

The problem here is a **failure to articulate goals**. This is an experience that was very common for me when I first began teaching educational psychology courses. My instruction was all organized around interesting, "hands-on" activities such as skits and role plays. But my classes weren't going well, and I couldn't figure out why. When I consulted my department chair, he simply asked me, "What were your goals for this class?" I couldn't answer. Students left the class unsure of what they were supposed to learn because I had set up an activity that—no matter how hands on it was—had no clear goals. When I revised this (and many other activities) so that they were clearly focused on clearly specified instructional goals, the classes started to fall together better. I was able to communicate to students what the instructional goals were, and this helped them understand better the point of the activities. And I modified the activities, too, to fit the goals more tightly.

Example 2. A recently hired history professor is teaching classes on her own for the first time. Although she uses a fairly traditional history textbook, she has the central goal of promoting "historical thinking" among the students. Her classes are heavily focused on discussions in which students debate what can be concluded from primary source documents. In each class, she clearly articulates the range of reasoning strategies that she hopes to see used in the discussion. Her exams consist of 30% multiple choice questions about the textbook, 50% short-answer questions about the textbook, and 20% essay questions in which she provides them with original source documents and asks them to draw conclusions and explain their responses. As the semester progresses, she finds that students participate less and less in the discussions. Lately she has been dreading going to class. She supposes that her students just don't like to think.

This professor's problem is a **mismatch between her goals and activities**, on the one hand, **and her assessments**, on the other. Although nearly 100% of her classes are focused on reasoning goals, only 20% of her exams have this focus. It is no wonder that students become less and less willing to participate in activities that are poorly represented on the exams. They become angry that she is not preparing them for the tests she gives. This professor should either change her goals and activities to reflect what is on the exams or change her exams to reflect her goals and activities. Here you can see that when exams are out of sync with goals and activities, students become disaffected and unwilling to participate in the class activities.

Example 3. This is a variant on the previous example. This time the same history professor has the same central goal of promoting "historical thinking" using primary source documents. Her exams are heavily focused on this. But her classes are mostly lecture classes in which lectures about the historical events described in the textbook. She provides information that goes beyond the text but very seldom brings in any primary sources. She occasionally provides pointers on how to think about primary source documents, but this activity takes up less than 10% of all class time. She is baffled at the end of the semester when she finds that she has received awful teaching evaluations.

This time the professor's problem is a **mismatch between her goals and assessments**, on the one hand, **and her class activities**, on the other. Her assessments are admirably tied to her goals, but she does not provide instruction during class activities that prepare students properly for the assessments. If she wants students to learn the difficult strategies involved in thinking like a historian, she must provide instruction that helps them understand these strategies and give them many opportunities to use the strategies they are learning.

The examples above illustrate some of the problems that can arise when goals, class activities, and instruction are not tightly aligned.

Figure 8.2 below elaborates slightly on the instructional cycle (Zola, 19xx). Once a teacher establishes instructional goals, the teacher can give pretests to find out what students know. The teacher designs instruction that is responsible to what students still need to learn. While providing instruction, the teacher monitors how learners are doing and diagnoses any learning difficulties that she notices; she uses this information immediately to revise her planned instructional procedures. At the end of the instructional cycle, she gives an assessment that is tightly linked to goals and classroom activities. Then she uses the information from the assessment to revise her own instruction so that it will be better the next time. The assessment also provides feedback to students, and it can be used to provide information to the entire school to help teachers and principals in general understand how students are doing.

Instructional Goals

Instructional goals are important for two reasons:

1. When teachers develop clear instructional goals, it helps them decide what to assess and what to focus on in class activities. (This is the instructional cycle again.) When the teacher formulates clear instructional goals, it makes it more likely that the teacher will focus instruction and assessment on what is most important.
2. When teachers develop clear instructional objectives and communicate these objectives to students, students show greater achievement. In part, this is because the objectives help the teachers structure and focus their instruction. In part it is because objectives help students understand what to focus on as they participate in class and study at home.

A large body of research evidence shows that when students know the objectives, achievement scores are better. Presenting objectives helps average students most of all.

As one example of such research, researchers have compared mathematics classes in elementary schools in Japan and the U.S. Here is a summary of the findings:

Table 8.1: Summary of findings in Japan and the U.S. Mathematics classes

	Teacher statement of goals	Students understanding of goals	Student achievement
U.S. classes	Teachers were not clear about the goals of the lesson.	In interviews, students showed that they did not know what principles they were supposed to learn during the lesson.	Lower mastery of the lesson content.
Japanese classes	Teachers made goals of the lesson clear.	In interviews, students showed that they knew exactly what the point of the lesson was.	Higher mastery of the lesson content.

ASSESSING UNDERSTANDING

What does it mean to understand something? And how would you test whether someone understands something? The purpose of this chapter is to give you some powerful answers to these questions.

Here's an initial but useful definition of understanding. You understand an idea when you can use that idea to answer novel questions and solve novel problems. These novel questions and novel problems should require students to use the information to make new inferences.

Many questions used by teachers are not novel questions, and students do not have to understand the material to answer these questions. You have seen some examples of some of these questions in class. Here is another example:

Read this paragraph (presented by **ref**), and then answer the questions at the end of the paragraph. (Pretend that you're taking a test and that your grade depends on getting the answers right.)

For most of the 20th century, the teaching and learning of restike has never aroused the same degree of interest within language teaching as have such issues as satical competence, tound analysis, and halish skills. Restike instruction has often been relegated to secondary status because restike acquisition was not considered a beal. Basically, restike instruction was seen as a means to improve other skills, especially halish skills.

Questions:
1. What hasn't aroused much interest for most of the 20th century?
2. What issues in language teaching have aroused a lot of interest this century?
3. Why was restike instruction relegated to secondary status?
4. What was the relationship between restike acquisition and halish skills for most of this century?

Because nonsense words were used in the paragraph, understanding the paragraph is impossible. Yet I'll bet that you could come up with plausible-sounding answers to most of the questions. Clearly, these questions are very poor at assessing understanding.

In class, you will see other examples of questions that are poor at assessing understanding. The purpose of this chapter is to help you develop skills at asking questions that will successfully assess (and promote) understanding.

In order to assess understanding, you must ask <u>novel</u> questions that require <u>new inferences</u>. Here are some guidelines.

1. Use Bloom's Taxonomy in Table 8.5 as a guide to asking questions at higher levels. Benjamin Bloom and his colleagues have developed a taxonomy of learning objectives that was intended to guide instruction. There were six categories of objectives in the cognitive domain.

<u>A. Knowledge of such items as facts, terms, classifications, theories.</u> Students are able to recall these items. These objectives could conceivably be achieved using rote memory.

<u>B. Comprehension.</u> Students show that they comprehend ideas, as indicated by their ability to communicate ideas in their own words.

<u>C. Application.</u> Students show that they can apply ideas, as by solving problems or applying ideas to concrete situations.

<u>D. Analysis.</u> Students separate ideas into their component parts. For instance, students might break a process into component steps, or students might analyze the role of different parts that make up a whole.

<u>E. Synthesis.</u> Students integrate new ideas with prior ideas, or students put two sets of ideas together.

<u>F. Evaluation.</u> Students evaluate the quality or ethics of something.

A very useful application of this taxonomy is to help you think of useful questions you could ask students. Here are some examples for several different topics:

Table 8.5: Bloom's Taxonomy

Category	Ed Psych: Responses to Anomalous Data	Literature: Romeo and Juliet	Mathematics: Adding fractions
Knowledge	List the 8 responses to anomalous data.	Name the main characters of Romeo and Juliet.	Give the definition of a numerator.

Comprehensio n	Explain in your own words what each of the responses is.	Explain why Juliet killed herself.	Explain why you have to get the same denominator before you add two fractions.
Application	You show your students that a thermometer in a sweater sitting in a closet does not get warm (as they expect it to). Anticipate responses in each of the eight categories to this experiment.	Generate a modern-day story with the same basic plot as Romeo and Juliet.	Solve this problem. 1 / 2 + 2 / 3 = ? (Word problems are even better.)
Analysis	What are the core psychological processes common to all the 8 responses to anomalous data?	Which plot elements of Romeo and Juliet could be removed without affecting the final outcome of the play?	Write down and explain each step needed to solve 1 / 2 + 2 / 3 = ?
Synthesis	Explain the relationship between the eight responses to anomalous data (in section 4.2) and the different ways in which people can respond to new sentences in a text (in section 4.3).	Compare and contrast West Side Story with Romeo and Juliet.	Solve this problem: Susan has half an apple. Lourdes has two thirds as much of an apple as Susan. How much pie do they have altogether? (This problem requires synthesizing knowledge of adding fractions with knowledge of taking a fraction of a fraction.)
Evaluation	Do teachers have a right to try to foster theory change in students in the domain of heat and temperature? How about in the domain of effects of capital punishment on the murder rate?	Which has greater artistic merit: West Side Story or Romeo and Juliet?	Which method of solving fractions is more efficient?

Generally, you can think of the top two question types (knowledge and comprehension) are lower-order questions. The other four question types (application, analysis, synthesis, and evaluation) are higher-order questions. Higher-order questions have generally been found to promote greater student learning than lower-order questions.

2. Here are some general question types that are often very useful in assessing understanding, if you ask about something students haven't already learned directly.

What would happen if . . . .
Explain why . . .
How would a new piece of information change your interpretation?
How does knowledge in situation A apply to a new situation B?

Table 8.6: Examples from history

Question Type	Example

What if (change in event)?	What would have happened differently in 1775 and 1776 if the British had repealed the Stamp Act?
What would you think if (change in historical data)?	What would you think about the justifiability of the American Revolution if the British had offered the colonists 5 seats in Parliament?
How does a new piece of data change your interpretation?	How does this testimony [have students read eyewitness testimony] affect what you think about who fired the first shot at Lexington Green?
Apply historical case #1 to a current situation.	We have studied the processes of the demise of communism in the Soviet Union and eastern Europe. Apply what you've learned about these countries to China. Is China likely to undergo a similar process?

Table 8.7: Examples from science

Question Type	Example
What if (change in event)?	How would the rusting process change if the temperature of the room was 20 degrees higher.
How would a process be different if . .. .?	How would the rusting be different if oxygen had a stronger electrovalence than it really does. (This is a hypothetical contrary-to-fact question.)
How does a new piece of data change your interpretation?	Now we see that there is no rust formed when the iron is below freezing. How does this change your theory?
Apply information #1 to a current situation.	Now you've learned about rusting. What do you think happens when copper pipes turn green? How would you explain that?
Explain a new event.	Rust doesn't form when oil is put on the iron instead of water. Why is this?

Table 8.7: Examples from math

Students have learned to solve problems such as this one:
Solve for a. $(2a + 1)(a - 1) = (3a - 2)(2a - 4)$ Solution: $2a^2 - 2a + a - 1 = 6a^2 - 12a - 4a + 8$ $15a - 9 = 4a^2$ $4a^2 - 15a + 9 = 0$ $(4a - 3)(a - 3) = 0$

Obviously, you can ask many questions of the same type. But also ask questions that "tweak" the process in various ways.

For example:

1. Give a problem with a denominator, such as a - 3 as a denominator.
2. Give a problem where it is not necessary to multiply out, such as $(2a + 1)(a - 1) = (3a - 2)(a - 1)$.

   In general, at the end of a lesson, you should give problems in which it is appropriate to use the procedure taught in the lesson, and you also should give problems in which it is inappropriate to use the procedure taught in the lesson. Otherwise, students will not learn when to use the procedure, and when not to use the procedure.
3. Give a more complex problem with a cube in it.
4. Give a problem that cannot be factored.
5. Give a problem in which the numbers don't turn out to be whole numbers. (In real life, unlike most math problems, the answers don't come out to nice round numbers!)
6. Add a complexity such as: $2a(a-3) - 6a = 16a^2 - 3a + 9$.
7. Have students write a problem that can be solved using this method.
8. Have students write a problem that looks as if it can be solved using this method but actually cannot.

Finally, just a couple of examples from literature.

Who do you find more appealing as a Jane Austen protagonist, Emma of Emma or Elizabeth of Pride and Prejudice? Give specifics to justify your view.

Judging from these five poems, what kind of person do you think Emily Dickinson might have been? Provide evidence for your answer.

To recap, the purpose of the previous sections was to illustrate questions that are successful at assessing understanding. Students cannot answer these questions using strictly rote memory. As a teacher, it is exceedingly useful for you to construct a large pool of questions of this sort. The questions have three uses:

1. You can use the questions to define understanding for this topic. By constructing novel, challenging questions and problems for a topic, you define for yourself what it means to understand that topic. Once you have this understanding, you can design your instruction to promote this understanding.

2. You can use the questions in instruction. By asking students novel, challenging questions and posing novel, challenging problems in your class, you can help students achieve deep understanding.

3. Obviously, you can use the questions to assess what students have learned.

4. Whenever you are trying to construct questions that assess understanding, ask yourself this question: IF I SUBSTITUTED NONSENSE WORDS FOR THE KEY WORDS IN THE TEXT AND IN MY QUESTIONS, COULD MY STUDENTS STILL GET THE ANSWERS RIGHT? If the answer is yes, you'd better start over.

ASSESSING FOR TRANSFER

Obviously, the goal of education is not to produce students who are highly skilled at taking unit tests. The goal of education is to produce students who can do things in the real world--design bridges, keep accurate accounts, market cars, discover new cures for cancer, negotiate agreements, choose investments, vote wisely, and so on and so on. In other words, we want our students to transfer what they are learning in classes to tasks in the real world. Transfer refers to using information learned in one situation in a different situation. Researchers have found that transfer is extremely difficult to obtain. In this chapter, you will learn about the difficulty of obtaining transfer and some techniques that you can use to increase the chances that transfer will happen among your students.

The Difficulty of Achieving Transfer

Over the past century, researchers have repeatedly found that it is very difficult to obtain transfer. In other words, people often (or usually) fail to transfer knowledge to situations in which that knowledge is relevant.

Here are some examples of research that has failed to find transfer:

1. Historically, one of the arguments for learning languages such as Latin and Greek was that learning Latin and Greek would improve one's general thinking ability. Research has not found any such transfer. It is possible that learning Latin may help a little with English vocabulary, but if your goal is to learn English vocabulary, you would be far, far better off spending your time studying English vocabulary than spending the same amount of time studying Latin. The finding that training in classical languages did not transfer to other aspects of thinking or reasoning was one of the important early findings of the field of educational psychology.

2. Many people believe that studying computer programming helps students get generally better at problem-solving ability because students learn to think through a problem very thoroughly. Research has been clear on this point. When students learn a computer programming language, they do not show improvement on tasks other than programming a computer. They often do not even show transfer to another computer language, at least in the early stages of learning. Even worse, students who learn to program in a language frequently fail to transfer their knowledge to troubleshooting a program in the same language, and vice versa.

3. People who are very good at doing comparative pricing at a supermarket are often completely unable to solve exactly the same problems when presented as paper and pencil tests. For instance, in one study, adults who decided that a 16 ounce can of tomatoes that cost 67¢ was a better buy than a 14 ounce can that cost 59¢ were unable to solve the exact same problem when presented as a word problem on a piece of paper.

4. Anderson et al. did a study of transfer in which they used three different word processing programs. The study was done years ago when word processors were nothing like what you are all using today. The programs were simple word processors that had lots of commands and required editing on just one line at a time. Anderson et al. found that only when two word processing programs had exactly the same feature (e.g., you delete a word in the same way) were people able to transfer their knowledge, and even then, they were only able to transfer those features that were exactly the same. When features were dissimilar, students who learned one word processor showed no advantage at losing the dissimilar feature on the second word processor, compared to students who had never used the first word processor at all.

5. When students learn a principle of mathematics while learning to solve a physics problem, they show little ability to use that new principle when they solve a mathematics problem.

6. Students who learn a cognitive strategy in one class (e.g., they learn to self-explain in physics) do not use that same strategy in another class in which it would be useful (e.g., they don't use self-explanation to understand their history textbook).

7. After learning to self-explain a history textbook in an experiment, students do not use the self-explanation strategy when the experimenters are no longer in the classroom to remind them to use the strategy.

8. A number of studies have examined whether students can transfer declarative knowledge to the solution of riddles. In a typical study, experimenters present participants with sentences such as these:

Sentence 1: If you throw a ball into the air, it comes back down.
Sentence 2: A deaf parrot will not learn to mimic sounds.

Typically, the participants are asked to do tasks such as rate how understandable each sentence is.

Then, a short time later, the participants are asked to solve problems such as the following:

Problem 1: Can you make a tennis ball go a short distance, come to a dead stop, then reverse itself, and go in the opposite direction? Note: Bouncing the ball is not permitted, nor can you hit it with anything, nor tie anything to it.

Problem 2: "This myna bird," said the pet shop salesman, "will repeat anything it hears." A week later the lady who bought the bird was back in the shop to complain that she had talked to the bird, but he had not yet said anything. Nevertheless, the salesman told the truth. Explain.

When solving these problems, participants are not told that the sentences they just read are relevant to solving the problems.

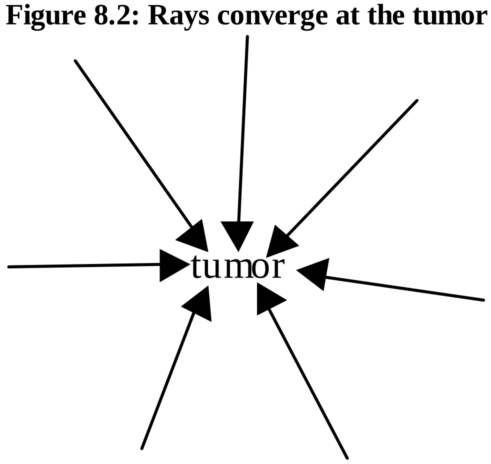
The first sentence is relevant to solving Problem 1. You can make the tennis ball do this by throwing it upward. The second sentence is relevant to solving Problem 2. The myna bird did not repeat what the woman said because the bird was deaf. Since it hears nothing, it repeats nothing.
Researchers have found that unless people are explicitly told that the sentences are relevant to solving the problems, people who read the sentences are no better at solving the problems than people who do not read the sentences at all. People do not transfer the information in the sentences to the solution of problems.

9. In another line of research, participants in studies read problems like the following.

Problem 1: Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays reach it all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either. what type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

If the participants cannot solve the problem, they are told the answer. The answer is that doctors can use many small rays sent from many different angles. The rays all pass through different parts of the body and all converge at the tumor. When the rays converge at the tumor, they add up to produce a high intensity, which kills the tumor. But when each individual ray passes through the tissue on the way to the tumor, that ray is not intense enough to destroy healthy tissue.

Figure 8.2: Rays converge at the tumor



After reading problem 1, people are provided with a new problem such as the following:

Problem 2: An oil well in Saudi Arabia exploded and caught fire. The result was a blazing inferno that consumed an enormous quantity of oil each day. After initial efforts to extinguish it failed, famed firefighter Red Adair was called in. Red knew that the fire could be put out if a huge amount of fire retardant foam could be dumped on the base of the well. There was enough foam available at the site to do the job. However, there was no hose large enough to put all the foam on the fire fast enough. The small hoses that were available could not shoot the foam quickly enough to do any good. It looked like there would have to be costly delay before a serious attempt could be made. However, Red Adair knew what to do. With his method, the blaze was quickly extinguished, and the Saudis were satisfied that Red had earned his three million dollar fee. What did Red do?

The test is to try to solve this problem. The solution is identical in principle to the solution in Problem 1. The solution is to use many small hoses to shoot foam on the fire from all directions. The foam would converge on the fire at the center and put it out.

Researchers have consistently found that people who first solve Problem 1 do no better at Problem 2 than students who have never seen Problem 1. Thus, learning about the “converging rays” solution to the tumor problem does not help people come up with the similar “converging foam” solution to the blazing fire problem. People do not transfer information learned on one problem to another problem.

All of the above examples are instances of failures to achieve positive transfer--a desired transfer from one situation to another situation. Another problem in transfer is that negative transfer sometimes occurs. With negative transfer, the learner transfers information from one situation to another, but the information that is transferred does not apply to the second situation. Here is an example of negative transfer, in the form of a problem that you should first do yourself.

When solving these problems, cover up my comments below. Do the problems in the order shown.

Given a 21-quart jar, a 127-quart jar, and a 3-quart jar, how would you measure out 100 quarts?

Given a 9-quart jar, a 42-quart jar, and a 6-quart jar, how would you measure out 21 quarts?

Given a 20-quart jar, a 59-quart jar, and a 4-quart jar, how would you measure out 31 quarts?

Given a 18-quart jar, a 43-quart jar, and a 10-quart jar, how would you measure out 5 quarts?

Given a 14-quart jar, a 163-quart jar, and a 25-quart jar, how would you measure out 99 quarts?

Given a 28-quart jar, a 76-quart jar, and a 3-quart jar, how would you measure out 25 quarts?

Given a 13-quart jar, a 43-quart jar, and a 4-quart jar, how would you measure out 22 quarts?

Given a 12-quart jar, a 36-quart jar, and a 9-quart jar, how would you measure out 6 quarts?

Given a 23-quart jar, a 49-quart jar, and a 3-quart jar, how would you measure out 20 quarts?

(Solve these problems before reading on.)

If you are like most people, after you solved two or three of these problems, you figured out that there was a usable solution that worked on all of the problems: Fill the second jar, pour out enough to fill the first jar, and then pour out enough to fill the third jar twice. Then what is left over in the second jar is the desired amount. You can symbolize this solution with the equation $B - A - 2C$. This equation works for all of the problems. However, there is a simpler solution to the last problem:
$A - C$. However, few people notice this easier solution; they just keep on using the tried and true solution each time. This is an example of using a less efficient but familiar strategy over and over and, meanwhile, not noticing an easier strategy.

Assessing for Transfer

In order to help students learn to transfer their knowledge to the real world, it is important to use assessments that really measure whether students can use what they are learning to accomplish real-world tasks. These assessments are often called performance assessments or authentic assessments.

To help you understand the idea of an authentic assessment, here is a definition and some examples:

Definition. An authentic assessment is a test item or other item used for a grade that has students perform a meaningful task that is typical of what people do in the real world.

An authentic assessment has these characteristics:

A. It is in fact an assessment (i.e., something graded, as a test question or a graded project).
B. It places students in a situation that simulates an authentic, real-world activity.
C. It includes much of the complexity and open-endedness of real-world problems.
D. Solving the problem requires the use of effective cognitive strategies and extensive knowledge.

Here is a good example of an authentic assessment:

> Design a museum exhibit that helps museum-goers understand the main events of the American Revolution. Explain why you have made the choices that you have. (This is used as a major project equal to two test grades.)

Why is this a good authentic assessment?
A. It is being used to evaluate students (it counts as two test grades).
B. It has students do an activity that real professionals do in the real world (museum curators do indeed design museum exhibits).
C. It is a complex, open-ended problem. A lot of deep reflection must go into solving it.
D. Students cannot solve the problem without much knowledge of the American Revolution and without using effective strategies such as explanation.

Examples and Nonexamples. To help you clearly understand the concept, I will next show you some examples and nonexamples that should help you focus on the key features of authentic assessment.

AUTHENTIC ASSESSMENT	NOT AN AUTHENTIC ASSESSMENT
This is an essay question on an exam: Imagine that you are an expert on television, and you have been asked to testify before a Senate committee on the effects of television violence. Prepare a short address to give to the Senators that tells your position on this issue and why you hold it, together with an outline of key points and key evidence that you will use to support your claims when the Senators ask you questions.	**This is an ungraded group assignment during class:** Imagine that you are an expert on television, and you have been asked to testify before a Senate committee on the effects of television violence. Prepare a short address to give to the Senators that tells your position on this issue and why you hold it, together with an outline of key points and key evidence that you will use to support your claims when the Senators ask you questions.

The item on the right is not an assessment of any kind because the assignment is not being treated as an assessment to evaluate students' progress. There is a good authentic activity, but the activity is not being used for assessment. The item on the left is being used for assessment.

AUTHENTIC ASSESSMENT	NOT AN AUTHENTIC ASSESSMENT
This is an essay question on an exam: Imagine that you are an expert on television, and you have been asked to testify before a Senate committee on the effects of television violence. Prepare a short address to give to the Senators that tells your position on this issue and why you hold it, together with an outline of key points and key evidence that you will use to support your claims when the Senators ask you questions.	**This is an essay question on an exam:** Write an essay that tells your position on the issue of the effects of television violence and why you hold it. Be sure to give key evidence to support your claims.

The item on the right is not an authentic assessment because it does not place students in a real-life activity. The item on the left places students in a meaningful position of having to prepare testimony for a Senate committee.

AUTHENTIC ASSESSMENT	NOT AN AUTHENTIC ASSESSMENT
This is an essay question on an exam: Imagine that you are an expert on television, and you have been asked to testify before a Senate committee on the effects of television violence. Prepare a short address to give to the Senators that tells your position on this issue and why you hold it, together with an outline of key points and key evidence that you will use to support your claims when the Senators ask you questions.	**This is an essay question on an exam:** Imagine that you are an expert on television, and you have been asked to testify before a Senate committee on the effects of television violence. Prepare an answer to this question that the Senators may ask: “What were the results of the 1997 study by Smith and Engel?”

The item on the right is not an authentic assessment because it is a low-level knowledge item in Bloom’s taxonomy. It does not invoke complex, open ended reasoning as the item on the left does. It also does not require nearly as much knowledge and nearly as many cognitive strategies to answer the item on the right as the item on the left.

AUTHENTIC ASSESSMENT	NOT AN AUTHENTIC ASSESSMENT
This is an end-of-semester graded homework assignment: Imagine that you are the editor of the Trenton Tribune in the year 1832. It is now time to write your election year editorial in which you decide whether your newspaper will support the reelection of Andrew Jackson or the election of Henry Clay to the presidency this year.	**This is an end-of-semester graded homework assignment:** Write an essay giving three reasons why Jackson should or should not be reelected.

The item on the right is not an authentic assessment because it does not place students in a real-world context. The item on the left places students in the historical position of being a newspaper editor.

AUTHENTIC ASSESSMENT	NOT AN AUTHENTIC ASSESSMENT
This is an end-of-semester graded homework assignment: Imagine that you are the editor of the Trenton Tribune in the year 1832. It is now time to write your election year editorial in which you decide whether your newspaper will support the reelection of Andrew Jackson or the election of Henry Clay to the presidency this year.	**This is an end-of-semester graded homework assignment:** Imagine that you are the editor of the Trenton Tribune in the year 1832. It is now time to write your election year editorial in support a candidate. Write an essay supporting Jackson, and give as reasons his main three accomplishments in the first term listed on pages 311-312.

The item on the right is not an authentic assessment because it is not complex or open-ended, and it doesn't require rich knowledge or strategies to complete. Students only have to parrot back the answer listed on pages 311-312.

AUTHENTIC ASSESSMENT	NOT AN AUTHENTIC ASSESSMENT
This is an end-of-semester graded homework assignment: Find out how much it will cost to carpet your entire house.	**This is an exam question:** Beatrice's bedroom is a 10 ft by 13 ft rectangle. How many square feet of carpet is needed to carpet it?

The item on the right is not an authentic assessment because is not very complex or open-ended. It can be solved straightforwardly by a simple algorithm. The item on the left is much more open-ended and complex and requires a lot more knowledge and strategies to solve. Students have to construct a plan to even figure out how to start the problem. They must work out costs of carpets in addition to using geometric knowledge to calculate areas.

FORMATIVE ASSESSMENT

Effective use of formative assessment can greatly improve teaching and student learning. We can define *formative assessment* as any method that teachers use to gather information about students' learning in order to improve instruction. There are two parts of this definition. First, teachers gather information about how well students are learning. Second, teachers use that information to adapt their instruction and make it better.

Formative assessments can be *formal assessments,* such as tests and quizzes. For example, consider a teacher who analyzes the results of a quiz to figure out what his students do not understand, or what they have misunderstood. Then the teacher uses this information to help students with the particular concepts that they are having difficulty with. This would be an example of formative assessment, because the teacher gathers information about students' difficulties and uses the information to adapt and improve instruction.

But formative assessments can also be *informal*. For example, a teacher can learn about students' thinking by listening carefully to what students say during group work or class discussions. A teacher might find out by listening to students during group work that a number of students have some misunderstandings about the causes of the Great Depression. A teacher can use this information to adjust instruction to address students' misunderstandings.

Whenever teachers get information about students' thinking and use this information to adjust and improve their instruction, they are using formative assessment.

Contrasts with More Traditional Assessment

Formative assessment contrasts with traditional forms of assessment in three ways, discussed below.

First, the main purpose of traditional assessment is to assign grades. In other words, in traditional assessment, teachers give tests primarily to evaluate the students and assign them grades. But in formative assessment, the primary purpose is to gather information about what students are learning and what they are having difficulty learning, so that this information can be used to improve instruction. Teachers may assign grades, but this is a secondary purpose, less important than gathering information in order to adjust and improve instruction.

Second, in traditional assessment, the main output of the teacher's evaluation is the set of scores and grades that the teacher has assigned. After grading a test, teacher might know that the class average is 73%, that 15% of her students got A's, 28% got B's, and so on. If you ask the teacher how her students did on a test, she can tell you that Joe got 83%, Cindy got 95%, and so on. But she may be unable to tell you very much

In contrast, in formative assessment, the most important output of the teacher's evaluation is a more detailed analysis of what the students know. The teacher does not just know that the class average is 73%, and so on. The teacher identifies exactly what it is that her students do and do not know. For example, a teacher might given a quiz in the middle of the unit on the Great Depression. From this mid-unit quiz, the teacher works out that 90% of the students know all the important dates related to the Great Depression, and more than 80% can identify one cause of the Great Depression. But only 43% can identify more than one cause. Furthermore, the teacher finds out that 78% of the students misunderstand the causal processes by which the stock market crash of 1929 triggered the economic collapse. The teacher gathers many such pieces of information.

Third, in traditional assessment, the teacher does not systematically use information from the tests to change their teaching. The assessment is usually done at the end of the unit, so that there is no chance to use this information to help students, because the unit is over. But in formative assessment, students are assessed not just at the end of the unit but at times before the end of the unit, so that the teacher can use the information gathered from the assessments to make mid-course adjustments in instruction. For example, the teacher described in the previous paragraph has gained valuable information from a mid-unit quiz that she can use to revise her instructional plans during the rest of the unit. From her careful analysis of students' difficulties on the mid-unit quiz, she knows that she need not spend any more time on dates, as most students have mastered the dates. But she must focus intensively on helping students understand the causes of the Great Depression, because few students understand the causes in any depth.

In short, the key to formative assessment is to carefully analyze students' work (on tests or quizzes, on homework assignments, and in group work and class discussions) so that teachers can identify very specifically what students' strengths and weaknesses are. Then the teachers use the results of the analysis to adjust their instruction.

An Example of More Complex Plan to Use Formative Assessment

In the previous paragraphs, we have considered a fairly simple example of formative assessment. In this example, a teacher analyzes students' work on a single mid-unit quiz in order to adjust instructional plans for the second half of the unit. In this section, I'll present an example of a more complex plan to use formative assessment. The following pages provide a detailed example of how social studies teachers might use formative assessment to identify students' learning difficulties and to adapt their instruction to address these difficulties.

This more complex example also revolves around a unit on the Great Depression. Suppose that a team of social studies teachers is developing and teaching a six-week unit on the Great Depression. The students examine a variety of original documents (written documents, photos, some early films) as well as read historians' interpretations of the events. Students write their own histories of the events, presenting arguments explaining their ideas. The students turn in essays at the end of weeks 2 and 4 so that the teacher can assess how well they are mastering each learning goals of the unit. The students also take quizzes at the end of weeks 2, 4, and 6 so that the teachers can assess students' conceptual understanding of the Great Depression.

The teachers want to develop a formative assessment system that they can use to systematically track learners' progress during the unit. The first step in developing such a formative assessment system is is to identify the core learning goals for the unit. The teachers decide that they would like to focus on two learning goals involving learning to write historical essays and two learning goals involving understanding of the causes and consequences of the Great Depression.

The teachers decide that they will focus on two learning goals involving strategies for writing historical essays:
Learning Goal #1: Argument construction. Students learn to construct good arguments in their writing.
Learning Goal #2: Considering counterarguments. Students learn to address counterarguments to their own position when they are writing.
The teachers will evaluate how well students are using these strategies using the essays that students write.

In addition, the teachers identify two content goals that they want their students to master:
Learning Goal #3: Consequences of the Great Depression. Students will understand a wide range of the consequences of the depression.

Learning Goal #4: Causes of the Great Depression. Students will understand several of the most important economic causes of the depression.
The teachers will use quizzes to assess how well the students are doing in achieving these two goals.

Now the teachers have completed the first step—deciding on their core learning goals. Next they undertake the second step of constructing rubrics that correspond to each of the four learning goals. In other words, for each of the four learning goals, the teachers construct a rubric to track students' progress during the unit. Rubrics are helpful because they help teachers identify, for each learning goal, exactly what students have mastered, and what they have not yet mastered. The teachers can then track how well students are progressing on the learning goals captured by each rubric. Let's illustrate how this works with specific examples.

This page and the next page show the rubrics the teachers construct for the two writing strategies (argument construction and considering counterarguments) that they want to focus on. The teachers will assess how well students are doing on each strategy by evaluating students' written essays.

RUBRIC FOR ARGUMENT CONSTRUCTION

	Definition of Level	Example
Level 4	Position plus evidence explained plus inclusion of some reasoning that shows why the evidence supports the position.	The main cause of the Depression was the collapse of the US stock market on October 29, 1929. One source of evidence for this is that worldwide economic decline occurred very rapidly after this event. The government reports of 1928, 1929, 1930, and 1931 show that the economy was strong until October 29, and decreased about that time. When one event quickly follows another like this, it is strong evidence that they are causally connected. <<< The last sentence explains *why* the evidence presented can be taken as support for the claim that the stock market collapse was the cause of the depression. >>>>
Level 3	Position plus evidence explained	The main cause of the Depression was the collapse of the US stock market on October 29, 1929. One source of evidence for this is that worldwide economic decline occurred very rapidly after this event. The government reports of 1928, 1929, 1930, and 1931 show that the economy was strong until October 29, and decreased about that time. <<< The evidence is elaborated with more detail. >>>
Level 2	Position plus evidence mentioned	The main cause of the Depression was the collapse of the US stock market on October 29, 1929. One source of evidence for this is that worldwide economic decline occurred very rapidly after this event. <<< There is evidence mentioned, but it is just mentioned, and not elaborated or explained at all. >>>
Level 1	Position only	The main cause of the Depression was the collapse of the US stock market on October 29, 1929. <<< There is a position, but no argument of any kind in support of this position. >>>
Level 0	No position	<<< At this level, the student does not take an identifiable position at all. >>>

Notice that this rubric can be used to determine how well students have progressed toward mastering argument construction in their writing. For example, a student at Level 2 has mastered some components of writing good arguments, but has not yet mastered the components that are emphasized in Levels 3 and 4.

This is the rubric that the teachers design to evaluate how well learners have progressed toward considering counterarguments in their writing.

RUBRIC FOR CONSIDERING COUNTERARGUMENTS

	Definition of Level	Example
Level 4	Mentions competing ideas and explains them. Also discusses evidence for and against these ideas, and resolves the conflict between the positions in some way.	A student defends the argument that the main cause of the Depression was the collapse of the US stock market on October 29, 1929. The student notes that there is another position that economists have taken, namely that the Federal Reserve's contraction of the money supply was the more important cause and elaborates on this position in several sentences to explain it more. In addition, the student discusses evidence for the idea the money supply was an important factor. <u>Finally, the student either (a) presents evidence for rejecting this causal factor as less important or (b) notes that the issue is not fully resolved, and that both factors may have been important.</u>
Level 3	Mentions competing ideas and explains them. Also discusses evidence for and against these ideas.	A student defends the argument that the main cause of the Depression was the collapse of the US stock market on October 29, 1929. The student notes that there is another position that economists have taken, namely that the Federal Reserve's contraction of the money supply was the more important cause and elaborates on this position in several sentences to explain it more. <u>In addition, the student discusses evidence for the idea the money supply was an important factor. However, the student does clearly explain why she has opted not to accept this theory.</u>
Level 2	Mentions competing ideas and explains them.	A student defends the argument that the main cause of the Depression was the collapse of the US stock market on October 29, 1929. The student notes that there is another position that economists have taken, namely that the Federal Reserve's contraction of the money supply was the more important cause <u>and elaborates on this position in several sentences to explain it more. However, the student does not discuss evidence for or against this claim.</u>
Level 1	Mentions competing ideas	A student defends the argument that the main cause of the Depression was the collapse of the US stock market on October 29, 1929. <u>The student also *mentions* that there is another position that economists have taken, namely that the Federal Reserve's contraction of the money supply was the more important cause.</u>
Level 0	No consideration of competing ideas	A student defends the argument that the main cause of the Depression was the collapse of the US stock market on October 29, 1929, and mentions no other position.

Again, the rubric helps the teacher identify how well students have progressed toward mastery of this learning goal. A student at Level 1 has progressed very little. A student at Level 3 is doing better, but there are still areas for improvement before Level 4 can be attained.

The teachers also construct rubrics for their two content goals, which will be assessed by quizzes.
1. Understanding the consequences of the Depression.
2. Understanding of the causes of the Depression.
The first rubric is on a 0 to 3 scale; the second is on a 0 to 4 scale.

RUBRIC FOR UNDERSTANDING CONSEQUENCES OF THE DEPRESSSION

	Definition of Level	Example
Level 3	Very high and personal understanding	In addition to doing what students at Level 2 have done, the students draw in personalized information from the documents they have examined to show an understanding of the real personal costs and difficulties faced by many people in their daily lives.
Level 2	High understanding	In addition to identifying a range of consequences, as in Level 1, the student notes some *differential consequences*. For example, the student notes that incomes in rural areas were hit harder than in urban areas and that unemployment was particularly high in mining.
Level 1	Moderate understanding	The student identifies a range of consequences, such as decrease in incomes, stock market price decreases, sharp drop in construction work, and several other consequences, etc.
Level 0	Very low understanding	The student identifies no more than one or two consequences, such as mentioning *only* the decrease in incomes.

RUBRIC FOR UNDERSTANDING CAUSES OF THE DEPRESSSION

	Definition of Level	Example
Level 4	Two or more causes with interactions explained	In addition to doing what students at Level 3 have done, the students explain how the causes interact. For example, the students explain that the collapse of the stock market exposed the inadequate capitalization of banks, which now had to close as their investment portfolios had collapsed, and they did not have enough cash or stronger investments in reserve.
Level 3	Two or more causes	The student identifies and explains three or more causes, such as collapse of the stock market, inadequate capitalization of banks, and the Federal Reserve's overly tight money supply policy. (Students get credit only if they can identify *and* explain these causes.)
Level 2	One cause	The student correctly identifies and explains just one cause, such as collapse of the stock market only. (Students get credit only if they can identify *and* explain a cause.)
Level 1	Causes identified but not explained	The student identifies one or even several causes by name, but cannot explain any of them.
Level 0	No causes	The student cannot correctly identify any candidate causes at all.

Now, using these rubrics, each teacher can track each and every student's progress at each assessment point (at the end of weeks 2, 4, and 6).

For example, here are the results for one student, Janice, after week 2. Note that Janice's teacher has this information for each and every student.

	Argument construction (0 to 4)	Generating counterarguments (0 to 4)	Understanding consequences (0 to 3)	Understanding causes (0 to 4)
Week 2	3	0	1	2

The teacher can also look at how *all* the students in her class are doing:

	Argument construction (0 to 4)	Generating counterarguments (0 to 4)	Understanding consequences (0 to 3)	Understanding causes (0 to 4)
Week 2	Level 4: 0% Level 3: 12% Level 2: 32% Level 1: 52% Level 0: 4%	Level 4: 0% Level 3: 0% Level 2: 12% Level 1: 4% Level 0: 84%	Level 4: 52% Level 3: 28% Level 2: 20% Level 1: 0% Level 0: 0%	Level 4: 8% Level 3: 8% Level 2: 40% Level 1: 4% Level 0: 40%

Using this information, the teacher adapts her instruction for this class, and for individual students. Here is what she does for each goal:

Argument construction. The teacher has learned that most students are at Level 0 or Level 1. This means that they are not even mentioning evidence for their positions at all (or, in the case of one student, not even mentioning a position). She designs and leads a lesson focusing on the importance of providing positions and evidence, and showing students how to do this in their writing. She also encourages them to elaborate on their evidence so that readers will understand what they mean when they write about evidence. She presents lots of examples of how to do this.

Janice is doing well on this goal in comparison to other students, so at this time the teacher does not offer additional instruction to her.

Generating counterarguments. Almost no students are at Level 0, which means that they are not considering alternative positions at all. The teacher conducts another lesson on how to consider and write about alternative positions and arguments, and she urges them to do this in their writing from now on.

Janice's level is the same as most of her classmates, so the teacher does not provide any additional assistant to Janice at this point beyond what was covered in the class lesson.

Understanding consequences. Students are doing relatively well on this goal. A majority (52%) are already at Level 3, with the other 48% at Level 3 or 2. The teacher decides to provide feedback to small groups of students who are not yet at Level 4, showing them how to improve their writing on quizzes to include elements of consequences that they are not yet writing about.

On Janice's paper, the teacher notes specifically where Janice has fallen short on this goal, and she provides examples to Janice of what she could write that would be better.

Understanding causes. The teacher has found that most students are at Level 0 or Level 2. Level 0 means that students are just listing causes without explaining any; Level 2 means that students are explaining no more than one cause. The teacher leads a discussion on the idea of multiple causation; she starts with examples that students are more familiar with, and then moves back to the Great Depression. The class agrees that many complex events have multiple causes. The teacher encourages them to apply this idea to their work with the causes of the Great Depression. She also spends additional remedial time with the 8 students who are at Level 0 (which means that they are only naming causes but not explaining them and practices generating explanations with them), so they will know what to do next time.

Note that the teacher can use the information she gains from the Week 2 quizzes and assignments to work with both individual students and to work with the whole class.

The teacher eagerly awaits the results of the Week 4 quizzes and writing assignments to see if students are doing better. She checks how each and every student is doing. For example, here are Janice's scores after Week 4:

	Argument construction (0 to 4)	Generating counterarguments (0 to 4)	Understanding consequences (0 to 3)	Understanding causes (0 to 4)
Week 2	3	0	1	2
Week 4	3	1	3	3

	Argument construction (0 to 4)	Generating counterarguments (0 to 4)	Understanding consequences (0 to 3)	Understanding causes (0 to 4)
Week 2	Level 4: 0% Level 3: 12% Level 2: 32% Level 1: 52% Level 0: 4%	Level 4: 0% Level 3: 0% Level 2: 12% Level 1: 4% Level 0: 84%	Level 4: 52% Level 3: 28% Level 2: 20% Level 1: 0% Level 0: 0%	Level 4: 8% Level 3: 8% Level 2: 40% Level 1: 4% Level 0: 40%
Week 4	Level 4: 12% Level 3: 72% Level 2: 12% Level 1: 4% Level 0: 0%	Level 4: 4% Level 3: 60% Level 2: 24% Level 1: 12% Level 0: 0%	Level 4: 92% Level 3: 8% Level 2: 0% Level 1: 0% Level 0: 0%	Level 4: 16% Level 3: 72% Level 2: 12% Level 1: 0% Level 0: 0%

The teacher uses the results of these assessments once again to revise her instruction, as summarized below:

Argument construction. Most students are at Level 3, which means that they have done well including and elaborating on evidence in their arguments. But most have not yet taken the final step to Level 4. The difference between Level 3 and Level 4 is that Level 4 requires students to explain *why* the evidence provides support for their position. The teacher decides to develop and lead a lesson helping students learn how to do this.

Janice's level is typical of her classmates, so the teacher will not offer additional instruction to her. However, there are several students who have not yet reached Level 3, and the teacher does some remedial work with those students, taking them aside and doing some practice with argument writing to help them master the ideas.

Generating counterarguments. Most students are now at Level 3, which means that they are well at discussing counterarguments and the evidence for and against them. But have not taken that last step that gets them to Level 4. This last step involves not just stating counterarguments, but explaining why they are not strong or by explaining why the issue cannot be fully resolved. The teacher develops and leads a lesson to focus particularly on this point.

Janice's level is the lowest in the class on this goal, so the teacher asks Janice to come in after school to work with her on learning how to consider counterarguments in her writing.

***Understanding consequences*.** Most students, including Janice, have mastered this goal. There are two students who are not yet considering the *personal* consequences of the Depression, which is what they are lacking in order to move to the highest level, so the teacher works with these students individually to help them see what to do to improve for next time.

***Understanding causes*.** Most students, including Janice, are now at Level 3, which means that they are doing well now at identifying and explaining two or more causes, but they have not yet reached Level 4, which means that they do not yet explain how these causes interact. The teacher designs and leads a lesson on the concept of interacting causes, and the class discusses how different causes might have interacted at the time of the Great Depression. This is designed to help students learn to discuss interacting causes so that they can move to Level 4.

Summary of Formative Assessment

By carefully evaluating each student's progress toward the four goals, the teacher is able to adapt her instruction so as to enhance students' progress to the goals. She identifies exactly what students are having trouble with, and then she provides instruction tailored to these difficulties.

After the Week 6 assessments, the teacher will be able to evaluate how well the students have done overall. She may still want to remediate with students who have not mastered certain goals. And she will also use what she has learned from the assessments throughout the unit to redesign the unit and make it more effective next year.

This example has illustrated how teachers can use formative assessment to evaluate exactly what students are having difficulty with and to adapt their instruction accordingly. Formative assessment is assessment that is used by teachers during instructional units to identify how to adapt their teaching so as to help students learn better.

CHAPTER 10
Creating Motivating, Engaging Classroom Communities

ANALYZING MOTIVATION

Five Perspectives on Motivation

Here are five perspectives on student motivation. You should regard them as complementary rather than competing perspectives. Each gives a somewhat different perspective on the multifaceted phenomenon of student motivation.

Expectancy-Value Theory. According to Expectancy-Value Theory, motivation is determined (very roughly) by the following formula:

motivation = value of goal X expectancy of success.

Here are some examples. Suppose that 10 is the highest number that can be assigned to value of goal and expectancy of success, and 0 is the lowest number.

Becoming a famous novelist has a high value for Dan but he thinks he has no chance to succeed, so his motivation is M = 10 x 0 = 0. Dan makes no effort to write a novel.

Suanna, an adult, can easily recite the alphabet (expectancy of success is high), but reciting the alphabet has no value for her, so M = 0 x 10 = 0. Suanna does not recite the alphabet.

Yoko wants to get an A on her ed psych exam, but she only thinks she has a moderate chance of success because she has no idea what will be on the test. M = 8 x 4 = 32. She studies fairly hard but not as hard as she studies on some other tests.

According to expectancy-value theory, some people are oriented toward achieving success, and others are oriented toward avoiding failure.

People who are oriented toward achieving success will show the greatest motivation on tasks of medium difficulty. Why? Because when the task is easy, the value is low. So even though expectancy of success is high, motivation is low, as in the alphabet example. (It’s not fun to achieve success on an easy task like reciting the alphabet.)

Similarly, when the task is very difficult, the expectancy of success is low, even though the goal may be highly valued, as in the example of Dan and writing a novel.

Motivation is highest for success-oriented individuals when the goal is moderately difficult, so that the goal has pretty high value and yet the individual has the expectation of achieving it if he/she works hard enough.

The situation is different for people who are oriented toward avoiding failure. For people who are avoiding failure, failure is very unpleasant, and they want to avoid it at all costs. So for these people, the equation becomes:

motivation to avoid task = degree of unpleasantness if failure occurs x expectancy of failing

Here are some examples. Again suppose that 10 is the highest number that can be assigned to the variables on the right side of the equation.

Larry doesn’t want to make a fool of himself when he answers a question in class. When the teacher asks an easy question, he raises his hand. Why? The expectancy of failing is almost zero, so the motivation to avoid the task is near zero: Motivation to avoid = 10 x 0 = 0. Therefore, Larry

Larry also raises his hand when the teacher says, "OK, here is a very hard question, and maybe none of you will be able to answer it, but let's give it a try." Here, there is little unpleasantness if failure occurs, even though the expectancy of failing is high, so Larry can raise his hand. Motivation to avoid = 0 x 10 = 0.

Larry does not raise his hand on moderately difficult questions. Why? Because the degree of unpleasantness is moderately high, and the expectation of failing is moderately high. Motivation to avoid = 5 x 5 = 25, which is high enough to keep Larry from raising his hand.

So the theory predicts that success-seeking individuals will prefer medium-difficult problems, whereas failure-avoiding individuals will prefer to work on very easy or nearly difficult problems.

Learning Goals versus Performance Goals. Students with learning goals want to master material, to improve, to do as well as they can. These students are intrinsically motivated. When they work on tasks, they are task-involved learners. That is, they are heavily focused on the task and not concerned about what others think about how they are doing. Errors may be seen as a natural part of learning.

Students with performance goals perform tasks not because they want to master the material but because they want to get recognition or rewards for completing tasks. These students have extrinsic motivation. They are motivated not by learning but by grades, praise from teachers or parents, recognition by peers, and so on. Students with ego goals are ego-involved learners, more concerned with enhancing their self-image than with learning and understanding.

Students with learning goals and students with performance goals use different kinds of cognitive strategies. Students with learning goals use strategies such as detecting inconsistencies, monitoring understanding, and self-explaining. Students with performance goals are likely to use short-cut strategies to get good grades, such as memorizing without understanding.

The following are examples of behaviors that are indicative of a student who has ego goals (see Woolfolk, 2000).

--uses short cuts to complete tasks
--cheats/copes classmates' papers
--seeks attention for good performance
--only works hard on graded assignments
--is upset by and hides papers with low grades
--compares grades with classmates
--chooses tasks that are most likely to result in positive evaluations
--is uncomfortable with assignments that have unclear evaluation criteria
--is unwilling to do extra work
--doesn't follow up on anything learned on his/her own time
--willingness to memorize to get good grades, rather than to self explain for real understanding

Attribution Theory. According to attribution theory, the key to understanding how students learn is to find out what they attribute success or failure to.

For example, suppose that a student succeeds at a test (i.e., gets an A on a test). What could the student attribute success to?

--general ability (e.g., high IQ)
--knowledge (e.g., knows a lot about history already)
--strategies (i.e., good learning strategies)
--effort (e.g., lots of studying)
--luck
--easy test

Now suppose that the student fails a test. What could the student attribute failure to?

--general lack of ability	(i.e., low IQ)
--lack of knowledge	(i.e., I just don't know about history)
--lack of strategies	(i.e., I don't know the best way to study for the test)
--lack of effort	(i.e., I didn't have time to study for this exam.)
--luck	
--hard or unfair test	
--teacher has it out for me	

Crucially for attribution theory, some of these potential causes for success and failure are controllable, and others are not. For example, general ability is not controllable: You're either smart or you're not. Effort is controllable. Luck is not controllable. Strategies may be controllable (e.g., "I could learn better study strategies").

If a student attributes failure to lack of ability, then the student will have little motivation to engage in academic tasks. ("If I try hard and fail, then everyone will know that I'm stupid.") On the contrary, students who attribute failure to a lack of ability will take pains to avoid making effort. ("Hey, it's not that I'm stupid. I failed the test because I didn't study at all. If I had studied, I'm sure I would have done well.") Notice that for American students, at least, it seems to be more shameful to be seen as lacking ability than to be seen as lacking effort!

If a student attributes failure to lack of knowledge, lack of strategies, or lack of effort, then the student will not come away feeling stupid. ("I could have gotten an A if I had studied harder, or if I had asked Ms. Smith to help me work out a better study method.") So these students will be motivated to try harder next time..

Notice a very important point: If students believe that intelligence is fixed, that their performance is locked in by an unchangeable intelligence, then they will not be motivated to try to achieve success.

According to attribution theory, some students are motivated to avoid failure, and other students are motivated to strive for success.

The following causal processes apply to students who are motivated to avoid failure:

failure + attributed to low ability --> shame + pessimism --> poor performance next time
success + attributed to luck + low ability --> little pride + pessimism --> poor performance next time.

These causal processes apply to students to are motivated to strive for success:

failure + attributed to high ability + low effort --> guilt + optimism --> better performance next time
success + attributed to high ability + high effort --> pride + optimism --> even better performance next time.

Now consider what happens to a student who fails. It is embarrassing and shameful to fail. Students want to avoid being embarrassed and ashamed. The student wants to hide the fact that she/he has failed because of lack of ability. So the student makes a big show of not making any effort. The student intentionally makes no effort in order to make it seem as if poor performance is really due to lack of effort rather than to lack of ability. The student makes no effort on purpose so that she/he can blame failure on lack of effort. Really, the student fears that even if she/he made a lot of effort, she/he wouldn't succeed.

Self-determination. Many researchers, especially Edward Deci, have argued that the desire to have self-determination—the autonomy to make one's own choices and to have some control over one's own actions—is a primary, fundamental motivator. When people have some self-determination over their activities, they are more motivated to engage in the activities. When people lack self-determination, they are less likely to want to engage in activities.

Instructionally, motivation improves when learners are given choices. Sometimes, relatively trivial kinds of choice promotes motivation. In one interesting study, students were playing a computer game to teach them the order of arithmetic operations (e.g., parentheses have priority over other operations, multiplication is carried out before addition, etc.). Students who were simply allowed to choose their token in the game (which rocket ship they wanted to "be" when playing the game) reported greater motivation, and they learned more than students who had not been given this simple choice.

In the business world, organizational psychologists have often found that a crucial aspect of motivation is giving employees the power to make decisions. For instance, engineers are likely to be more engaged in their work if they have control over challenging decisions than if their work is all highly specified for them.

In schools, motivational researchers argue that students should have more choices in their daily school lives. To give a very simple example, when students choose their own books to read, they are likely to be more eager to read it than when the book is selected for them.

There is sometimes a tension, however, between providing students with more choices and maximizing student learning. When given choices, students may make choices that fail to promote their own learning. Researchers investigating computer-assisted instruction have often found that students who are given choices over what instructional material they will study fail to study enough to master the material. Students who are required to go through all the instructional sequence often learn more.

Interest. Researchers who have studied students' interest have pointed out that there is a difference between situational interest and general interest. Situational interest is a temporary interest. For instance, a history student might not usually be interested in the history of ancient Rome but be interested temporarily on a day in which her professor comes to class dressed in a toga.

General interest is interest that an individual generally has on a topic. One student may be generally interested in mathematics. Another may be generally interested in European history. Professors usually have a general interest in the topics covered in the courses they teach, especially graduate courses which focus on their area of specialty. Teachers must usually try to stimulate situational interest in students to win their temporary attention. But then they should go on to try to build general interest in students.

What increases interest? According to one theory (Schank, 1979), interest is raised when (a) expectations are violated through incongruent information or (b) expectations are unfulfilled because potentially relevant information is missing. In addition, Schank argues that some topics are inherently and universally interesting to humans: death, danger, power.

Here are some ways to enhance interest:

> An obvious way is to try to relate the material to the students' existing goals.

> A very important way to enhance interest is to help students learn cognitive strategies. Cognitive strategies help students increase their understanding, and material that is well understood is usually much more interesting than material that is poorly understood. This is a method that is often ignored by teachers.

> Interest can be enhanced by various forms of cognitive conflict, such as expression of different opinions within a classroom. Disagreement among students with different points of view raises interest in students.

> Stimuli that are moderately different from what students understand generally enhances interest. Thus, a moderately novel math problem may generate interest, whereas a math problem that is very similar to or very different from previous problems will be less interesting.

Integrating the Five Perspectives

This section presents a way to integrate all of these perspectives into a single framework. Expectancy-value theory provides a basic framework into which all the other perspectives fit very nicely. According to expectancy-value theory:

Motivation = Value of Goal x Expectation of Success

You can increase motivation by increasing either the value of the goal or the expectation of success.

First, how can you increase the value of the goal?

1. **Increase interest (interest perspective).**
   - **A. Use more interesting tasks or topics.** This is obvious.
   - **B. Use group work.** This naturally increases interest because of the social interaction.

2. **Increase perceived relevance to larger goals (interest perspective).** Either explain how the current activities are relevant to larger goals, or choose goals that do in fact have more relevance.

3. **Increase autonomy.** The value of engaging in the task will increase when learners have some autonomy in how they approach the task.

Second, how can you increase the expectation of success?

1. **Increase students' belief that they already have the ability to succeed.**

   - **A. Improve students' knowledge and strategies so that they are in fact more likely to succeed.** In other words, improve students' ability to do a task. If students gain strategies and knowledge that helps them succeed, they will have a much higher expectation of success.
   - **B. Teach students to attribute success to effort rather than ability.** If students come to believe that successes result from effort rather than from natural ability, they will develop an expectation that they already have the ability to succeed and that they will be successful if they make effort. One way to do this is for teachers themselves to attribute students' successes to effort rather than to ability (e.g., "This was an excellent paper; I can tell that you put a lot of work into finding the evidence to support your main points.").

2. **Increase students' belief that they can improve their ability.**

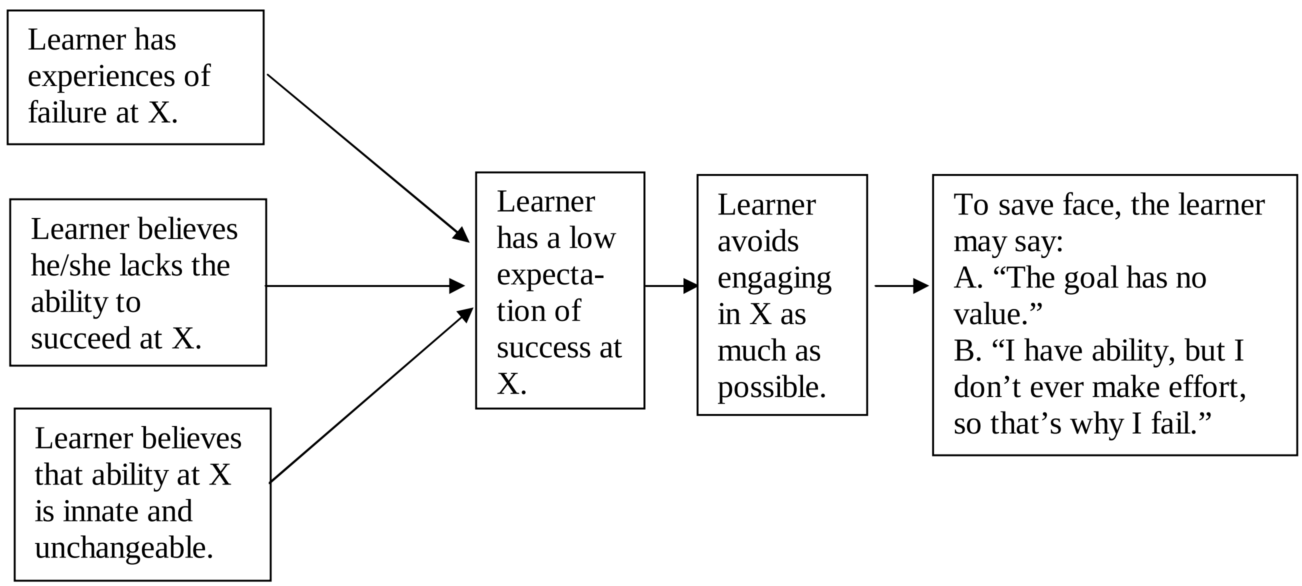
   - **A. Foster the belief that ability can be changed because ability is a combination of knowledge and strategies, all of which can be learned.** If students think that ability is fixed and innate, they will not believe that there is any point to trying to get better. If students think that ability is fluid and learnable (because ability is nothing more than the knowledge and skills that you have), then

   - B. **Foster the belief that ability can be improved by making effort.** If students become convinced that they can improve by making effort, then their expectation of success will increase.

To bring the learning-goals/performance-goals perspective into the equation, you only need to remember that the learners' goals can be either learning goals or performance goals. Learners who have the goal of getting the highest grade in the class on a math test (a performance goal) and who believe that they has the ability to achieve this goal will be highly motivated to achieve it. However, they will only use those techniques that will improve performance on the test; they will not learn anything extra. They will not learn in a way that goes beyond the tests and applies knowledge to real life

Figure 10.1 summarizes some of the main processes in the student who becomes an avoider of learning. This is often called avoidance motivation.

Figure 10.1: Avoidance motivation



I will illustrate with the example of a male middle-school student, Jeremy, who has avoidance motivation for reading.

Jeremy has often experienced failure at reading. He believes that he is a poor reader. He also believes that reading ability is pretty much innate and unchangeable: "Some people can read, and some can't, and I just don't have the ability to do it. That's not one of the talents I was born with."

Given these beliefs and the experience of failure, it is not surprising that Jeremy has a low expectation that he will succeed at any reading task. Therefore, he avoids reading whenever he can, because he finds it unpleasant to engage at an activity that he is so poor at. Since he doesn't believe he could ever get substantially better, he might as well not bother.

However, Jeremy doesn't stop there. He attempts to save face in his own mind in two ways. First, he devalues reading. "Reading is for nerds. I won't ever need much reading when I get a job someday. I know people who have good jobs who hardly ever read." In school, he says that English class is stupid, that they never read anything worth reading. Second, Jeremy makes a big deal about his lack of effort. He purposefully never turns in homework, and he brags about how little effort he puts into English. Sometimes he asserts to his friends that he could get a good grade if he wanted to, but "it's such a stupid class, it's not worth spending any time on it."

Note that the real cause of the devaluing of the goal of reading is not that Jeremy originally believed that reading is not valuable. He came to believe that reading is not valuable because of his lack of success. Because Jeremy thinks that success is impossible, he convinces himself that reading is not worthwhile anyway. In addition, Jeremy can explain away his failure without losing face because he makes a great show of his lack of effort. He wants people to think that he is intelligent, but he just doesn't care about school, and that's why he fails.

It is interesting to note that Jeremy does not want to openly admit that he is incapable of reading well, that he has poor reading ability. He would much rather be seen as making no effort. He would feel a sense of shame in admitting that he read poorly, but no shame in telling people that he makes no effort. There is a great deal of cross-cultural research comparing American culture with Asian cultures, and one interesting finding is that it appears that Asian students find it more shameful to say that they didn't make effort on a task than to say that they lacked ability at that task.

Four Myths of Motivation

In this section, we will look at four myths that are commonly held about motivation.

Motivation = Only Interest. Most people's theory of motivation goes something like this: People are motivated if they are interested. To increase motivation, you have to make things more interesting, through such activities as teaching English by showing movies (The Blackboard Jungle), teaching poetry through rap music (Dangerous Minds), outrageous bizarre behavior (Dead Poet's Society), and cutting apples in a fractions class (Stand and Deliver). Similarly, if people are unmotivated, it means that they are not interested. And, according to this theory of motivation, if a student says that she/he finds a class to be boring, the cause of the student's poor motivation must be that the teacher uses dull instructional techniques.

Motivational researchers have a very different perspective. Interest is certainly an important part of the motivation equation. But as you have seen, there's a lot more to motivation than interest. Interest is just one of many components.

Interest ---> Competence. (If a student is interested, she/he will become competent soon.) This is not necessarily so at all. It would be easy to inspire me to want to read Japanese comic books, but I lack the competency to do so. Similarly, if a student decides that English class this year is really interesting, but the student cannot read well enough to understand the novels being read, motivation will still end up being low.

If I say I'm bored because the class is boring, then you can take me at my word. One reason why the student says the class is boring might be that the class really is boring. But there are other possible reasons, as well:

1. The student lacks competence, which makes the class seem boring, no matter how hard the teacher tries.

2. The student is covering up a presumed lack of ability. As shown in the diagram on the previous page, because the student lacks competence (or at least a belief in competence), the student saves face by declaring that the goal of learning or succeeding in school is worthless.

When students lack the knowledge, skills, and cognitive strategies that they need to succeed, then the expectation of success is low, which again makes motivation low. The student says that the class is boring, but the reason that it is boring is that the student lacks the knowledge, skills, and strategies to succeed, not because the teacher is using dull teaching techniques. The solution to this problem is not to use more interest-enhancing teaching techniques. The solution is to do a better job of teaching students the knowledge, skills, and strategies that they need to succeed. Teaching cognitive strategies is particularly important.

According to attribution theory, students want to protect their self-worth. They don't want to admit that they have failed because of lack of ability. They would rather fail because of lack of effort, because this is less embarrassing and shameful. So they say that the class is boring as an excuse for not trying. The solution: try to convince the student that failure is not due to lack of ability but rather to lack of effective cognitive skills and strategies. Then teach those skills and strategies so that the student can succeed.

In short, if a student says that the problem is a lack of interest, don't assume that the problem is that the teacher is using boring teaching techniques. Instead, the real source of the problem may be that the student lacks the knowledge, skills, and strategies needed to succeed, and/or that the student has fallen into a pattern of avoiding failure by making a big show of making no effort. Note that this is not just true of kids who do poorly in school. Kids who do moderately well may show the same symptoms.

Rewards enhance motivation. One of the surprising findings of motivational research is that external rewards can undermine intrinsic motivation. Here are two classic studies that showed this.

1. Deci (1971) had college students work on a geometric puzzle that most college students find interesting. Deci gave half of the students money to work on the puzzle. The other half worked without being offered money. Then the college students came back for a second session and were given an opportunity to engage in any of several tasks. Students who had received no pay were more likely to spend more time playing with the puzzle than were students who had been paid. Conclusion? External rewards (money) seems to undermine intrinsic motivation to engage in a task.

2. Lepper, Greene, & Nisbett (1973) selected preschool children who had shown high initial intrinsic interest in a particular art activity. The children were then randomly assigned to one of three groups. Children in one group were offered a reward for engaging in the activity. Children in a second group were not offered a reward but instead simply worked on the activity without reward. Children in a third group were not offered a reward but were unexpectedly given a reward later on. The children were observed again three weeks later in their natural play environment. Children in the first group spent significantly less time engaging in the particular activity than were children in the other two groups. Conclusion? Again, external rewards undermine intrinsic interest.

Recent research suggests that external rewards are most likely to be harmful when the rewards are seen by students as "bribes" to engage in the activity. External rewards may even have positive effects on intrinsic motivation when the rewards are seen as "bonuses" for good performance rather than as bribes.

The Relationship Between Motivation and Strategy Use

Recent research has demonstrated an important relationship between goal type and use of cognitive strategies. In a nutshell, here are the findings:

1. Students with learning goals tend to use effective cognitive strategies (all the effective strategies discussed in Chapter 7).

2. Students with performance goals tend to use ineffective cognitive strategies (such as rote memorizing). They do not use strategies such as explanation, elaboration, planning, etc.

3. Students with avoidance goals basically do not use any cognitive strategies at all.

ENHANCING MOTIVATION

A Quiz

In this part of the chapter, you will learn about a range of teaching techniques for improving your students' motivation. Before you begin reading about these techniques, please try your hand at answering the questions below to see how well your current beliefs about motivation accord with the findings of motivational researchers.

For each question, predict whether the activity is more likely to increase or decrease students' academic motivation to learn in school, or whether it will have no effect on students' academic motivation (I = increase, D = decrease, N=no effect). After you finish, check your answers on the following page.

_____ 1. Introduce a math lesson with a comment such as "I think you'll find today's lesson really interesting, and it'll give you ideas for showing your parents how to make some home improvements."

_____ 2. After a three-week unit on the Civil War, give middle school history students the project of writing a Civil War drama that illustrates as much about the Civil War as they know.

_____ 3. Give a class that has been getting near-perfect grades on quizzes a somewhat more difficult quiz.

_____ 4. Allow high school English students to choose any book they like for a book report.

_____ 5. Let your math students take turns to lead a math lesson.

_____ 6. Use a program such as Pizza Hut's "Book-It" to promote reading in your school. (The Book-It program provides monthly free pizzas to elementary-school students as they achieve goals they set for the number of books they read each month. Then, at the end of the year, all the students who have met their goals each month get to have a pizza party.)

_____ 7. Encourage your high school students' parents to reward students with money if they get a 3.5 average or better.

_____ 8. Announce honor role students over the P.A.

_____ 9. Have your top math students lead a math lesson as a reward for their good achievement.

_____ 10. When grouping students, group according to students' ability so that good students don't get dragged down and poor students don't feel that they are being put down.

_____ 11. Use group work sparingly.

_____ 12. Allow writing students a chance to turn in a revised essay paper in after getting your written comments.

_____ 13. Evaluate students on improvement as well as on absolute performance.

_____ 14. Grade on a curve, but a curve that isn't strict, so that 50% of students get As.

_____ 15. Hold students to a tight time limit when giving tests and quizzes.

_____ 16. Provide many and varied club activities after school.

_____ 17. Ask students to write down their learning goals for the week on Monday.

_____ 18. Prior to a discussion, have a student who has been disruptive tell you how many times he will make relevant contributions during the discussion.

_____ 19. Teach students how to memorize dates for the AP history exam.

_____ 20. Teach students to self-explain math problems as they are studying their math book.

Here are the answers that would be predicted by most motivation researchers.

I	1.	Introduce a math lesson with a comment such as "I think you'll find today's lesson really interesting, and it'll give you ideas for showing your parents how to make some home improvements."
I	2.	After a three-week unit on the Civil War, give middle school history students the project of writing a Civil War drama that illustrates as much about the Civil War as they know.
I	3.	Give a class that has been getting near-perfect grades on quizzes a somewhat more difficult quiz.
I	4.	Allow high school English students to choose any book they like for a book report.
I	5.	Let your math students take turns to lead a math lesson.
D	6.	Use a program such as Pizza Hut's "Book-It" to promote reading in your school. (The Book-It program provides monthly free pizzas to elementary-school students as they achieve goals they set for the number of books they read each month. Then, at the end of the year, all the students who have met their goals each month get to have a pizza party.)
D	7.	Encourage your high school students' parents to reward students with money if they get a 3.5 average or better.
D	8.	Announce honor role students over the P.A.
D	9.	In art, hold a contest for the best drawing in the class.
D	10.	When grouping students, group according to students' ability.
I	11.	Use group work frequently.
I	12.	Allow writing students a chance to turn in a revised essay paper in after getting your written comments.
I	13.	Evaluate students on improvement as well as on absolute performance.
D	14.	Grade on a curve, but a curve that isn't strict, so that 50% of students get As.
D	15.	Hold students to a tight time limit when giving tests and quizzes.
I	16.	Provide many and varied club activities after school.
I	17.	Ask students to write down their learning goals for the week on Monday.
I	18.	Prior to a discussion, have a student who has been disruptive tell you how many times he will make relevant contributions during the discussion.
I	19.	Teach students how to memorize dates for the AP history exam.
I	20.	Teach students to self-explain math problems as they are studying their math book.

The TARGET and BESS Techniques

Motivating your students to learn will help you in many ways. Obviously, it makes your class more fun and exciting. It will often raise your students' achievement; they will learn more if they are academically motivated. And it will improve classroom management. Indeed, effective motivational techniques are at the heart of effective classroom management; motivated students are much less likely to be disruptive.

Motivational researchers have identified many different techniques that help increase students' motivation. Because there are so many varied techniques, researchers have proposed to organized these strategies around acronyms. A commonly used (and very useful) acronym is the TARGET acronym (Ames, 1992; Anderman xx; xx). The letters in the TARGET acronym stand for:

Task
Autonomy
Recognition
Grouping
Evaluation
Time

In my view, there are some important motivational techniques that are either left out of the TARGET framework or not made salient enough within it. To highlight these techniques, I will present additional motivational techniques under a second acronym of BESS. BESS stands for:

Belonging
Expectations
Short-term goals and self-evaluation
Strategies

Altogether, then, I will present 10 categories of motivational techniques, the six TARGET categories and the four BESS categories. As I discuss the techniques within each category, I will also explain why these instructional techniques work. These techniques work because they increase the value of academic tasks and/or the expectation of success, and because they encourage learning goals rather than performance goals.

Recall from the previous chapter the formula of expectancy-value theory:

$$\text{Motivation} = \text{Value of Goal} \times \text{Expectation of Success}$$

Recall, too, that the motivation can be motivation to perform, or motivation to learn (or both). You can increase motivation by increasing either the value of the goal or the expectation of success. You can increase value of the goal by increasing interest, by increasing relevance to goals, or by increasing autonomy. You can increase the expectation of success by improving students' knowledge and strategies so that they believe that they can succeed, by encouraging students to attribute success to effort rather than ability, and to foster the belief that "ability" can be improved by making effort to increase knowledge and strategies.

The TARGET Techniques

Carole Ames and her colleagues have tested the TARGET framework using the following method: One group of teachers learned about the TARGET framework, and they each agreed to implement <u>one</u> specific technique within each dimension. Following discussion among the teachers and researchers, each teacher decided on his/her own what technique to implement. A control group of teachers conducted their classes as usual. The students in the classes in which teachers implemented the techniques from the TARGET framework were more highly motivated than the students in the control classes.

Tasks

There are many different ways in which tasks can be designed so as to enhance students' motivation. Four general ways are presented below, with some more specific techniques discussed within each of the general categories.

Employ tasks that make learning interesting. To many people, the most obvious way of increasing motivation is to make tasks interesting. And this is certainly an effective way. Interesting tasks enhance motivation by increasing the value of the goal: Students are more likely to want to engage in tasks that are inherently interesting.

One way to make tasks more interesting is to use tasks that involve **suspense, surprise, discovery, exploration, and fantasy**. Teachers can increase interest by doing the unexpected, by inducing perplexity or bafflement, by using relevant simulations and games when it is instructionally productive to do so.

Another way to increase task interest is to **vary tasks** from day to day. Even interesting tasks can get monotonous if there is no variation. An English teacher who is skilled at holding interesting class discussions may find that if she does this every single day, student interest wanes. Varying activities from day to day can make a difference.

Increase the relevance of tasks. If students understand that instructional tasks are relevant to their lives and goals, then they will increase the value of the goal of participating in the task; motivation will thus increase.

There are two main ways of increasing the relevance of tasks. One is to **use tasks that are clearly relevant** to the real world. When students complete worksheets, they will have probably have little belief that this activity has anything to do with the real world. When they formulate a detailed plan for converting a vacant lot to a park and present their plan to the city council, they will clearly understand the relevance of their class activities. Computer simulations can mimic real world situations such as conducting scientific research or developing and executing marketing plans. Class activities such as mock trials also clearly simulate real-world activities. Later in this textbook, in the chapter on Teaching for Transfer, you will learn about creating authentic activities in the classroom that students will view as highly relevant.

The second main way of increasing the relevance of tasks is to clearly explain to students how it is that what they are doing is relevant to the real world. Teachers can begin each lesson with a reason why students should be motivated.

Good examples: "I think you'll like this, and it will come in handy at home, as well."
"The problems we're doing today is like the ones that engineers do every day."
Bad examples: "I know you won't like this, but . . . ."
"This is really boring stuff, I know, but I don't have any choice--we have to cover it."

It is tempting to make statements like the bad examples because you might want to let students know that you empathize with their lack of interest in a required topic that you yourself would rather not have to teach. But messages like this are counterproductive.

More examples of ways to make what students are learning relevant to their lives include using everyday examples in chemistry, relating economic concepts of supply and demand to television advertisements, and relating a novel to students own relationships.

Another useful idea for making tasks relevant is to make sure that new tasks clearly require students to use what they have learned before. This will help them see that what they are learning in generally useful.

Provide learning goals rather than performance goals. Teachers can teach in ways that encourage learning goals rather than performance goals. One way is to establish **tasks** that emphasize learning goals rather than performance goals. For example, a teacher can have students learn something in order to teach it to another rather than to score high on the exam. Similarly, the main focus of learning can be presented as solving a problem rather than preparing for a test.

In large part, teachers emphasize learning goals by how they talk about classroom activities. If teachers constantly remind students that "this is going to be on the exam," they will tend to encourage performance goals. If, on the other hand, teachers regularly focus on what students will learn from activities and how it can be used, students are more likely to adopt learning goals.

Teachers can also talk explicitly to students about performance goals. One high school teacher I know spends time during the first two weeks of class in September talking to students about how important it is to focus on learning rather than doing better than their neighbors on exam. He spices up his stories with humorous examples from his own life in which he refused to buy into the idea that "he is better than I am because he got two more points on his exam."

Make sure that students understand the goals of the learning tasks. This means that you should students with clear instructional objectives so that they know what they are supposed to be learning. You will learn more about instructional objectives in Chapter 10.

When you tell students what they are going to be learning, then students have a built-in way to assess their own progress. As the lesson continues, students realize that they are indeed attaining the goals that the teacher outlined. This enhances their sense of competence and their belief that they can learn effectively.

The questions at the beginning of each chapter in this text are an example of another way to help students focus on the crucial information that they are supposed to learn.

Have different students do different tasks so that they can't directly compare their performance. Another way to discourage performance goals is to assign different tasks so that students cannot directly compare their performance. If students are preparing presentations on different states, it will not be as easy to see how their performance measures up to each other as if they are all making presentations on the same state. If students are doing different kinds of book reports on different books, students will be less inclined to rank order students in terms of quality of report, because the reports will vary along so many dimensions that it is difficult to tell

Tasks should challenge students with a moderate degree of difficulty. Students find tasks that are too easy to be boring because of their lack of challenge. Tasks that are too difficult produce poor motivation because students lack an expectation of success. Tasks that are of moderate difficulty are ideal because they are difficult enough to provide an engaging sense of challenge but not so difficult that students have a low expectation of success. But keep in mind that a moderate degree of difficulty means different things for different students.

Autonomy Dimension

By giving students choices in the classroom, teachers can promote greater motivation by directly increasing students' sense of autonomy. Here are several approaches to increasing autonomy.

Give students opportunities to take leadership roles in learning activities. For example, students can take turns leading small group discussions. Or in group work, students can take turns being the group leader.

Give students choices over what learning activities to engage in and/or how to engage in the activities. You can also give students choices about what they learn or how they learn it. Allow students to pick which book they will read for a class project. Allow students to select their own books to read during free reading period. Allow students to investigate a scientific question of their own choosing; for instance, students might decide to investigate why some of the trees on the school grounds are dying (xx).

Choices over how to learn something might involve something as simple as choosing which order they do practice problems. Researchers have found positive effects on motivation and even learning with simple choices such as this. As another example, students might choose where to sit during free reading periods, or they might choose whether they want to study a textbook chapter using outlining or concept mapping.

Researchers have found that seemingly minor choices that are actually irrelevant to what is being learned can have positive effects on learning and motivation. In one study (Lepper, xx), children learned about the order of operations in mathematics (e.g., carrying out multiplication before addition in a problem such as "3 x 4 + 5 x 6 = ?" They learned as they played a computer game involving motifs of flying spaceships in outer space. Those students who were simply allowed to choose which spaceship they would use in the game learned more and were more interested than students who were assigned the spaceship they would use. This was true even though which spaceship was used was completely irrelevant to what was being learned. Thus, there can be strong benefits to providing choices that seem very minor.

When you give students choices, be careful to avoid the problem that students may make unwise choices. For instance, if you allow students to choose their own book for a report, some students may choose books that are far too easy for them; others may choose books that are too hard. You need to provide structure for students' choices and guidance in what can be chosen. For example, you could give students a choice of what book to read but set guidelines for how difficult the book should be (e.g., no more than 4 words you don't know on an average page).

Simulations, games, and projects give students a great deal of choice about how to proceed with the activities.

Help students learn strategies that will help them regulate their choices. One way to help students make wise choices is to explicitly teach them the strategies for making good choices. For example, teachers can teach students how to choose books to read that are the right level of challenge.

Recognition Dimension

To fill all the letters in the TARGET acronym, researchers differentiated between Recognition (R) and Evaluation (E). In fact, however, it is very difficult to sharply distinguish between actions that provide recognition and actions that provide evaluation. For instance, if a teacher assigns an A to a paper, the teacher is evaluating the student's work, but she is also providing recognition to the student for a job well done. Similarly, if the teacher praises a student in class, the teacher is providing recognition, but she is also letting the student know that the student's work has been evaluated positively.

Because it is so difficult to separate the R and E dimensions of TARGET, I will discuss them together below, under the evaluation section.

Grouping Dimension

Make opportunities for cooperative group learning and peer interaction. One way to add situational interest to tasks is to have students work in groups. Opportunities to work in groups tends to enhance students' motivation. You will learn much more about cooperative learning in the later chapter on collaborative learning.

Use heterogeneous and varied grouping arrangements. Historically in the U.S., teachers and schools have grouped students by proficiency. Beginning in first grade, teachers have formed "high," "medium," and "low" reading groups, for instance. Many schools track larger groups of students in what may be called honors, regular, and basic tracks.

The research on the effects of such grouping and tracking on achievement are mixed. The effects on high groups are inconsistent across different studies. Some have argued that grouping and tracking have, on the average, small positive effects for high-proficiency students, in comparison with high-proficiency students who are not grouped or tracked (xx). However, grouping and tracking have strong negative effects on low-proficiency students; that is, low-proficiency students learn much more when their schools do not group or track.

Once students are placed in lower-performing groups, they are extremely unlikely to be moved up to higher-performing groups. One reason for this is that lower-performing groups are taught less. In reading groups, for example, low-proficiency groups read less text, and they are less likely to get instruction that focuses on understanding or meaning. They are less likely to learn and practice reading comprehension strategies such as elaboration or explanation. Every year, they fall further and further behind their peers in the higher-performing groups.

A clear negative effective of grouping is that they reinforce performance goals rather than learning goals. Early in the elementary school years, children develop strong notions of who the "smart" kids and "not so smart" kids are. This is facilitated by the groups teachers form. Students all know who is in the "high" group and who is in the "low" group, even if these groups are given innocuous sounding names such as "the bluebirds" and "the sparrows." Motivationally, students in low-performing groups develop very low expectations of success. Given that students assigned to the lowest-performing group seldom move out of this group, it's also no surprise that some of these students may come to view ability as fixed.

To avoid these problems, motivational researchers recommend that teachers employ grouping flexibly. If there are some students who need to work on a particular aspect of decoding, the teacher may form a group of these students. But the teacher does not assume that this is a permanent group. Once the students master these points, the students fan out to different groups that are focused on other strategies. Reading groups may also be formed on the basis of interests rather than reading proficiency; students interested in a particular book join a group to read and discuss that book. When that book is finished, new groups are formed.

This flexible approach to grouping allows teachers to work with students on strategies that they need to learn without stigmatizing some students as generally less capable. Because groups are constantly forming, dissolving, and reforming, and students end up working with all other students in the class at various times during the year, students are much less likely to compare themselves with others. This has positive effects on motivation.

Evaluation Dimension, together with the Recognition Dimension

In this section, I'll describe some of the key recommendations of motivational researchers with respect to the evaluation and recognition dimensions.

Don't create an artificial scarcity of rewards and recognition; give all students opportunities to receive rewards and recognition. Many classrooms create an artificial scarcity of rewards. To see what I mean, consider this contrast between two teachers. (And ignore for a moment the use of stickers as an external reward.)

Teacher A regularly gives tasks such as this: "Study these 20 words, and then we'll have a test. The top 3 scorers will get a sticker."

Teacher B regularly gives tasks such as this: “Study these 20 words, and then we’ll have a test. Everyone who gets at least 16 of 20 correct will get a sticker.”

Assuming that students want to get stickers, which teachers’ students will learn more? Most people readily recognize that Teacher B’s students will learn more. After a while, many or most students in Teacher A’s class will stop trying hard, because they decide that they have little chance to get the desired stickers. In contrast, most of the students in Teacher B’s class will try hard because the teacher has set an attainable goal for everyone. Teacher A has created an artificial scarcity of rewards by restricting the stickers to 3 per test. Teacher B has created a situation in which all students who achieve at high levels are recognized. It is no surprise that students learn much more with Teacher B than with Teacher A.

Many observers of education have argued that schools should be highly competitive because society as a whole is highly competitive, and students need to learn to thrive in a highly competitive society. However, this argument ignores the fact that successful corporations are effective in large part because their employees collaborate successfully. And when companies attempt to use highly competitive reward systems, it often backfires. To illustrate, here is a story told to me by a former corporate manager who was responsible for managing large events such as conferences and shows around the country. He worked with a team of about 20 people, all of whom had to work long, hard hours—usually on the road—to make the events successful. For years, the company allowed the manager to reward all of his subordinates according to whether their job performance was at a high level, and the manager spread the available money for bonuses and raises among all who performed well. Morale was generally high, and he had little turnover in employees. Later, however, the company decided to require managers to give all of the money available for raises and bonuses only to the workers ranked in the top 20% of the work group. Now, even if the manager believed that 75% of his workers had done everything he could possibly have asked, he had to select just 4 to reward. Soon the group’s performance dropped noticeably. Workers who did not receive bonuses or raises were no longer willing to work such long, hard hours. They felt that the company was not treating them properly. The quality of the events the workgroup was staging declined. Turnover increased sharply, which posed serious problems, because it took more than a year to fully train each worker who left. And workers stopped working for the sake of putting on a good event. They worked only when they thought that their work would gain the notice of the manager, who would be responsible for deciding whether they earned a bonus. By limiting the number of people who could receive monetary rewards, the company intended to increase motivation. Instead, their policy had the precise opposite effect.

The example above is supported by a great deal of research. In the corporate world (xx) and in the athletic world (xx), as well as in the classroom (xx), making rewards scarce within a team or class often lowers performance.

There are many ways in which teachers can give recognition to all students. Teachers may have a gigantic bulletin board where excellent work is posted. All students will have the opportunity to post something that they have done well. Teachers can also use a variety of activities; students will have more opportunities to earn recognition if they have an opportunity to try their hand at different kinds of activities.

Do not over-recognize or over-praise mediocre performance. The idea that teachers should aim to recognize all students may imply that teachers will end up recognizing mediocre performance. If students are performing poorly, then teachers can provide recognition only by lowering their standards so as to begin giving recognition to poor performance.

However, motivational researchers do not in any way advocate giving undue recognition to mediocre performance. In fact, teachers often cause problems by overpraising lower-performing children. In one fascinating study, elementary school students said that students who were praised a lot were the poor students, whereas students who were criticized a lot were the good students (ref xx). Think about this for a moment. This suggests that the teachers were probably overpraising inadequate performances, and that the students knew it, too. It also means that these students are getting fewer opportunities to learn from criticism, which is a double disadvantage. Students who are overpraised in this way will not develop a self of self-efficacy. Instead, they will come to believe that they are in fact not very “smart,” which is why their teachers praise them so much.

Thus, teachers must make their recognition meaningful, or students will begin to discount this recognition as meaningless. Teachers should criticize all students work honestly (and with kindness, of course) so that students learn where they can improve. Now, teachers can and should praise improvement (this will be discussed below). But teachers should not pretend that mediocre performance is excellent. Students will either see through this as a sham, or they will get the wrong idea about what counts as excellent work.

Vary the method of evaluation. By using different methods of evaluation, teachers provide greater opportunities for success. Teachers shouldn't use the same kind of test item all the time. By mixing different kinds of exam questions, and by mixing exams with other kinds of assessments (various kinds of homework, performances or presentations, projects, writing, etc.), teachers can give students who are weaker at one type of assessment an opportunity to succeed at other types of assessment.

Provide recognition for effort and good strategy use rather than ability. Suppose that a teacher says to a student, "Your paper is very clearly written. You're really good at writing!" Is this a good thing to say? Research by Mueller and Dweck (19xx), as well as by other researchers, strongly supports the conclusions that statements such as this can be very harmful to students. The problem is this: When the teacher says this, she is attributing success to ability. That's fine as long as the student is succeeding. But when teachers give feedback such as this, students come to believe that they are successful because they have a lot of ability. But what happens when the child who has received this ability-based feedback encounters a more difficult assignment and does more poorly? Because the student has come to believe that her success is based on her ability, she will now believe that her failure is a result of lack of ability. She will think she only has enough ability to do easy assignments, and she will quickly give up when she encounters more difficult assignments. This is true even when the teacher doesn't say anything about the failure! The problem is that the ability-focused praise leads to a general belief that ability is what matters, and then the child attributes failure to lack of ability, too.

Motivational researchers recommend avoiding ability-based recognition and making at least some recognition based on effort. By saying to the young writer introduced in the previous paragraph, "Your paper is very clearly written. You must have worked really hard on this paper," the teacher communicates that success is predicated on effort. The same research discussed above shows that when the student encounters a more difficult writing assignment, she is much more likely to work at it persistently and eventually achieve success.

Recognize improvement. Grade on individual progress and improvement as well as mastery. As I noted earlier, students should not be told their work is excellent when it is not. That poses a problem, though. How can you encourage students whose work is in fact mediocre? The solution is to recognize improvement as well as mastery. You do not have to say that a composition is excellent when it is not, but you can point out the many ways in which a student has made marked improvements. When you do this, your recognition of improvement as a number of positive consequences. Students will continue to try to make improvement, and they will begin to attribute their success to the specific things they are doing to make these improvements.

If you grade partly on individual progress and improvement, then you give students an incentive to work hard and make effort. One way to do this is give students' opportunities to improve their performance. Teachers might allow students to rewrite an essay in response to feedback. Another way is to include in component of the grading that is explicitly focused on recognizing improvement.

Tie recognition to specific aspects of a child's performance. Vague, global recognition and feedback is less effective than highly specific recognition and feedback. Teachers will have a much greater effect on students' motivation and achievement if they tie recognition to specific aspects of a child's performance. For example, instead of simply giving an A on a paper, the teacher should provide comments on specific strengths that the student should continue to build upon and weaknesses that can be improved on.

This means giving specific rather than vague praise and feedback. Here in Table 10.1 are some examples of effective and ineffective praise (adapted from Brophy, 1981). (There is redundancy within this list to some of the other points made in this section.)

Table 10.1: Effective and ineffective praise

Effective Praise . . .	Ineffective praise . . .
is dependent on performance.	is given randomly, whether students do well or not.
specifies the particulars of the accomplishment. "You did a very good job in this paper of making sure that each example supported your main idea." "Your diagram makes your point really convincingly."	is a general positive reaction. "Good job." "I liked your paper."
shows spontaneity, variety, and other signs of credibility; shows clear attention to the student's accomplishments.	shows a bland uniformity. Teacher says "Good" or "Nice job" every time.
rewards attainment of specified performance criteria (which can include effort criteria). "I'm really proud of you for hitting your goal of 85%." "I can tell that you spent a lot of time in the library preparing your note cards. They show tremendous effort."	rewards mere participation, without consideration of performance processes or outcomes.
focuses students on the task. "Your essay answers were all to the point and highly focused."	focuses students on comparisons with other students. "You got the best grade in the class on this test." "I think we should all try to answer as clearly as Jamie did."
recognizes noteworthy effort or success at tasks that are difficult for this student. "I am particularly impressed that you chose an essay topic that required a large amount of library research and then you read all the needed materials."	ignore the effort expended or the meaning of the accomplishment. "This was a very nice paper."
attributes success to effort and good strategy use, implying that similar successes can be expected in the future. "So you see, if you self explain as we practiced last week, your score really increases."	attributes success to ability alone or to external factors (luck, the ease of the task). "You all did well on this test--it was a pretty easy test, I guess."

Make evaluation private rather than public. Minimize social comparisons. When students are encouraged to compare themselves to others, as when teachers announce students' scores on a test in class, they will focus on performance goals. Students who are performing less satisfactorily may soon reduce effort if they conclude that they will remain in the bottom half even if they try hard. Students who are performing well will likely adopt quite strong performance goals rather than learning goals. Their motivation may be limited to performing well on tests rather than on really learning the material.

Teachers can make evaluation and recognition private by engaging in activities such as the following:

--Do not announce grades or scores aloud.
--Have private conferences with students to discuss performance.
--Give feedback in writing.
--Do not make praise a central feature of class discussions. (We'll address this issue again in the chapter on leading discussions.)
--Encourage students not to rush out of the class and compare their test scores, and explain why.

A more controversial recommendation of motivation researchers is to get rid of honor rolls. From the perspective of motivational researchers, honor rolls promote performance goals among both successful and less successful students, and they may encourage less successful students to stop trying hard. But honor rolls are also vague, general forms of recognition, and motivational researchers believe that more specific recognition (such as specific praise for strengths of a well-done project) are more conducive to promoting high motivation and achievement.

Use mastery criteria for grading rather than grading on a forced curve. Many schools and instructors still use forced grading curves. For instance, the Harvard Business School has a policy that 10% of the students in each class must receive an unsatisfactory grade of C. Any student receiving three C's will fail and be expelled from the university. This means that no matter how hard students work, 10% will fail.

A large introductory class might also employ a forced grading curves. There may be a policy that 10% of students get A's, 20% B's, 40% C's, 20% D's, and 10% F's. Even if 30% of the student get 95% or better on the exams, only the top 10% will get grades.

In studies, forced curves have consistently negative impact on learning and motivation. In contrast, mastery systems of learning promote much higher performance as well as very high levels of motivation. In mastery learning systems, teachers set very high standards for getting A's or B's. Students learn exactly what they must do to get A's (such as writing compositions with particular, specified characteristics or completing elaborate projects with specified features). Researchers have found that when mastery learning systems are used, students work much harder and learn much more; the clear specification of standards enables them to see what they must do to succeed, and students tend to work hard to meet these standards.

Avoid external rewards for activities that students already enjoy. In a previous chapter, I discussed some of the research that suggests a harmful effect for giving rewards for performance. Most motivation researchers acknowledge that rewards can be useful in an early stage if students are unwilling to engage in an activity. But the rewards should be faded away as students' interest in the activity increases. When students are rewarded for doing activities that they already enjoy, they may well come to enjoy it less.

Make room for student errors. Errors can be an essential part of learning. Students frequently learn a great deal from their errors. But in classes with a strong performance orientation, students may want to avoid errors at all costs, because making an error signals that one is not as "smart" as others. Teachers can improve motivation and performance by strongly emphasizing that errors are a natural part of learning and by treating errors as important, exciting events that provide an opportunity for learning.

Thus, teachers should avoid embarrassing students for making errors. As we will learn in later chapters, they can avoid stating right away whether students have made errors or not and instead ask students to explain their reasoning. This will lead students to consider arguments for and against different answers; they will thus come to understand why some answers are better than others.

Time Dimension

Many teachers give tests or work that is very difficult to complete on time. This can occur in a number of ways. Tests may be too long for the time period provided. Teachers may give time-consuming homework assignments that are due the next day. Teachers may give too little time for groups working on projects to make adequate progress.

Motivational researchers recommend that teachers give students adequate time to take tests and complete other work. Some students, such as students with limited English proficiency or students classified as learning disabled, may be very unfairly disadvantaged when they have too little time. Students who are more reflective on exams and work may also be disadvantaged, whereas students who work very speedily, even hastily, may be rewarded.

This is not to say that teachers cannot provide training in taking tests that are on strict time frames, such as annual standardized tests or the SAT test. But teachers are less likely to "lose" some of their students if those students have opportunities to earn grades that are not strictly timed.

Some of the specific recommendations of motivational researchers are as follows.

1. Adjust time requirements for students who have difficulty completing their work.

2. Avoid classroom tests where time constraints make a difference in evaluation.

3. Give students opportunities to plan their schedules so that they can progress at an optimal rate.

The BESS Strategies

Belonging Dimension

Recent research has supported the conclusion (which we all intuitively know and believe) that students will be more motivated if they feel a greater sense of belonging, with other students, with the school, even with the community.

One aspect of the belonging dimension is to minimize the attractiveness of competing motivational systems. This can often be done by convincing students' natural leaders to buy into school programs. When the students' leaders buy into the school programs, then belonging to school groups and working toward school goals work hand in hand.

To further create a community in which students come to value academic goals and feel a sense of belonging when helping to achieve academic goals, schools should engage in practices such as these:
--Avoid P.A. announcements except at clearly defined times.
--Avoid disruption of class time through excessive assemblies, etc.
--Decorate the school with academic-related images, artwork, etc.
--Be active in events such as the Science Olympiad.

Extracurricular activities (such as athletic events, club events, and school-wide social affairs) are also important for promoting a sense of belonging.

Research by Wentzel (xx) and others supports the conclusion that teacher caring is an important motivational factor. Students are more likely to feel a sense of belonging if they feel that their teachers care about them. According to surveys and interviews with students, teachers are viewed as caring when they:
--make clear efforts to help students understand the materials.
--are willing to meet with students outside of class time.

--show students that they care about them personally.

Expectations Dimension

As I discussed earlier, it is important not to tell students that their work is excellent if it is not. This implies that teachers should set high expectations for students and make sure that the students meet these expectations. High expectations are extremely valuable in promoting higher motivation and academic success.

However, it is not enough to set high expectations and then fail every student who doesn't meet these expectations. If a teacher walks into class the first day and hands out a demanding syllabus that does indeed embody high standards, he may find within two weeks that he will either have to fail half of his students or abandon his high expectations. If you have high expectations, you must set up a careful plan that enables you to ensure that all students will meet these expectations. This means that you will have contingency plans to work with or otherwise assist students who fall behind or fail to understand something.

Short-term Goals Dimension

Students will be more motivated and learn more if they set (perhaps with your help) realistic short-term goals that they can achieve. Short-term goals have powerful effects on motivation as well as on achievement. When students set and achieve short-term goals, they increase their expectation of success because they learn that that they can improve themselves step by step. As they attain their goals one at a time, they can see how they are in fact improving, and they develop a strong belief that they can improve further. In addition, short-term goals often help them see that improvement is a matter of developing specific knowledge and strategies. If students set the short term goal of elaborating as they read in the next week, then as their performance improves due to the use of this strategy, they learn to attribute this higher performance to their strategy use.

There are many different ways in which teachers can encourage students to set short-term goals. Here are some examples:

<u>Elementary school:</u>
--On Monday, have students set two goals for the week.
--Ask students to record reasonable goals on the board and provide them with specific forms of guidance on how to meet such goals.
--Encourage students to write something in a journal every day and discuss how this helps/hinders thought.
--Students write down three daily learning goals in their morning journal. One goal is about behavior, one is about a strategy they will use, and one is about something they learned yesterday that they will apply today.
--Before students write a composition, each sets four goals for good writing techniques they will use (such as spending 15 minutes generating ideas before starting, making sure that they think about counterarguments, etc.).

<u>Middle-school and high school:</u>
--Have students help establish weekly goals for themselves.
--During first week of each marking period, encourage students to set realistic goals for the period. Students write these in their journals.
--Students keep a journal of weekly short-term goals and they chart their own achievement in relation to these goals.
--On Mondays, students write in their journal one strategy that they will focus on using that week. On Friday, they will evaluate how they did.
--Before group discussions, students in each group write down three specific goals that they have for the group work period.
--Before

--During a soccer game, each soccer player states one skill-based goal for his/her play in that game, such as "I will keep my shots low" or "I will release my passes more quickly."

Strategy Dimension

One of the very best ways to increase student motivation is to teach them the cognitive strategies they need to succeed. It is impossible for students to have a high expectation of success if they don't know the strategies needed to study effectively. In fact, teaching cognitive strategies may be one of the very most effective ways of promoting motivation. Students who learn strategies will come to understand that success is to be attributed to good strategy use. They will believe that if they lack the strategies to succeed at a task, it is certainly possible for them to learn these strategies. They develop a strong expectation of success for nearly any task that they undertake.

CHAPTER 11
Creating Well-Managed Learning Environments

Tracey Garrett & Clark Chinn

Chapter Outline	**Applied goals**
Reflecting on Students' Thinking	
Challenges in Classroom Management	
Goals of Classroom Management	
Organizing the Physical Design of the Classroom	
Arranging Students' Desks	Plan the physical design of a classroom
Arranging Other Furniture, Equipment, Supplies, and Décor	
Students' perceptions of the physical environment	
Establishing the Rules and Routines of the Classroom	Establish rules and decide how you will develop rules.
Rules	
Routines	Establish your classroom routines.
Developing Effective Interpersonal Relationships	
Teacher-Student Relationships	Develop methods to promote effective interpersonal relationships.
Student-Student Relationships	
Teacher-Parent Relationships	
Planning Engaging, Well-Organized Instruction	Design instruction that is engaging to minimize management problems.
Developing Engaging Instruction	
Developing Well-Organized Instruction	Design well-organized instruction
Preventing and Responding to Behavior Problems	
Preventing Behavior Problems	Use techniques to prevent misbehavior and encourage student self-regulation of behavior.
Responding to Behavior Problems	
Extensions	
Developmental differences	Use the Principle of Least Intervention to respond to minor misbehavior
Students with Behavior Disorders	
Culturally and Linguistically Diverse Students	Plan effective responses to more serious misbehavior.
Chapter Summary	
Application Problems	

Reflecting on Students' Thinking

An elementary-school principal has noticed that the teachers in her school who have many discipline problems lead discussions that are very different from the discussions led by teachers who have few discipline problems. Below are transcripts of typical discussions led by (1) Krysta, an earnest teacher whose students are often disorderly and off-task (meaning that they are not engaged in academic school work) and (2) Maia, whose students are generally well behaved and highly engaged in academic work. Both teachers teach fourth grade classes.

One day, the principal observes both teachers leading a discussion on a text about wolves. The main points of the text are as follows: *Wolves used to be common throughout the U.S. West. Now there are few or no wolves in many of these areas. The government is bringing wolves back to some areas, but not all citizens are happy about this decision.* The text goes on to present arguments on both sides of the question.

Here is the beginning of Krysta's discussion (this segment is representative of the entire discussion):

Krysta: If we look at the title, we can see what this text is about. What is the title? Carl?
Carl: Shall we bring wolves back to the West?
Krysta: Great. From the title, what is this story going to be about? Lane?
Lane: It will be about wolves and the West.
Krysta: Yes, it will be about whether wolves should be brought back into the West, won't it? How many wolves used to live in Montana, Idaho, and Wyoming? Kaitlynn?
Kaitlynn: More than 50 thousand.
Krysta: Right. *More than 50 thousand.* You found that on page 74, didn't you? And how many wolves are there now? Juan?
Juan: About 1,500.
Krysta: Yes. And what are government officials now doing? Sylvie?
Sylvie: Um… …
Krysta: Look in the third paragraph on page 75.
Sylvie: [after a pause] They want to bring wolves back to some places.
Krysta: Exactly. And does everybody like that idea? Augusto?
Augusto: Um, no.
Krysta: Why not? What is one reason?
Augusto: Well, because wolves eat baby sheep and stuff.

Here is the beginning of the discussion in Maia's class (also representative of the class's entire discussion):

Maia: Today our question is the same question that we see as the title of the story: Shall we bring wolves back to the West? You've all written at least two arguments on each side after you read the story. So what do you think? Let's have a show of hands: How many think that the wolves should be brought back? [Eight students raise their hands.] How many think that they should not be brought back? [Ten students raise their hands.] How many are not sure right now? [Seven students raise their hands.] Brendon, you said you're not sure. Tell us why.
Brendon: Well, I can see both sides. The ranchers have a good worry. They are worried that the wolves will kill their livestock—the babies, especially. So they would lose a lot of money. But on the other hand, wolves are needed in the mountains, or there gets to be too many deer and other animals like that. And that's bad, too.
Maia: Maddie. Please respond to what Brendon said.
Maddie: It says…. It says that the wolves killed about 500 sheep and cows last year. That's a lot. But if the government pays the ranchers for the animals killed, I think that would be OK. The government can pay for that many. It's not that expensive.
Brendon: How do they know that wolves killed less than 500? [Maia points to Shayla to speak next.]
Shayla: I think that the farmers, I mean the ranchers, will know how many livestock they have lost. I'm

	sure they count them. And if they say that there are a certain number of cattle killed by wolves each year, I think they would be accurate.
Maia:	Ramiro.
Ramiro:	It's not just the ranchers. The wolves are important for the ecosystem. The whole ecosystem. [Maia points to Vanessa to speak next.]
Vanessa:	That's right. Without the wolves, the ecosystem gets all messed up.
Maia:	OK, Ramiro and Vanessa have argued that the ecosystem gets messed up without the wolves. Is there any evidence for that in the text? Ramiro?
Ramiro:	Yeah. It shows a graph that the deer population is really high when there aren't any wolves, and it goes down lower when the wolves are brought back.

You have probably noticed many differences between the two discussions in what teachers and students say. Develop a quantitative analysis of at least three differences between the two discussions. Then use your findings to develop a hypothesis explaining why Maia's classes are better behaved than Krysta's.

In this chapter, we examine how to create a well-managed learning environment that enables all students to learn. Our focus is **classroom management,** which refers to the processes that teachers use to create smoothly-run classroom in which students are fully engaged in learning. Teachers with good classroom management skills maximize the time that students spend learning and have little student misbehavior in their classrooms. Teachers with poor classroom management skills have classes in which students misbehave and spend a great deal of time **off task**, which means that the students are not focused on learning. Instead, the students may be talking, goofing off, or just daydreaming.

The instructional lessons that teachers create are an important part of classroom management. In the Reflection you just read, the teacher whose students were well behaved and engaged in learning asked different kinds of questions than the teacher whose students often behaved badly. We will learn more later in this chapter how effective classroom managers design instruction, as well as how teachers implement other components of a well-managed classroom.

CHALLENGES IN MANAGING CLASSROOMS

Beginning teachers, and even experienced teachers, often struggle with creating a well-managed classroom in which students can learn (Jacques, 2000; Jones, 2006; Ladd, 2000; McCormack, 2001; Stough, 2006). One reason why classroom management is challenging is that many teachers approach it with some incorrect alternative conceptions. Consider your own answers to the two simple questions below. (Write your answer down before looking ahead.)

Question #1: What is the first word or phrase that comes to mind when you hear the phrase "classroom management"?

Question #2: What is the goal of classroom management?

When undergraduates beginning their study of education are asked these questions, they typically give answers such as these:

Answers to Question 1: discipline, punishment, control,

Answers to Question 2: good behavior, orderly classroom, control, quiet

The idea that classroom management is mainly about discipline (or punishment) is an alternative conception held by teachers that can actually interfere with effective teaching. In fact, effective managers organize their classrooms so that they avoid most behavior problems and so do not have to worry about discipline very often (Brophy, 2006; Evertson and Weinstein, 2006). As we will discuss in this chapter, a focus on discipline as the main way to run classes will exacerbate behavior problems.

A second alternative conception that can create problems for teachers is the conception that the central goal of classroom management is a well-controlled classroom in which students are quiet. It is true that in well-managed classes, students are on task and are seldom disruptive, but they are not necessarily quiet. Well-managed classrooms can be noisy and even a bit chaotic, as when students working in groups are excitedly discussing a project that interests them. Conversely, students who are well-behaved and quiet may not be learning anything, as when they are sitting quietly at their desks daydreaming rather than listening to the teacher.

Classroom management is one of the greatest research success stories of the 20th century (Brophy, 2006). We now have a good understanding of the teaching strategies that are used by effective classroom managers. Many of these strategies are generally applicable to a variety of styles of teaching—from teachers who employ more traditional forms of instruction to teachers using constructivist instruction (Brophy, 2006). We will discuss these strategies in this chapter.

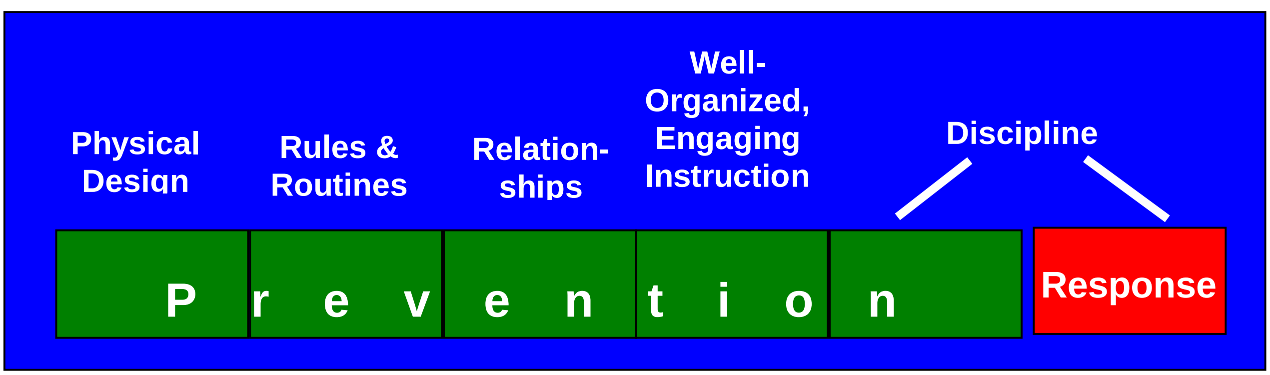
GOALS OF CLASSROOM MANAGEMENT

Teacher educators Carolyn Evertson and Carol Weinstein (2006) have emphasized that classroom management has two goals: academic learning and social-emotional learning. **Academic learning** refers to learning content specified in state content standards (learning to read and write, learning to reason, learning science, math, and social studies, and so on). **Socio-emotional learning** is learning that promotes growth in social skills and the ability to express emotions maturely. Classrooms are well managed only if the teacher has created environments that promote both of these kinds of learning.

Effective teachers not only reduce student misbehavior but also minimize wasted time in which learning is not occurring. If a teacher spends 5 minutes each day taking attendance and passing back papers, that adds up to 15 hours lost in a year of potential learning time. Effective teachers aim to maximize student learning time.

Figure 11.1 highlights the five key components of effective classroom management. This chapter elaborates in detail on each of these five components.

Figure 11.1: The five components of classroom management



1. *Physical design of the classroom.* Physical design refers to how the classroom is laid out—where the students' desks are, where the teacher's desk is, where learning centers and materials are located, where heavily used items such as pencil sharpeners are, and so on. Effective managers arrange the classroom in ways that increase enhance student learning and reduce opportunities for misbehavior.
2. *Rules and routines.* Teachers establish class rules and routines (such as routines for handing back papers and taking attendance) to keep class activities running smoothly with as little disruption and as little loss of time as possible.
3. *Relationships.* Effective classroom managers develop caring, supportive relationships with students and with parents, and they promote supportive relations among students.
4. *Engaging, well-organized instruction.* Effective classroom managers develop instruction that engages learners, and they carefully plan their instruction so that each learning activity is well-organized and runs smoothly.

5. *Discipline.* Discipline refers to a variety of teacher actions focused on *preventing* and *responding to* students' misbehavior. Discipline does not only mean punishment, nor does it only mean what teachers do after misbehavior occurs. Discipline includes teacher actions that keep misbehavior from happening.

As Figure 11.1 highlights, four of the five components of management (physical design, rules and routines, relationships, and engaging instruction) are aimed at preventing misbehavior rather than responding to misbehavior. The fifth component—discipline—includes both actions designed to prevent misbehavior and actions that respond to misbehavior. Thus, it is crucial for teachers to understand that most of their management activities are directed at *preventing* misbehavior, not at *responding to* misbehavior. The more skilled a teacher is at preventing behavior problems (implementing the prevention components), the fewer problems will arise.

ORGANIZING THE PHYSICAL DESIGN OF THE CLASSROOM

The physical layout of the classroom is important in well-managed classrooms. According to teacher educator Walter Doyle (2006), one of the main factors determining how much time teachers spend organizing and directing students and dealing with inappropriate and disruptive behavior is the physical arrangement of the setting.

In a classic study, teacher educator Carol Weinstein (1979) reviewed research on the effects of physical features of the classroom environment. She found that physical arrangements primarily affected students' attitudes and behavior rather than their achievement. She also found that it was important to separate areas that serve different purposes and plan clear pathways for movement between areas. The supplies area should be separated from the class library area, for example. If students need to move from one part of the room to another (e.g., to get supplies), the pathways for this movement need to be wide enough for students to move easily (Carter & Doyle, 2006).

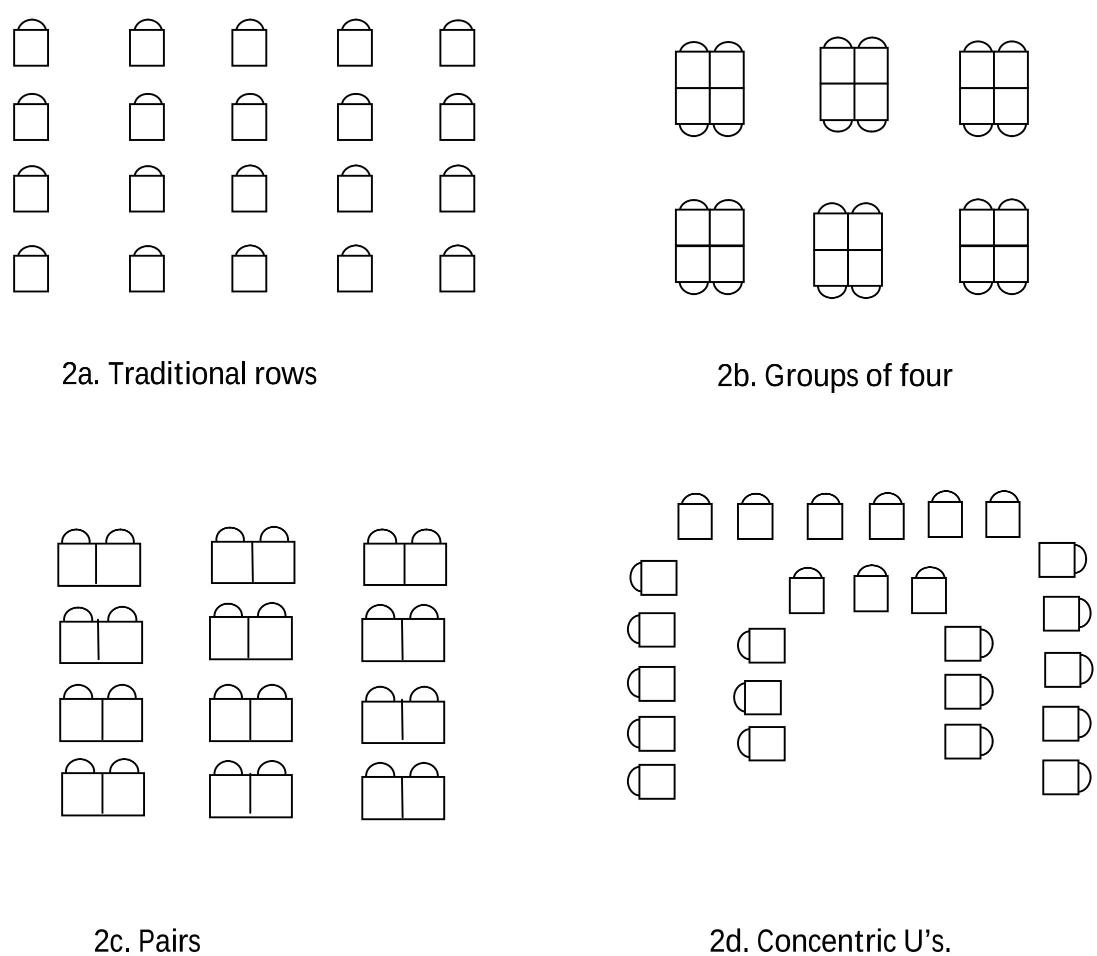
Weinstein also found that the density of the classroom affected the frequency of misbehavior. In dense classrooms, students are crowded into a relatively small space. In less dense classrooms, there is more space per student. Students were more attentive, less distracted, and less aggressive in classrooms with lower density. This relationship has been found at very different age levels—in preschools as well as college classes (Weinstein, 1979), suggesting that students need adequate space to learn effectively.

In the following sections, we discussion several important components of physical layout. These include arrangement of students desks as well as arranging other furniture and materials.

Arranging Students' Desks

When laying out their classrooms, teachers must decide how to lay out the students' desks. Classrooms have an **action zone** (Doyle, 2006), which is the area of the classroom in which students interact most frequently with the teacher. When desks are arranged in traditional rows, the action zone is typically the front and the center of the room—the parts of the room that are closest to the teacher. Students who sit in these parts of the classroom benefit from having more frequent interactions with the teacher (Adams, 1969; Adams & Biddle, 1970). It is very important for teachers to be aware that they may have a strong tendency to interact disproportionately with these students. Teachers should compensate by circulating to all parts of the room during lessons and to make sure that they are interacting equally with students in all parts of the room (Evertson, Emmer & Worsham, 2003; Savage & Savage, 2010; Weinstein & Mignano, 2007).

Figure 11.2: Four desk arrangements



Is it better to arrange desks in traditional rows or in other arrangements such as clusters or semi-circles? Figure 11.2 displays four of the options that teachers have for arranging students' desks: in traditional rows, in groups of fours, in pairs, and in two concentric U-shapes. Unfortunately, there is little research on the effects of different desk arrangements. In one study, when students were asked to complete assignments independently, their work involvement and efficiency were higher in traditional rows than in clusters (Bennett & Blundell, 1983). This effect was greater for students who had behavioral or learning problems. Does this mean that teachers should always use traditional rows? No—because there are also some disadvantages to seating students in rows. It is difficult to engage students in group work without losing substantial time as students move their desks. In addition, students sitting in traditional rows cannot see each other very well during class discussions, which can tend lead to students talking to the teacher instead of to each other. In class discussions, the students in the back of the class often cannot even hear what students in the front of the class are saying, because these students are facing the teacher.

Table 11.1 summarizes the pros and cons for each of the student desk arrangements shown in Figure 11.2. Because there is no single best way, the best solution for teachers is to be open to a variety of desk arrangements depending upon the task at hand and students' learning needs. When students are engaged in a week-long group project, teachers might group students' desks in fours so that they can easily work in groups, whereas teachers may want to switch to concentric U's in weeks when they are holding many extended class discussions.

Table 11.1: Advantages and disadvantages of different student desk arrangements

Arrangements of desks	Advantages	Disadvantages
Traditional rows	*Circulation*. It is easy for teachers to move around to any desk in the room. *Attention*. Because all the students are facing the teacher, it is easy for students to look at the teacher when she is talking. During individual work, students may be less distracted by their peers when they are not sitting right next to them. *Teacher monitoring of students during whole-class activities*. Because teachers can see all the students' faces, they can more readily monitor whether students are paying attention, whether they are understanding, and so on.	*Collaboration.* Students cannot easily work in groups and have to move desks around in order to work together. This means that short group tasks cannot easily be assigned (e.g., spending five minutes to discuss a topic in groups before joining a class discussion). *Discussions.* Students cannot see each other during group discussions. Students in the back can often not hear students in the front, who are facing forward toward the teacher. *Epistemological implications.* The arrangement is most consistent with an epistemology that makes the teacher the authority, standing in front of the room and "transmitting" knowledge to the class.

Groups of four	*Circulation*. It is to easy for the teacher to move around to talk with individuals or with groups. *Collaboration*. Students can readily work in groups of four, although if students are working in pairs, they may be somewhat distracted by the pair facing them across the table. *Discussions.* Students must turn around to see each other during class discussions, but students are no longer all looking at the teacher. The focus is more on looking around the room at each other, which makes it easier to encourage students to talk with each other. *Epistemological implications.* This arrangement emphasizes the importance of students working together to construct knowledge.	*Attention*. Because some students are not facing the teacher, maintaining attention may be more difficult when the teacher is talking. *Teacher monitoring of students during whole class activities*. Because teachers cannot see all the students' faces, they cannot monitor behavior or understanding as readily as when the students are facing them.
Pairs	*Circulation*. It is to easy for the teacher to move around to talk with individuals or with pairs. *Attention*. Teachers can expect that all students look at them when they are talking. *Teacher monitoring of students during whole-class activities*. Because teachers can see all the students' faces, they can more readily monitor students' attention and understanding. *Collaboration*. Students can readily work in groups of two, and by having one pair turn their chairs around to join the group behind them, students can quickly form groups of four. *Epistemological implications.* On the positive side, this arrangement emphasizes the importance of students working together to construct knowledge.	*Attention:* When students are doing individual work at their seats, they may be distracted by their partner. *Discussions.* This arrangement has the same disadvantage as traditional rows. Students cannot see each other during group discussions, and students in the back can often not hear students in the front, who are facing forward toward the teacher. *Epistemological implications.* On the negative side, this arrangement places the teacher in front of the room as the authority.

Concentric U's	*Attention*. All students can see the center of the room, which makes it easy for the teacher to maintain attention when talking. *Teacher monitoring of students during whole-class activities*. Because teachers can see all the students' faces, they can more readily monitor students' attention and understanding. *Collaboration*. Adjacent students can work in pairs, usually without moving their desks much, as desks usually must be close together. *Discussions.* A strength of this format is that most students can look at the person who is speaking. The U format encourages students to talk directly to each other, as they are looking directly at each other. *Epistemological implications.* This arrangement emphasizes the importance of students talking directly to each other, and it also allows for collaborative knowledge construction by pairs of students.	*Circulation*. It is to easy for the teacher to move around to talk with students in the inner U, but it can be harder to get to the students in the outer U. This arrangement can be crowded, because the space in the center of the inner U is not being used, so the desks must be fit into a smaller area. *Attention:* When students are doing individual work at their seats, they may be distracted by their partner. *Collaboration*. Work in groups of 3 or 4 is difficult.

Arranging Other Furniture, Equipment, Supplies, and Décor

Student desk arrangements are not the only important component of the physical layout. Teachers must also decide where to place (1) the teacher's desk, (2) any additional tables or other furniture, (3) computers or other equipment, (4) materials and supplies students use regularly, such as art supplies, materials for science experiments, and pencil sharpeners, and (5) special centers that the teacher might create, such as a library corner. Teachers also plan the room's décor, including materials on walls (such as posters or students' work) and items placed around the room (such as plants, aquaria, or student art work). The best physical layout for teachers' classrooms depends upon the teacher's goals, the shape of the room, and the physical constraints of the classroom (i.e. where outlets and internet connections are, they type and size of furniture, the size of the room) (Carter and Doyle, 2006). Some principles that can guide teachers as they arrange their classrooms are discussed below (Evertson, Emmer & Worsham, 2003; Weinstein & Mignano, 2007; Savage & Savage, 2010).

Creating adequate space for students and for teachers to interact with students. Students need adequate space to learn, individually and collaboratively. Students need enough desk space and space to put their personal belongings so that they do not feel cramped. Teachers can increase involvement in lessons by making sure students have enough space among them to be able to focus on the lesson.

Teachers should arrange the furniture in ways that allow them to circulate and interact with all students, especially those who are seated in the back and on the perimeter. If students will sometimes come to the teacher's desk to ask questions, the teacher should make sure there is enough room for students to stand or sit without being in other students' way. One way to generate needed space in the classroom is to set aside or remove furniture that is not needed. If a table is not being used, the teacher can ask the administration to remove it from the classroom. Teachers who rarely use their desk can move it to the side or back of the classroom or ask the administration to remove it from the classroom altogether.

Minimizing traffic problems . In every classroom, there is a potential for traffic jams. In close quarters, students are more likely to jostle and push each other. Teachers should place supplies, equipment, and materials in locations that avoid congestion and that make it easy for students to get what they need. Putting materials in crowded corners can lead to problems. For example, if a science teacher puts all the beakers and test tubes needed for a lab in one corner of the room, there will be a traffic jam as students all converge to pick up their equipment. Students may drop and break supplies as they try to get through the crowds. By spreading the equipment out along a long counter, the teacher can minimize congestion as students get up to get and return the equipment. Similarly, teachers will want to avoid placing the pencil sharpener or frequently-used art supplies in a cramped corner where it will be difficult for students to reach them.

Pleasant classroom décor. It is important for teachers to decorate their classrooms to create an aesthetically pleasing environment. Posters, pictures, and student work on the wall helps students feel that the room is a welcoming, comfortable place to be. This can include posters that express values and class norms, pictures that teachers and students like, or notable quotations from books the students are reading. Bare walls may make the classroom seem like a cold, impersonal institution rather than a community where students learn together. Posting student work from projects and other assignments is a good way to recognize students for high-quality work. The classroom décor can also communicate information about the teacher. By displaying posters of their favorite places or their favorite quotations, teachers enable their students get to know them better.

Adapting the room to the instructional purposes and activities. Teachers should fit the physical layout to their preferred instructional activities and purposes. Teachers who want students to work in different learning centers will need to arrange the classroom so that there are learning centers spread around the classroom. Teachers who plan to use computers extensively during group work will need to spread computers far enough apart so that students can work in groups of two or three around each computer. In early childhood classrooms, lessons tend to be more informal with a great deal of play, so teachers must design their classroom to include play materials and areas for different kinds of play.

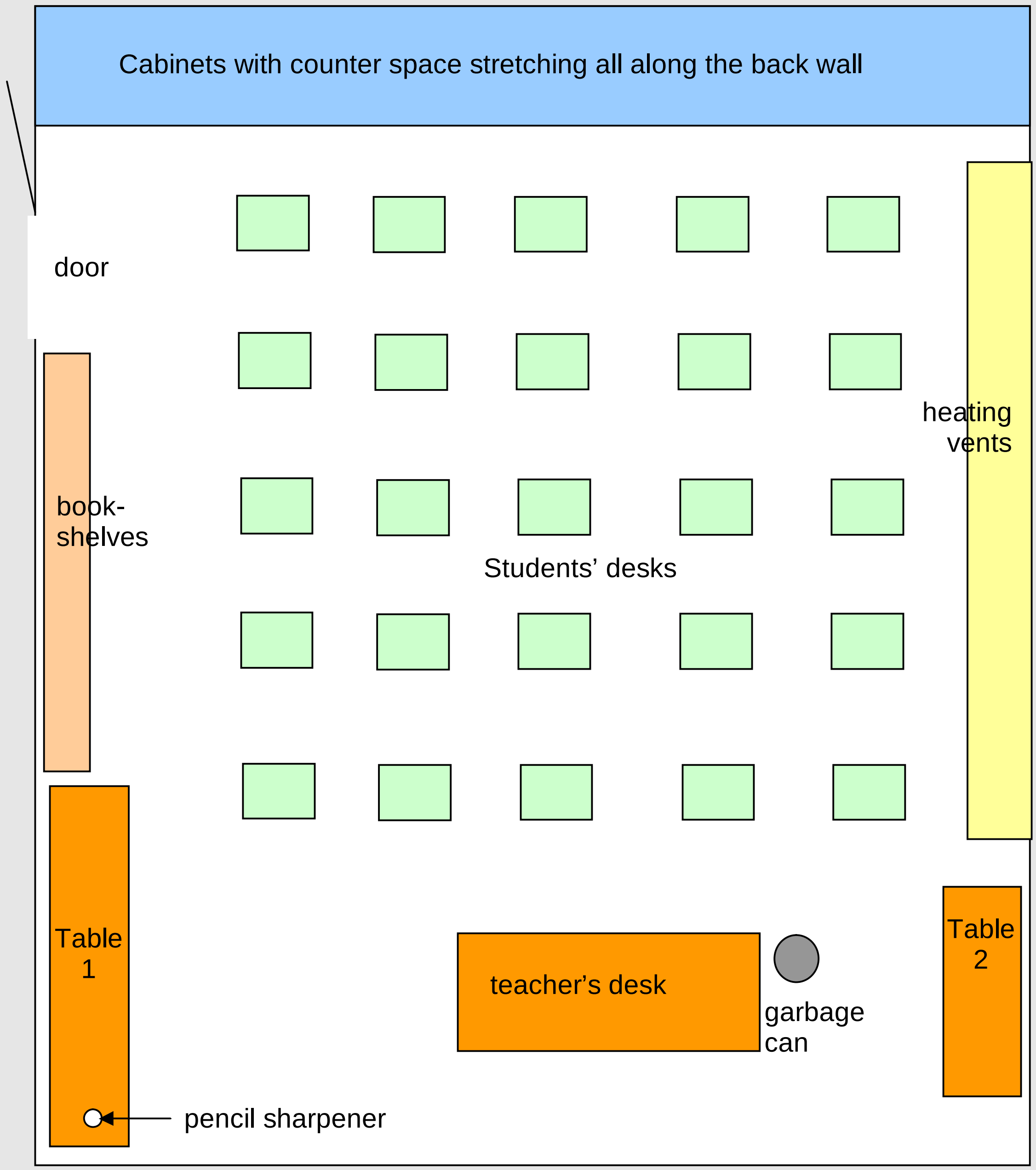
Students' Perceptions of the Physical Environment

It is important to consider students' perceptions of the physical environment when designing the classroom. Students' ideas about their surroundings may be different from what the teacher expects, and teachers will need to understand what students are thinking in order to design an environment that meets their needs.

In a recent study, teacher educator Kim Heuschkel (2004) investigated what elementary students think and feel about the physical environment of their own classroom. Heuschkel investigated the ideas of her own students in the second-grade class she was teaching. She was interested in where her students thought they did their best work and where they liked to socialize with their friends. Heuschkel found that that her students reacted to various parts of the classroom in ways different from her expectations. Heuschkel had created many different learning areas in her classroom, including a cozy reading area with a large couch, several content area learning centers and several individual work spaces/cubbies. She had expected that many students would identify one or more of these learning areas as the place where they did their best work. To her surprise, *all* of her students selected their own desks as the place where they felt they did their best work. In addition, she anticipated that students would report preferring to socialize in some of the wide open spaces she had created, such as the large carpeted area. However, almost all students preferred to socialize in areas where they could squeeze several people together in a cozy, little nook.

Based on findings such as these, Heuschkel decided to give her students more of a decision-making role in the overall design of the classroom. Before rearranging the classroom, Heuschkel asked students for their ideas and even asked them to submit sample drawings. The students and the teacher discussed the pros and cons of different layouts. The students thus participated in the process of arranging the room and then evaluating it. Using techniques such as these, teachers can give students a voice in designing the classroom, and students can help design an environment that pleases them. Giving students a voice in the design of the physical layout also contributes to students' autonomy and a sense of belonging.

Problem 11.1 Evaluating Teaching: Physical Design of the Classroom



Jarod Haynes teaches 6th grade language arts. He has to make do with a small classroom. This diagram shows the layout of his classroom. On Table 1, he keeps handouts for the day. Students turn in homework by stacking their papers on Table 1. The bookshelves are where he stores additional textbooks that his classes are not currently using. Table 2 is where he keeps reference books that students need for current group projects that are the focus of class for the next two weeks.

Evaluate the physical layout that Jarod has developed for his classroom.

Problem 11.1 Continued

Response: There are many possible responses to this question. Here are some issues that Jarod should consider:

1. He is spending two weeks on group projects but still has desks (which he could easily move) in rows. During two weeks of group projects, it would likely be a good idea to rearrange desks so that students can readily work in their groups when they enter the classroom.

2. Jarod has a whole wall of counter space that he is not using. Instead of keeping handouts on Table 1, Jarod should leave the day's handouts in a stack on the counter right next to the door so that students can pick up everything they need for the day as they walk into the classroom. Reference materials could also be spread along this counter, so that they are not all crammed in the corner on Table 2.

3. He is wasting bookshelf space for books that are not being used. Jarod could either store books in the cabinets or ask the administration for places to put the books. The bookshelves could be used for some of the reference materials for the projects (now on Table 2), or he could begin a class library of fiction that students could check out.

4. In general, materials students need to get (handouts, reference materials) should be spread out more, taking advantage of the poorly-used bookshelf and/or the counter in the back of the room. With his current arrangement, there may be traffic jams around Tables 1 and 2.

5. Jarod should try to move the pencil sharpener out of a hard-to-get-to corner of the room.

ESTABLISHING THE RULES AND ROUTINES OF THE CLASSROOM

Both rules and routines are essential components of an effective classroom management plan (Emmer, Evertson & Anderson, 1980; Marzano, 2003; Bondy, Ross, Gallingane & Hambacher, 2007). Classroom **rules** specify general norms for overall conduct, and they say generally how students should or should not behave. A teacher will have a small number of rules that govern all aspects of classroom behavior. **Routines** are much more specific to certain tasks (such as routines for going to recess or handing in homework), and they provide a series of steps for how to carry out the task (such as the steps to take when handing in homework). A teacher will have many different routines to carry out all the necessary classroom tasks.

Rules

Classroom management researchers have recommended some general guidelines or "best practices" to guide teachers in developing effective classroom rules (Evertson, Emmer & Worsham, 2003; Weinstein & Mignano, 2007). These guidelines are discussed below:

Number of rules. Teachers should develop approximately 4 to 6 rules. If teachers have too many rules, the classroom will seem overly rigid, and students may have a hard time remembering them all. If there are too few rules, critical aspects of behavior that should be covered by class rules will probably be neglected. Rules should cover several dimensions of behavior including classroom safety (not fighting, being careful with equipment), respect (e.g., listening to others, treating others respectfully), and making appropriate effort (e.g., doing one's best, coming to class prepared every day).

When developing the final set of rules, teachers should be sure that the classroom rules are congruent with school-wide rules. Some school-wide rules should double as class rules. For example, if the school emphasizes respecting others throughout the school, then the teacher will want to including respect for others as one of the class rules.

How to word the rules. Teachers should write rules using **positive language**, which means avoiding negative words such as "no" or "not." Instead of a classroom rule that says "No running," teachers should write this rule as "We walk at all times." Writing the rules using positive language results in an overall more positive classroom environment because it emphasizes good behavior. Negative rules, in contrast, emphasize what students cannot do and what they will be punished for.

An important issue regarding wording the rules is whether to word the classroom rules in more general or in more specific terms. Rules with **general wording** refer generally to many different situations. Examples include: "Be a good friend," "Do your best," and "Respect others." Rules with **specific wording** focus on particular situations, such as "We walk at all times," "Follow directions the first time they are given," and "One person speaks at a time." There are again pros and cons to each approach. The advantage of more general rules is that they cover more situations and behaviors. The rule "Respect others" can include listening to others, speaking politely to others, not stealing their property, and so on. This rule can be applied to many situations, whereas the rule "One person speaks at a time" only covers behavior in class and group discussions. On the other hand, the application of general rules can be ambiguous, which means that teachers may find that students frequently argue with them over whether they have really violated a rule or not. When a teacher tells a student that she has violated the rule "Be respectful" by interrupting a classmate, the student may argue that she was just excited about another classmate's ideas and was not being disrespectful. Whether the student was really disrespectful may be unclear. Conversely, the rule "One person speaks at a time" has clearly been broken if a student interrupts a classmate.

Making sure that students understand and remember the rules. Effective classroom managers make sure that students understand and remember the rules. One way to help students remember the rules is to post the rules in a conspicuous place where everyone in the classroom can see them easily. If the rules are displayed saliently, students will see them frequently and be reminded of them when they see them. When teachers need to remind students of one or more rules, they can point to the posted rules.

Teachers should also explicitly teach the students what the rules are and how to interpret them. Many teachers announce their rules, post them on the wall, and then assume that students will understand and follow the rules. However, students may not understand the rules in the same way that the teachers intend. For example, if a teacher has a rule that says, "Respect each other," the teacher may interpret this to mean that students should not call each other names. However, some students may not think that the rule applies to name calling, because they may think of name calling as "teasing" rather than as "disrespect." To ensure that all the students understand what is meant by this rule, the teacher should discuss with the students what it means to respect each other so that everyone develops the same understanding.

When explaining the rules, teachers can model appropriate behaviors and discuss with students what will count as violations of the rules. In this way, the teacher leaves no room for misunderstanding. In addition, it is important to make sure that students understand *why* the rules are important. Students are more likely to follow the rules when they understand the rationale for them. When a teacher explains that the rule "Listen to others" exists to ensure that everyone can learn from the good ideas that others have, then the teacher has given the students a reason for wanting to follow the rule.

Deciding whether to give students a voice . An important decision that teachers must make is whether to involve the students in developing the rules. On one hand, the *teacher* may determine what the rules are. On the other, the teacher may have the *students* help generate the rules. There are pros and cons to each approach. Although involving the students in the development of the rules is time consuming, this process can allow students to feel more ownership over the rules, and, as a result, students may be more likely to follow them. However, if teachers generate the rules themselves, they ensure that they have the exact set of rules they need in order to teach. It is possible to use a combination of both teacher and student-generated rules. For example, teachers can hold a class meeting to discuss the importance of rules and to generate ideas for rules. Teachers can then guide the discussion so that it focuses on those rules that they want to highlight in their classroom.

Applying the rules. How might different teachers develop rules in accordance with the guidelines discussed above? The examples below show two successful teachers who use different approaches.

- Helen, an eighth-grade mathematics teacher, has students help generate the classroom rules to encourage them to be accountable for their actions. During the first day of school, she holds a class meeting in each of her classes, and the class decides on the appropriate ways to behave. Helen uses the MOST common ideas generated during her five classes to develop a code of discipline, but she rewords the ideas so they are written in a positive manner to create a more positive environment. Her code of discipline is: "We have the responsibility to be safe, to keep others safe, to do our schoolwork, to show respect for ourselves and others, to take care of the things around us, and make our school a peaceful place." The code of discipline is posted on the wall, and she asks students to recite it once each week.
- Connor, a third-grade teacher, believes that it is important for students to feel that they developed the classroom rules because then they will feel a responsibility to follow them, but there are still certain rules that he wants to make sure appears on the final list of rules. Based on these beliefs, Connor uses a combination of teacher- and student generated rules. Using a story that the class reads as a springboard, Connor holds a whole class discussion about the importance of classroom rules, and then the students brainstorm a list of all the classroom rules that they think are important for their own classroom. Because the list is almost always too long, and because Connor is ultimately trying to guide the students toward rules that he has in mind, he guides the students through another discussion, encouraging them to group all the rules that sound similar into categories and then come up with a more general rule that encompasses all the rules that sound alike. The end result is: (1) Do your best, (2) Be prepared, (3) Be kind and (4) Be safe. Once the rules are finalized, each student signs a poster that lists the classroom rules, and the poster is displayed prominently in the classroom.

> Designing Instruction 11.1: Rules
> Envision a future class you will be teaching (e.g., elementary school, middle-school history, etc.). Develop a set of rules for your classroom. Assume for the purposes of this problem that you have decided to develop the rules yourself.
> *Response: There are of course many possible sets of sound rules.*

Routines

Routines are essential for the overall fluidity of the classroom. They show students how to carry out common tasks in an efficient, orderly manner. Most classrooms have many different needed routines, and it is critical for teachers to work out what these routines will be (Emmers & Gerwels, 2006). Most routines fall into three broad categories.

Three types of routines. There are three types of routines: *movement routines*, *lesson routines*, and *general procedures*. **Movement routines** provide students with explicit steps for entering, exiting, and moving about the classroom. For example, teachers can establish a routine by which students may leave the room to get a drink of water by following these steps: request permission, take a hall pass, return within 2 minutes, and return the hall pass. Common movement routines are: arriving in the morning (elementary school), arriving at class (secondary school), using the restroom, getting drinks, exiting and reentering the class during a fire drill or an evacuation drill, exiting the class as a whole class, sharpening pencils, getting and disposing of tissues, disposing of garbage, getting and returning supplies, using the sink, moving to computer stations, and storing classroom materials.

Lesson routines are routines to carry out tasks that occur regularly during instructional lessons, such as passing back homework and taking tests. When teachers ask students to write their names, period, and date in the upper right corner of every paper they hand in, they are teaching a lesson routine for how to identify themselves on their written work. Other common lesson routines include procedures for how teachers will get students' attention, how students should ask for the teacher's assistance, what students should bring to class, how materials will be distributed, how papers will be collected, how to correct homework in class, what to do if someone is absent, what to do when individual work is completed early, how to assign and have students record homework, how to work on the internet, how to save work on computers, and when students may and may not talk. Many of these routines will vary depending on the type of instruction (whole class, small group, or individual) that the teacher is using. For instance, the procedure the teacher uses to get students' attention will need to be different when students are working in groups that may be rather loud versus when individual students are working quietly at their desks.

General procedures include all other routines that teachers and students must complete to keep the class running smoothly. Taking attendance is a routine that is not part of a lesson and does not involve moving around the classroom but must be carried out every day. Other examples include recording lunch orders, updating the calendar, watering plants, cleaning chalkboards, feeding and cleaning class pets, cleaning desks, and so on.

Developing many efficient routines. Teachers must plan for *many* different routines in the classroom to allow for all needed activities to occur. There is no substitute for working out, one by one, what these routines will be. The routines should be planned before the school year begins so that the teacher can begin teaching the routines to the students on the first day of school.

Routines should be as efficient as possible. As we discussed earlier, the goal of classroom management is to enhance learning. When time is wasted unnecessarily during daily routines, then valuable time is lost that would be better spent on instructional activities. Well-crafted routines can reduce wasted time. For example, when students sit in the same seat every day, teachers can quickly take attendance just by noting which seats are empty. Thus, teachers can speed up the attendance routine simply by having assigned seats (which may be chosen by the students or assigned by the teacher).

"Do Now" routines are an effective way to maximize learning time. A teacher implements a "Do Now" routine by writing an academic task on the board. When students come into the room, they are expected to sit down and immediately begin writing their response to the "Do Now" activity. A math teacher might write a problem to solve related to the homework due for today. A history teacher might ask students to write and give two reasons for their position on whether President Andrew Johnson should have been impeached. The Do Now routine helps ensure that students are ready to begin learning when the bell rings, so that time is not lost after the bell rings while students slowly settle down.

Although teachers may want to involve students in the creation of classroom rules, teachers should developed routines by themselves, without student input. There are too many routines to make it practical for students to help decide what all the routines should be. In addition, the teacher will know best, based partly on past experience, what routines work best and what routines will minimize wasted time.

There are many options for teachers to choose from when developing efficient classroom routines, and there are many routines that can work well. Table 11.2 presents examples of how three different teachers implement three common routines.

Routines should involve students' assistance whenever doing so can make the class run more efficiently. Teachers can speed up the routine of handing out papers or supplies by teaching students routines in which students help with the distribution. Students may take turns caring for class pets, watering plants, and cleaning the chalkboards. By involving students in routines, teachers can foster student responsibility and promote an overall cooperative classroom environment.

Teaching routines to students. Teachers must model and discuss the routines with students so that they will understand how to accomplish them. With younger students and sometimes even with older students, teachers will also want to have students practice the routines. Schools practice fire drills regularly with students of all ages to ensure that the procedures will be carried out flawlessly in case of a real fire. In a similar manner, teachers may want to have students practice other routines so that students can carry them out efficiently, as well.

Practicing routines is especially critical with elementary school students. One difference between effective classroom managers and ineffective classroom managers in the elementary school is that the effective managers invest a considerable amount of time having students practice routines (Savage &

Savage, 2010). Before going to recess in the first week, the teacher might have students practice three times how to get up, get the equipment, and stand in line. A teacher might have a class practice the procedure for turning in homework six times in a row until everyone gets it right and it is done as swiftly as possible. Effective classroom managers know that it is not sufficient with younger students simply to explain and discuss the procedures with the students. Repeated practice is needed.

Table 11.2: Examples of routines

	Elementary-School Example	Middle-School Example	High-School Example
Initial arrival	Students in Mr. Minor's class arrive in the morning, unpack and find a seat in the group meeting area. They may talk quietly with their classmates as they await the start of the morning meeting. During the morning meeting, attendance and lunch count are recorded and important announcements are made.	When students in Ms. Matthews's class arrive to the classroom they follow these steps: 1. Unpack your bag 2. Turn in any important notes to the teacher 3. Put your homework in the homework bin. 4. Sharpen pencils if needed. 5. Begin the "Do Now" listed on the board.	Students in Ms. Farrell's classes arrive, get settled at their desks and begin the Do Now on the board. Once the bell rings, Ms. Farrell reviews the Do Now, shows the connection to yesterday's lesson and today's lesson, and begins today's lesson.
Restroom and drinks	Mrs. Kay's students can use the lavatory or get a drink whenever they need to as long as they place a designated cup on their desk. This is a quick, unobtrusive way for Mrs. Kay to quickly scan the room and know who is out of the room.	Students in Ms. Lyman's class must use the bathroom and get drinks during the four minutes between classes. In case of an emergency, students must ask at either the very beginning or end of class.	Because Mr. Jones's students have kept their promise not to abuse the privilege, he allows them to use the restroom whenever they need to, one at a time. When leaving, students flip a sign hanging next to the door from "Vacant" to "Occupied," and flip it back when they leave. Mr. Jones gives students who are leaving a hall pass.
Assigning and recording homework	At the end of every day, Miss August leaves 7 or 8 minutes for students to copy all of the day's homework into their homework notebooks. During this time, she also helps the students figure out what books they need to take home.	Mr. Sanchez designates a different area of the chalkboard for each of his five classes and writes the assignments for that class in that area. Upon entering the classroom, students copy the day's homework assignment into their homework notebooks.	Ms. Crane has a class website where she posts the weeks worth of assignments at one time. This way she only needs the last minute of class to remind the students of the homework and what materials they will need in order to complete the assignment.

Problem 11.2 Evaluating Teaching: Routines
Two high school mathematics teachers have developed the following routines to collect and hand back students' work. Evaluate each of these routines.

Teacher #1. Miriam Tsai's students sit in assigned seats each day. Miriam collects students' homework, quizzes, and tests by rows; students hand papers forward. She is careful to keep the collected homework together in the same rows that they came from. Her routine for handing back the evaluated work is that she sets each row's homework in a stack behind their row on a counter at the back of the room. As students come in, they go to the stack behind their rows, and they pick up their papers on their way to their desks.

Teacher #2. Sonia White's students also sit in assigned seats each day. When Sonia's students hand in homework, quizzes, or tests, they pass their papers to the front of the row. Each student is taught to be very careful to make sure that his or her work is placed on *top* of the stack of papers as it is passed forward. In this way, the stack that reaches the front of the room has papers in the same order that the students are sitting in the row. Sonia collects the papers from left to right, so that the papers are always in the same order from each period.

When handing back the homework, quizzes, or tests, Sonia sometimes sets the papers on students desks, face down, before the period begins. This takes only a minute because the papers are all in order, so she can quickly walk down each row and lay each student's work on his/her desk. On other occasions (when there is not time before the class period starts, or when she doesn't want to hand work back at the beginning of the period), she sometimes hands each row's stack of papers to them so that each student tasks his/her paper off the top of the stack and passes the rest of the stack back. If she wants to make sure students don't see other students' work (as when handing back an exam), she quickly walks around herself and hands the papers out. Again, because the papers are all in order, it takes just a minute for her to hand back all papers.

Response: *One crucial goal of routines is to minimize time not spent learning. Both teachers have developed systems that can accomplish this goal. Both teachers have fairly efficient routines for having students hand papers in. They vary mainly in their procedures for handing papers back.*

Miriam does not lose any class time handing back papers, because students pick up their papers before the bell to start class even rings. However, a possible problem with Miriam's system is that teachers are often busy addressing students' concerns and getting instructional materials ready for the next class during the short period between classes. Miriam may often find that she lacks the time to get the papers stacked in the counter before the first student comes in for the next class. She might need a way to place papers from all periods at the back counter at the beginning of the day. But a problem with Miriam's system is that it violates a principle we learned in Chapter 10—the principle that evaluation should be kept private whenever possible. Miriam's system allows students to leaf through the papers to see the grades and comments that other students received.

Sonia's system is not quite as efficient in avoiding lost learning time, as she sometimes uses a minute of class time to hand papers back. However, her system allows her to keep her evaluations of students' work private whenever she needs to, as when she is handing exams back. By having students keep all their papers in order, she can even hand back papers herself very quickly.

DEVELOPING EFFECTIVE INTERPERSONAL RELATIONSHIPS

The third component of classroom management is developing effective interpersonal relationships. The different types of relationships that exist within a classroom setting can have a direct impact on a teacher's ability to develop an environment conducive to learning (Pianta, 2006; Newman, 2000). The three key relationships are (1) teacher-student relationships, (2) student-student relationships, and (3) teacher-parent relationships. We will discuss each of these below.

Teacher-Student Relationships

Students who perceive their teachers to be caring are more likely to cooperate, adhere to classroom rules and routines, and engage in academic activities (Hamre & Pianta, 2001; Osterman, 2000; Wentzel, 1997, 1999). Students want teachers to care about them. But what does it mean for teachers to care about students?

Students can identify specific teacher behaviors that they believe demonstrate that teachers care about them (Cothran & Ennis, 2000; Cothran, Kulinna & Garrahy, 2003; Osterman, 2000; Wentzel, 1997). Two general types of caring are *academic caring* and *personal caring*. **Academic caring** refers to acts of caring that help students learn, such as helping students with homework, taking extra time to explain an idea to a class, and meeting with students after school to give extra help. **Personal caring** refers to showing an interest in students' lives out of the classroom, as by asking students about their families and attending extracurricular events. Personal caring can play an important role in promoting academic engagement. In a study of urban high school students, students were more likely to engage in academic activities when they felt that their teacher showed an interest in their personal lives (Cothran & Ennis, 2000).

Figure 11.3 lists some general teacher strategies that teachers can use to demonstrate that they care about their students. Some of these strategies can be implemented during class time, such as making sure that students understand material during lessons. But other strategies require teachers to invest time outside of class—talking with students, going to school events, giving students careful feedback on written work, and so on. It is difficult for teachers to provide sufficient academic and personal caring if they do not make time to meet students or attend events before or after school or during their lunch periods.

Student-Student Relationships

Relationships among the students in a classroom have a strong impact on classroom management. The better students get along with one another, the fewer problems will arise. Classroom management programs that focus on promoting positive student relationships have recently gained in popularity (Felner, Favazza, Shim & Brand, 2001; Battistich, Watson, Solomon, Lewis & Schaps, 1999). The goal in these programs is to promote a sense of community. As we discussed in Chapter 10, **community** refers to a group of people who share goals and who enjoy spending time together as they work collectively to achieve these goals. Community is the foundation of classroom management and caring relationships, including positive student-student relationships, are the foundation of community.

The key to developing positive interpersonal relationships among students is to provide students with opportunities to form connections with their classmates. If students feel personal connections with each other, they are less likely to engage in bullying and other disruptive behaviors. This does not mean that all students in the class need to be close friends; this would be an unrealistic goal. Rather, the goal is to develop a caring and respectful classroom environment in which students respect each other and in which academic and social emotional learning can take place as a result.

Figure 11.3: Teacher strategies to communicate caring

Strategies to Communicate Academic Caring

- Regularly evaluate whether students are achieving learning goals, and remediate as needed.
- Reflect carefully on each students' written and oral academic work, so that you gain a detailed understanding of how to help each student.
- Invite students to come to get help, and be available at times when they can come (before school, after school, during lunch, etc.).
- Call students on the phone to provide help when they need it or to tell them how well they are doing if they have achieved their learning goals.
- Use the principles of instructive feedback discussed in Chapter 10.
- Work with students to help them build the content knowledge and strategic knowledge to regulate their own learning successfully.

Strategies to Communicate Personal Caring

- Learn all students' names quickly at the beginning of the year.
- Learn personal details about each student (i.e. favorite sport, hobby or book, or something important going on in their lives).
- Outside of class, talk with students about their personal lives.
- Use examples from students' lives out of class to illustrate academic concepts.
- Be available to talk to students if they show a desire to talk about personal issues. (But be aware that some issues should be referred to a school counselor.)
- Go to student performances and club activities (soccer games, swim meets, theater performances, debates, concerts, club fundraising activities, etc.).
- Share with students aspects of your own personal life.

Other General Strategies

- Smile!
- Greet students at the door.
- Project a sense of humor.
- Be a real person (not just a teacher); tell students about your own life out of the classroom.
- Avoid sarcasm with students; they are likely to feel hurt rather than amused.

Community building-activities. A good way to help students form connections with their classmates is through the use of community-building activities. **Community-building activities** are class activities that help students learn more about each other as persons or that help students learn to work together as a team. In general, community-building activities fall into two categories. (1) **Get-to-know-you activities** are ice-breaking activities that provide students with the opportunity to learn new things about their classmates. These are typically done when a group of students first comes together. The goal is for students to learn about each other so that they will feel a more personal connection. (2) **Team-building activities** are activities that require the whole class or a small group to work together to accomplish a task successfully. These activities promote positive interconnections because students need to work together to succeed. An example of each kind of activity is presented in Figure 11.4.

Figure 11.4: Two community building activities

An Ice-Breaking Activity: Human Treasure Hunt

Students are given a sheet with a list of 25 to 30 various personal characteristics and traits on it (e.g., has a pet, likes rock music, plays a sport, is outgoing). The objective is to find a person in the class who fits one of the descriptions and get that person's signature next to the trait. Students mill around asking each other questions to fill in their signature sheets. When making up the list of items, be creative, but include traits pertinent to the group. Each person may sign a classmate's sheet only once. If this activity is used in a foreign language class (or in an ESL class), students can gain practice by using the new language to ask and answer questions.

A Team-Building Activity: Master Designer

Students working in groups of 4 or 5 are given envelopes with geometric shapes in them, together with a cardboard enclosure. Students arrange their geometric shapes into a design. Students sit so that they cannot see each other's designs behind the cardboard. One student is arbitrarily chosen as the "master designer." *This* student tries to explain using words and gestures, but without touching or showing any of her pieces. The other students try to reproduce the master designer's design. The other students may ask questions of the designer and also discuss what to do among themselves.

After community-building activities, teachers should hold a follow-up discussion with students, encouraging them to reflect on what they have learned. A teacher might simply ask, "Who learned something new about someone today?" This question serves two purposes. First, it holds the students accountable for paying attention during the activity. Second, it allows other students to learn what only a few students learned about particular classmates, thus enabling other students to form their own connections with that particular student.

Collaborative academic tasks . Teachers can also build community through academic tasks that require students to work collaboratively to produce a team product. For example, history students working in groups could develop presentations on the civil rights movement to present to the class; students will need to work as a team to succeed in this activity. The process of working well as a team to produce the presentation can foster positive feelings among group members.

To ensure that students have a good experience working together in teams, teachers may need to teach students effective strategies for working well together to create team products. Students may not yet be proficient at critical teamwork tasks such as listening to other group members and making sure that everyone contributes to the group product.

An example of an activity to provide training in teamwork skills is the *four-stage rocket* activity, which is designed to train students to use four effective group interaction skills: being concise, listening to others, reflecting, and making sure everyone contributes (Epstein, 1972; Cohen, 1993). To start the activity, the teacher gives students an interesting topic to discuss. Then groups of five or six students participate in the following stages, each lasting 5 minutes. The group chooses a different timekeeper at each stage. (1) *Stage 1: Learning to be concise.* The group begins discussing the topic. Each student is to talk for no more than 15 seconds; the timekeeper alerts students when it is time to change speakers. (2) *Stage 2: Learning to listen.* The group continues discussing the topic as before, with no more than 15 seconds per speaker. This time, students must pause for 3 seconds to make sure that everyone has clearly heard what the previous speaker has said before the next person begins to speak. (3) *Stage 3: Learning to reflect.* The group continues to discuss as in Stage 2. At this stage, they add one new requirement. Each speaker must repeat something that the previous speaker said before saying his or her new ideas (the speaker has 15 seconds for the new ideas). This encourages students to reflect on what their group mates are saying. (4) *Stage 4: Learning to make sure that everyone contributes.* The final stage adds a fourth requirement. Everyone in the group must speak before anyone else can speak.

By engaging in the four-stage rocket activity, students learn four key communication skills needed to interact effectively in collaborative groups. This will help them learn teamwork skills that will enable their teams to run more smoothly so that students are more likely to develop positive relationships with other team members.

Teacher-Parent Relationships

Students achieve more when their parents are involved with their learning process (Walker & Hoover-Dempsey, 2006). Parental involvement means that parents stay abreast of what their children's assignments are and what they are doing in school. It also means that parents attend school functions such as athletic events or concerts and back-to-school night. There is evidence that parental involvement improves students' behavior, values, and character (McNeal, 1999). Thus, teachers can improve learning and classroom management by involving parents in their children's learning processes. It is teachers' professional responsibility to work to build cooperative relationships with parents.

However, cooperative relationships do not emerge automatically. They require mutual effort, good communication, and interpersonal skills. Some personal skills and attributes that teachers must acquire in order to build cooperative relationships include respect for all parenting styles (even those that differ from their own preferred styles), good listening skills, kindness, consideration, empathy, enthusiasm, and an understanding of parent-child relationships. In addition, there are concrete strategies that teachers can implement to foster cooperative relationships with their students' families.

Here are examples of strategies that you can use as a teacher to promote good teacher-family relations:

- Send a welcome letter to the parents at the beginning of the school year. This should be written in a positive way that expresses enthusiasm for having their child in class. It should also convey the idea that you look forward to working as a team to help their child reach their full potential during the school year, and it should communicate your core instructional goals for the year.
- Make sure that your first interaction with a student's parent is be a positive one. For example, during the first week of school, write a note or email to that particular child's parent informing him or her about something that you have observed his or her child is doing well. You don't want your first interaction with parents to be one in which you are complaining about the students' behavior or academic performance; parents may then develop negative feelings about their interactions with you.
- Send positive notes and emails home throughout the school year. Both students and parents like to receive positive notes. Unfortunately, too many parents only hear from their child's teacher when something is wrong.
- More generally, send progress notes home. Progress notes enable parents to keep up to date on how their children are doing in your class. You can also write your own newsletter to parents describing what your classes are learning and what projects they are engaged with. These can be posted on your website or sent home to parents with your students.
- Invite parents in to help with various classroom activities. There are many ways to involve parents in

the classroom. Elementary school teachers can extend invitations to parents to read with individual children, play math games with small groups, or give a guest talk about their job or an interesting hobby. At the secondary level, parents can lend expertise to projects (e.g., an parent who works as an urban planner can talk with students working on an urban planning project about how professional planners go about their job) or to club activities (e.g., lending expertise to the garden club).

Have students help develop a class website or a class newspaper. This will help keep parents up to date on classroom or school happenings with input from the students.

When teachers use these and similar strategies, they enhance their chances of developing cooperative relationships with their students' parents. Because these interactions focus on positive messages, it is easier for you to contact parents and gain their cooperation when problematic situations arise as well. When parents have had positive interactions about their children with you, they will be less likely to react negatively when you ask their help with a problem with their child. It is important to be aware that some parents will be more involved than other parents. This is normal, and it doesn't mean that your plans to involve parents is flawed. But you do want to develop a plan that engages as many parents as possible.

Problem 11.3 Evaluating Teaching: Parent-teacher conferences

A website provides tips from teachers on how to handle parent-teacher conferences. Below are three of these tips. How would you evaluate these contributions from teachers? Which teacher's tips are most useful? Which are least? What else could you add to strengthen the advice?

Teacher #1: I take the "sandwich" approach. I start with something positive, continue with the things that the child needs to work on, and I finish with something positive. I also have his or her portfolio with me the day of the conference.

Teacher #2: It is extremely important to start with a positive statement about the student and to point out any positive experiences that child has had to date. . . . I like to make sure that, as the parent ends the conference, I review two or three main things the student must do to become an even better student and ask that the parent contact me in a couple of weeks to see if there has been an improvement.

Teacher #3: I write notes about the child before the conference and put them into two categories; Glows and Grows. This helps me to stay focused on the child and their strengths and needs both academically and behaviorally.

Response: All of these teachers agree on the importance of saying positive things about the student; Teacher #1 and Teacher #2 sensibly emphasize starting the conference with positive statements about the student. Teacher #2 introduces strategies of goal-setting and monitoring, to promote learning by every student; this is strongly in line with goals of promoting self-regulated learning and enhancing motivation through goal-setting. One could also include the students in the goal setting. One teacher notes that she includes the child at the parent-teacher conferences so that all together they "make a home-school plan that everyone can buy into. The child is now aware that parents and teachers are talking the same language and there is more commitment on all sides." Through these meetings, all can agree on goals that then all can monitor and work toward. If teachers regularly communicate goals and standards to parents via a website or newsletters, then parents will be in a better position to evaluate how well their children are doing.

Source: http://www2.scholastic.com/browse/article.jsp?id=4195.

PLANNING ENGAGING, WELL-ORGANIZED INSTRUCTION

The fourth component of classroom management is planning well-organized, engaging instruction. This component has two parts: Instruction must be both (1) engaging and (2) well-organized.

Planning Engaging Instruction

As we discussed in Chapter 10, one of the central goals of instruction is to promote student engagement. Engaging instruction promotes good behavior as well as improved motivation. When instruction is highly engaging, fewer behavioral issues arise because students will be actively focused on the lesson (Savage & Savage, 2010; lliams, 2009; Weinstein, 2007). For example, students are more likely to behave well if teachers hold interesting discussions with higher-order questions that make students think. More challenging discussions tend to be more engaging (Chinn et al., 2000; Chinn, 2006), and greater engagement tends to translate to less misbehavior. In contrast, students tend to be bored by discussions centered on lower-level questions that can be easily answered by repeating words in the textbook. When students are bored, they are more likely to misbehave. (This was the topic of the Reflection at the beginning of the chapter.)

Planning *engaging* instruction involves using all the instructional techniques that increase motivation and engagement that we discussed in Chapter 10. We will not discuss them further in this chapter, but it is important to remember that techniques that promote motivation also tend to promote better student behavior.

Developing Well-Organized Instruction

In addition to developing engaging instruction, teachers must also develop *well-organized* instruction. Well-organized instruction ensures that all the activities run smoothly, with little or no wasted time. Well-organized instruction also ensures that students have the skills needed to accomplish the tasks efficiently. Students understand how the lesson is organized and what they are supposed to do. To create well-organized instruction, teachers must carry out these five processes: (1) organize the instructional activities and materials carefully before the lesson, (2) provide the students with any needed training to make sure they know how to carry out the activities, (3) provide clear instructional signals during the lesson, (4) monitor students' behavior during the lesson, and (5) follow up appropriately on the lesson. By implementing these five processes, teachers can ensure that their instruction runs smoothly.

To illustrate these five processes, we'll consider a middle-school science teacher, Rachel, planning a lesson in which students develop their own explanations of what happens to the human body during exercise. In one key activity, students measure their heart rate and lung volume before and after different kinds of exercise. Students use equipment including buckets of water to measure their lung volume. Although the lesson is highly engaging, there will be many opportunities for misbehavior if the teacher does not plan carefully. There is a danger that the buckets of water could be spilled. Students could end up gabbing or even fighting with classmates as they wait to use equipment. Or students might simply get off task because of the excitement of a fun activity. For this lesson to be successful, Rachel must carefully execute each of the five processes listed in the previous paragraph.

Organizing activities and materials . When **organizing activities and materials**, teachers develop a clear sequence of activities that minimizes wasted time, and they prepare materials so that students can access them quickly and in an orderly fashion. Before class, Rachel gathers all the materials, making sure that she has enough of everything for all five of her classes. Rachel decides how to lay out the equipment and materials in the room in order to make it easy for students to get them. She decides to group students in groups of four, and she checks to make sure that there are no groups that include students who cannot work together. She also plans what to do in case of student absences. Rachel next decides that groups will spread out to different parts of the room as they conduct their experiments. Because there is not enough equipment for all groups to use at the same time, she plans lesson-relevant activities for groups to accomplish as they are waiting to use the equipment. She creates an overhead slide with a schedule showing students which groups use the equipment first and which groups use the equipment next. She prepares handouts to make sure students understand what they are doing and why they are doing it at each step.

Providing needed training. Providing needed training refers to teaching students all the routines and lesson-specific procedures that they need to carry out the day's lesson efficiently. Effective teachers are constantly teaching students general routines; sometimes they must also teach procedures specific to a particular lesson, as when students are using special equipment in a particular lesson. Rachel has been providing training in effective groupwork throughout the year. She begins the lesson with a short refresher; she asks students what kinds of questions they are expected to ask each other during experiments (e.g., "What are our results?" "How can we explain these results?" "What do you think?" "Could you explain your ideas more?" "What's the evidence for this claim?"). She gives them the handout with step-by-step explanations; she goes over the procedure with them and answers several questions. She then trains students in two lesson-specific procedures. Students first practice feeling their pulse to make sure that they can find it. Then she spends 3 minutes demonstrating to them how to use her apparatus to measure lung volume. She has one group demonstrate how to do it to make sure that everyone understands.

Providing clear instructional signals during the lesson. **Providing clear instructional signals** means clearly communicating to students what the instructional goals are, what the different parts of the lesson are, and how the different parts of the lesson will help them achieve their goals. When providing signals, teachers also provide cues to keep students informed about where they are in the sequence of activities (e.g., "We'll start with group work today"; "the purpose of the next activity is to take what you learned from the group work and apply it to your own individual work"). Rachel clearly communicates with students that the goal of the lesson is for them to generate their own scientific explanation—based on the evidence they gather—of what happens to the human body during exercise. As they proceed through the lesson, step by step, Rachel provides clear instructions to ensure that her students understand how each activity will help them develop their explanation. When it is time for students to move to the different parts of the room, she gives clear instructions on where each group is supposed to be at each step. After the experiment, she reminds them what their goal is, and she coaches them on how to generate an explanation using their data.

Monitoring students' behavior during the lesson. When **monitoring students' behavior**, teachers keenly watch students to see how they are doing—not just whether they are on task but whether they are mastering the key learning goals. During her science lesson, Rachel circulates among the class, making sure that each group is carrying out the experiments correctly and that the students are asking each other the questions that they have learned to ask. She gives help and feedback as needed. The teacher is prepared for what to do if a student does not engage appropriately in the activity: If a nonverbal or verbal warning does not work, she will have that student sit at her desk until he or she is ready to participate properly. We will discuss more about monitoring students' behavior in the next section.

Following up appropriately on the lesson. Following up appropriately on the lesson includes making sure that students understand what the goal of the lesson was, collecting and filing away all student work, ensuring that equipment is put away properly, and checking that everything is ready for the next period (for secondary school teachers) or the next lesson (for elementary school teachers). Rachel follows up on her science lesson by making sure that she saves 5 minutes at the end of class for the lesson wrap-up. She first checks that all equipment has been collected and that everything has been cleaned up. When she sees that a small amount of water has spilled next to one bucket, she asks the nearest student to wipe it up with paper towels that she has stacked next to each bucket. Simultaneously, she collects students' written work, putting the papers she has collected into her file folder for that class period. Before the bell rings, she has two minutes to ask students questions about what they have learned today. She emphasizes that they will discuss tomorrow the students' various explanations for their data and that they will refine their explanations as they get some additional evidence.

To run a lesson as smoothly as Rachel does requires a great deal of preparation—planning the lesson, planning the logistics of the activity, preparing all the materials, thinking about how to give feedback and help, and so on. A teacher who is only partially prepared will end up with substantial downtime that reduces the time for instruction and opens the door for student misbehavior.

Problem 11.4: Organizing Lessons

Evaluate this teacher's teaching in terms of what you have learned about classroom management.

Five months into the school year, Sarah Applegate, a fourth grade teacher, begins the school day with a math lesson on fractions. The school day starts at 8:45.

8:40. As the children enter the room, four boys run to the back of the room to look at a comic book. One girl sits in her seat with her coat on and stares at the bulletin board. Three students put their things away; other pupils are taking their time as they talk and remove their coats. As this is happening, Sarah is reviewing her lesson plan for the day, which she initially wrote two years ago. She suddenly realizes that this math lesson requires the use of some picture flashcards, and she doesn't know where her flashcards are.

8:45. Morning announcements begin, and Sarah asks everyone to be quiet. Many students still have their coats on and are standing near their friends in the back of the room.

8:49. Once the announcements are over, the students sit put their coats away and sits down. Sarah asks a student to go to the room of the teacher next door to ask if she can borrow that teacher's fraction flashcards. Sarah takes attendance as the students talk, much more quietly now. She asks students to write in their journals as they are waiting. The students slowly follow her instructions. There is a considerable amount of side talk as students are writing.

9:00. Sarah has the fraction pieces, so now she asks the students to take out their math books. She begins the lesson on fractions.

Sarah:	OK. Please look at this picture of a pizza. How many slices of pizza do you see?
Adam:	Four
Sarah:	Yes, Adam—there are four slices of pizza. Now if I wanted to eat one slice, how many pieces would I have consumed out of four?
Mary:	One. And that makes one-fourth. I know that because I study math in special class after school.
Sarah:	OK. Well, you're really good at this, Mary. Maybe you can help the other students as we continue. Let's look at this one. Here's a picture with cake. How many slices of cake are there? Joan?
Joan:	Five.
Sarah:	Good, and how many pieces would I eat if I eat these [Sarah points to two pieces].
Joan:	Two.
Sarah:	That's right. And now let's put those two numbers together. I ate *two*, and the cake is divided into five pieces. How much did I eat? In fractions.
Joan:	Um….
Sarah:	I ate *two* pieces, and the cake is divided into *fifths*. How much did I eat?
Joan:	Um…. Two fifths?

This is representative of a 10-minute discussion. Then Sarah directs the students to answer the related fractions questions on page 72 of their mathematics workbook.

Response: Sarah has failed to follow any of the recommendations for organizing lessons discussed in this section and in earlier sections, as well.

First, Sarah evidently has not taught her students to follow any morning routine. She does not provide students with a "Do Now" or any other activity to focus their attention when they come into the room. They have not learned to follow a regular series of steps when they enter the room (e.g., take coats off right away, get any needed materials, and sit down). Moreover, Sarah is not monitoring the students' behavior as they enter the room. She should be walking among the students, greeting them warmly, reminding them of the morning routine if needed. Instead, she is undertaking a far-too-late review of her lesson plans.

Sarah has obviously failed to have the day's materials ready to go. Even worse, she has obviously not carefully planned her math lessons prior to the start of the day. If she only just realized that she needs math flashcards, she obviously failed to even read her lesson plans through before the day, let alone review her plans carefully so that she will know them thoroughly. If her first lesson is any indication of her general behavior, she is probably woefully unprepared for the entire day.

Sarah does not tell her students what the goal of the lesson is or how the instruction will help them achieve their goals. She just launches into the lesson without explaining its purpose. There are no signals giving meaningful instructional continuity to the morning's activities. Sarah's questions appear to be at a low level. She doesn't ask questions that get at students' understanding of fractions. Even though Joan probably does not understand, she does not try to help Joan understand the meaning of the fractions; she instead gives a blatant hint ("I ate two pieces, and the cake is divided into fifths") so that Joan can say the right words ("two fifths") to answer the question, even though Joan gives no evidence of understanding what this means or why it is the right answer. Sarah seems to be content if her students parrot the correct answer, whether they understand it or not.

You may think that Sarah's lack of preparation must be very uncommon, but I have repeatedly encountered teachers who have not reviewed their lesson plans thoroughly (or at all) before their lessons begin. This is a recipe for horrible instruction and for disasters in classroom management.

PREVENTING AND RESPONDING TO BEHAVIOR PROBLEMS

The fifth and final component of effective classroom management is **discipline,** which we define as **preventing and responding to behavior problems**. The four components of classroom management that we have discussed to this point are all designed to prevent misbehavior. This fifth component is the only component of the classroom management model that includes both preventive teaching strategies (strategies design to keep misbehavior from happening in the first place) and responsive teaching strategies (strategies that respond to misbehaviors after they occur).

Preventing Behavior Problems

In a classic study that still provides the foundation for current thinking about preventing discipline problems (Doyle, 2006; Emmer & Gerwels, 2006), educational psychologist Jacob Kounin (1970) studied what effective and ineffective classroom managers did as they were teaching in their classrooms. He found that effective classroom managers and ineffective classroom managers did not differ substantially in their responses to misbehavior. However, they differed significantly in the strategies they used to prevent misbehavior. Kounin discovered that effective classroom managers display four key behaviors to prevent misbehavior: withitness, overlapping, signal continuity and momentum, and variety and challenge within lessons. We discuss each of these below.

Withitness. The first behavior that prevents misbehavior is **withitness**, an ability to constantly monitor student behavior. Teachers who display **withitness** are aware of what is happening in all areas of the room and communicate this awareness to their class, thereby preventing many opportunities for misbehavior to occur. They watch students constantly and vigilantly to notice student behavior that could lead to discipline problems and to head off serious discipline problems before they occur. It is as if they have eyes in the back of their heads. Those teachers who catch misbehavior just as it is beginning are much less likely to have disruptions (Emmer & Gerwels, 2006). Two examples of teachers' withitness are:

- May, a sixth-grade math teacher, is working with two students at the front table as students do math problems in the back of the room. As she scans the room, she sees that one boy appears distracted. She says, "Mike what number are you on?" He looks up at her and gets right back to work. May displays withitness because, although she was working with one child, she was able simultaneously to monitor other students' behavior and get the boy back on task quickly, before he became disruptive.
- As Bill, a third-grade teacher, collects lunch money at the beginning of the day, he periodically scans the room. He sees that Emily has finished her "Do Now" and is now looking around the classroom (possibly unsure of what to do). As Bill continues to collect money, he says, "Emily, remember, next you choose a nonfiction book to read in the reading corner." Emily nods and makes her way to the reading corner. Bill's withitness kept Emily on task and may have prevented misbehavior.

Withitness places heavy demands on working memory. Teachers must use some of their working memory to monitor student behavior while using the majority of their working memory to process what they and their students are saying. This requires a lot of practice. Through practice, teachers develop a capacity to monitor students and handle class routines more automatically, which frees up working memory to focus on the academic content of the lesson. Teachers must also be extremely familiar with the lesson plan so that they move from activity to activity smoothly. If teachers are unfamiliar with their lesson, so that their working memory is fully occupied with trying to remember what comes next, they will leave too little working memory to effectively monitor students' behavior. Thus, to exhibit withitness, teachers must prepare thoroughly, and they must constantly practice this skill so they can do it more and more automatically over time.

Overlapping. A second strategy identified by Kounin is **overlapping**, the ability to do more than one thing at a time. Overlapping is important because teachers are constantly interrupted during the day, and it is important for teachers to keep the flow of the lesson going while responding to the interruption at the same time.

Here is an example of overlapping: Nina, a high-school history teacher, is in the middle of explaining directions for a homework assignment when one student returns from the nurse's office with a note indicating that he is sick and needs to pack up his things to go home. Nina continues to speak to the class as she simultaneously scans the note. After reading the note, she signals to the student, indicating he needs to wait one minute. Next Nina calls on a student to read a famous historical speech that plays an important role in the homework assignment. As that student is reading the speech, Nina quietly helps the ill student copy his homework and pack up his bags. She then sends the child back to the nurse's office. Then Nina begins a discussion about the speech that the student has just read. Nina's ability to overlap in this situation avoided downtime that would have lost instructional time and could also have led to students misbehaving.

Like withitness, overlapping places heavy demands on working memory because teachers must perform two tasks at once for a short time. If teachers are not very familiar with their lesson plans (so that they can continue running the lesson without using all of working memory), they will be unable to use the overlapping strategy. If teachers are so familiar with their lesson plans that they can implement them without constantly thinking about what they are doing, they are more likely to have the working memory capacity needed for overlapping, as well as for withitness.

Signal continuity and momentum. A third key behavior that effective classroom managers exhibit is signal continuity and momentum during a lesson. As we noted earlier, **signals** are all the teacher's statements and other signs (e.g., lists on the board) that tell the students what is happening in the lesson. A list of the day's activities on the board provides one kind of signal to students about what the day's tasks will be. Teachers also provide clear signals about the learning events of the day when they introduce the lesson to the class, explain the goals of the lesson, announce that they will move to a new phase of the lesson, give directions for activities, and explain how the different parts of the lesson are related to each other (or ask students to tell how the different parts of the lesson are related to each other).

Signal continuity and momentum refers to the ability to teach well–prepared and well–paced lessons that keep students' attention focused on the lesson and provide continuous academic signals that are more compelling than competing distractions. To put it simply, signal continuity and momentum are about the teacher's ability to maintain the flow of the lesson. The lesson moves along at a good pace—not so fast that the students lose track of what they are learning but not so slow that students can afford to stop paying attention to the lesson. The teacher also avoids any pauses in the lesson that invite students to start talking among themselves or otherwise misbehave. The most basic way teachers can maintain signal continuity and momentum is to make sure they are well prepared and that all the necessary materials for every lesson are organized before the day begins. We examine two examples below.

- At the end of each day, Jocelyn (a high school psychology teacher) writes the next day's schedule on the board, along with the materials needed (e.g., textbook, a group work handout, etc.) This allows her students, as they enter the room, to immediately have an idea of how the day is organized. Jocelyn finds the schedule on the board especially helpful between lesson activities. As she finishes one activity, her students know to look at the board and see what is next and what materials they need to take out, without further direction from Jocelyn. This strategy keeps the instructional flow between activities.
- Tyrone (a fourth-grade teacher) arrives at school an hour early each morning. Once in his classroom, he reviews his day's lesson plans, paying careful attention to what materials he needs for the entire day. Before the students arrive, he organizes all of the day's materials on his front table in the order they are needed for the day. This strategy allows Tyrone to maintain the flow from one lesson to the next because he doesn't lose the classes' attention as he locates the materials for the next lesson.

Variety and challenge in academic assignments. Effective classroom managers also plan for variety and challenge within academic assignments so that students are actively engaged throughout lessons. We discussed the importance of variety and challenge in Chapter 10. The active engagement that arises from variety and appropriate challenge leads to fewer management problems.

Teaching students to regulate their own behavior. In addition to Kounin's methods for preventing misbehavior, educators in recent years have focused on another method of preventing behavior problems: teaching students to regulate their own behavior (McCaslin et al., 2006; Soodak & McCarthy, 2006). This idea is directly related to our discussion in Chapter 6 about self-regulated learning. Just as students can learn to regulate their learning processes, they can learn to control their behavior. Students can learn to set goals about behavior (e.g., "I'm going to focus on this lesson without irrelevant chit chat to my friends"), monitor their behavior (e.g., "Am I meeting my goal so far?"), and use strategies to help them achieve their goals (e.g., the student learns to say "Focus!" whenever her attention is straying). As we learned, setting goals, monitoring progress toward goals, and selecting appropriate strategies are at the heart of self-regulated learning.

One way to help students learn to regulate their behavior is to teach them how to resolve conflicts on their own. An increasing number of schools are teaching students methods of conflict resolution. One method of conflict resolution is found in Figure 11.5.

As we noted earlier, when helping students learn to regulate their own behavior, it is important for teachers to make sure that students understand the reasons for the rules and procedures of the class. Students will be more willing to regulate their behavior if they understand that there are sensible reasons for doing so. Thus, teachers should make sure that students understand why it is important to follow the class rules (e.g., "we listen to others because they have important ideas worth thinking about"), and why common procedures are used (e.g., "students help hand back homework so that we maximize time for learning in class").

Figure 11.5: A Program of Conflict Resolution

Phase 1. Understand the conflict

Students learn to recognize when a conflict is occurring. They also learn that conflicts can be constructive ways to reach compromises or to negotiate better solutions.

Phase 2. Choose an appropriate conflict strategy

Once students recognize that they are in a conflict, they decide which strategy to pursue. Two strategies that do not require anyone to "lose" are finding a quick compromise and negotiating. Negotiating requires more work, if that strategy is chosen (see Phase 3).

Phase 3. Negotiating to solve the problem

Students work together to forge an agreement that is a "win" for everyone. The steps each student follows are:

1. Describing what you want. "I want the book now."
2. Describing how you feel. "I'm frustrated."
3. Describing the reasons for your wants and feelings. "You have been using the book for the past hour. If I don't get to use the book soon, my report will not be done on time. It's frustrating to have to wait so long." (This is an I-message.)
4. Taking the other's perspective and summarizing your understanding of what the other person wants, how the other person feels, and the reasons underlying both. "I understand that you want the book, too, because you need to finish your report and cannot finish the report without the book."
5. Inventing three optional plans to resolve the conflict in ways that maximize joint benefits. "One option is that we read it together…. A second option is …."
6. Choosing one option and formalizing the agreement with a handshake. "We decided to take turns every 15 minutes. That way while one is reading, the other is writing the report, and then we take turns."

(Examples are from Johnson & Johnson, 2006, p. 819).

The program and the examples are from Johnson & Johnson (1995; 2006, p. 819).

Responding to Behavior Problems

Even when teachers are extremely proficient at employing teaching strategies that prevent misbehavior, students will sometimes misbehave. Behavior problems requiring a teacher's response will arise even in the best-managed classrooms. These misbehaviors can be classified into two categories—minor or more serious. Teachers (and schools) may vary in which misbehaviors are classified as minor and which are classified as more serious. But most would probably agree that examples of minor misbehavior include calling out, eating a piece of candy, daydreaming, and talking to a classmate instead of participating in group work or in a class discussion. More serious misbehavior may include fighting, bullying, and disrespecting the teacher or other students. When students chronically commit minor misbehaviors despite the teacher's warnings, teachers should treat the chronic pattern of misbehavior as more serious misbehaviors.

According to teacher educator Carol Weinstein (Weinstein & Mignano, 2007), teachers should always follow two guidelines when addressing all misbehaviors, whether the misbehaviors are minor or more serious. First, teachers should *preserve the dignity of the students.* All students want the respect of their teachers and peers. In many cases, students will attempt to "save face" with their peers at any cost. Therefore, if teachers discipline students in a way that embarrasses them, they run a risk of having the situation escalate rather than achieving their goal (stopping the misbehavior). The student may react defiantly, worsening the situation. Even if the student stops misbehaving, she or he may remain resentful, making it more difficult to teach that student in the future. Other students, too, may resent the teacher's act of embarrassing a classmate, even if they agree that the student should have stopped misbehaving. These feelings can undermine positive personal relationships that the teacher is trying to build.

The second guideline for responding to misbehavior is to *keep the lesson going with as little disruption as possible*. It is vital to remember that one of the goals of classroom management is to maximize learning time. This means that, whenever possible, discipline should be done in a way that distracts students from the lesson as little as possible. It is very common to see teachers interrupt their lessons every time misbehavior occurs, resulting in a very choppy lesson with no instructional flow. It is more effective to address minor misbehavior in ways that do not interrupt the flow of the lesson and reserve interruptions for dealing with more serious misbehavior.

Beginning teachers are told to be consistent in their classroom management plan. But consistency does not mean treating all misbehaviors the same. It is ineffective to treat calling out or daydreaming (minor misbehaviors) in the same way as a fight (a more serious misbehavior). That is why classifying misbehavior as minor or more serious is an important first step in planning a discipline program. Once teachers make this classification, they can consistently respond to minor misbehaviors using one set of responses and respond to more serious misbehaviors using a different set of responses.

Responding to minor misbehaviors. The majority of behavior problems that arise in the classroom are minor. Teachers can usually respond to these misbehaviors quickly and efficiently using a nonverbal and/or verbal interventions. A good rule of thumb for responding to minor misbehavior is to begin with a nonverbal intervention and then move to a verbal intervention only if necessary. Nonverbal interventions are less disruptive to the flow of the lesson than verbal interventions; in fact, many students may not even be aware that the teacher has used a nonverbal intervention with a misbehaving student. If nonverbal interventions are not effective, teachers can move to verbal interventions. With verbal interventions, it is best to try to disrupt the lesson as little as possible. Gently saying a chit-chatting student's name is less disruptive than stopping the lesson to formally reprimand the student. Some examples of nonverbal and verbal interventions are listed in Table 11.3. All of the responses in the table are consistent with the two guiding principles for dealing with misbehavior (preserving the dignity of the student and keeping the instruction going with minimal disruption).

Table 11.3: Nonverbal and verbal interventions to address minor misbehavior

Intervention	Description	Examples
Proximity	The teacher moves closer to the misbehaving student. Most students will not continue to engage in misbehavior if the teacher is standing right next to them, which makes this a very simple and effective strategy.	When two students are talking in the corner during a class discussion, the teacher walks over and stands next to the two students. A teacher knows that several students in the back of the room in her third period class have a tendency to start packing up a minute or two before the bell rings, so she goes to the back of the room and stands there before the bell rings.
“The Look”	The teacher makes a stern face that communicates disapproval to misbehaving students.	When a high school student pops a piece of gum in her mouth, the teacher catches her out of the corner of her eye, looks directly at her, and gives her “the look,” and the student spits out the gum into a piece of paper.
Hand signals	The teacher uses hand signals or gestures to communicate to misbehaving students.	When a fourth grader calls out an answer without raising his hand, the teacher places one hand over his mouth and raises his other hand. This communicates to the child that the teacher prefers that he not call out right and that he raise his hand instead. When two ninth graders are talking during seatwork, the teacher catches their eyes and makes a “Shhh” gesture by placing her index finger over her lips.
Confiscating forbidden items	When a teacher sees students using forbidden items (checking cell phones, passing notes), he or she quietly takes the item, quietly directing the students to meet to discuss this after class.	When one student passes a note to another, the teacher walks back to the recipient’s desk, quietly takes the note, and puts it in her desk, without missing a beat in the lecture. Later, when students begin group work, the teacher tells the students to see her after class.
Facial expressions	Teachers can use a large repertoire of facial expressions to communicate dissatisfaction to misbehaving students.	A raised eyebrow and a slight turn of the head toward the garbage can signal to a student who has slipped a piece of gum into his mouth that he is to throw the gum away.
Call on the student	If the teacher suspects that a student is not behaving appropriately, he or she calls on the student or uses the student’s name in a lesson. This subtly communicates to the student that the teacher is aware of the misbehavior.	A teacher calls on a student who has started drawing a picture in her notebook instead of taking notes for the exam. As Sarah begins whispering to her neighbor, the teacher mentions several students, including Sarah, who will be responsible for clean-up after the art lesson.
Praising good behavior by other students	This is a technique that works primarily with elementary school students. When some students are misbehaving, the teacher praises other students for being well behaved.	A third-grade teacher says, “I am very happy to see that the students on *this* side of the room have already got their math books open and are ready to begin.” The other students in the class stop talking and get their books out.

Private reminder	The teacher privately reminds a student of a rule or privately reprimands the student.	When Ellen is chewing gum in class, the teacher walks over to her and, whispering, reminds her not to chew gum. Two boys were talking quietly for several minutes during high school history class. After class, the teacher privately speaks with them and directs them not to talk when others are talking.
Reminder in a soft voice	The teacher warns students in a soft rather than a loud voice.	The teacher is lecturing while two girls are talking. The teacher pauses, lowers her voice level so that it is not so loud, and says, "Girls . . ." as she looks at them.
Public rule reminder	A teacher can also directly remind students that they are breaking one of the classroom rules.	A teacher explicitly reminds two boys holding a side conversation in the back of the room of the rule to listen when others are speaking.
Warn of consequences	The teacher warns students of consequences of continuing to misbehave.	When Bob and Allen are off task during group work, the teacher warns them that they will have to come to the teacher's room after school to complete their group work if they do not stop.

Teachers often use more than one intervention to respond to minor misbehavior effectively. A teacher may use two or more interventions simultaneously, or a teacher may use one intervention and shift to another if the first one is not effective. Here are two examples of teachers using responses from Table 11.3:

- As Meagan, a third grade teacher, is explaining directions for a group activity, she observes that one young girl (all the way across the room) is talking excitedly to her neighbor. Meagan continues to explain the directions but makes her way very quickly toward the girl. She stands next to the girl, places her hand on the girl's desk and takes a deep breath (indicating to the girl that she needs to calm down. This example demonstrates the teacher's use of proximity and hand and facial expressions. In this instance, there was no need to interrupt the lesson to verbally address this minor misbehavior.
- Upon returning back to the classroom, a student picks up the book bag that is on his desk and begins to make a big show and a little noise while unpacking it. Melvin, his teacher, begins to walk toward the student as he gives him "the look." Unfortunately, this does nothing to stop the misbehavior. Therefore, Melvin walks all the way over to the student, leans down a bit and quietly instructs him to tone it down. In this situation, the teacher first tried to use a combination of proximity and "the look" (two nonverbal interventions). Then, when nonverbal interventions did not work, he issued a private reminder (verbal intervention). It is important to note that since the private reminder was done in a relatively respectful way, there is higher probability that the student will stop the misbehavior and not harbor resentment that could fester into future misbehavior.

There are occasions when the best strategy for dealing with minor misbehavior is to ignore it. Sometimes students act out inappropriately because they crave attention. By responding to the misbehavior, teachers are giving them attention, which functions as a positive reinforcement of the inappropriate behavior. In these cases, the student may stop the misbehavior if it is ignored, as the misbehavior is not rewarded with attention. When the student begins behaving well, the teacher can *then* give the student attention, thus rewarding the student for good rather than bad behavior. Teachers' knowledge of particular students is critical in allowing them to wisely decide whether or ignore misbehavior. If ignoring the misbehavior isn't effective for a particular student, a teacher can implement a different strategy.

A general principle that teachers should use when responding to minor misbehavior is to respond to minor misbehavior using the least disruptive intervention possible. This recommendation is known as the **Principle of Least Intervention** (reference): Teachers should intervene as mildly as possible to avoid losing instructional time, to maintain the dignity of the students, and to avoid fostering unnecessary resentment. When teachers find that a minimally disruptive response does not work, they can move on to slightly stronger responses. Each instance is unique, and it takes practice for teachers to learn the optimum level at which to intervene in each instance.

I-messages. One especially useful verbal intervention is the *I-message* (Gordon, 1974; Elias & Schwab, 2006; Brophy, 1996; Brophy & McCaslin, 1992). An **I–message** is a statement by a teacher or a student in which the teacher or student describes an undesired behavior and explains how the behavior affects him or her. An effective I–message has three parts. The first part is a nonjudgmental, non–blaming description of the behavior that the speaker finds undesirable. The second part explains how this behavior affects the speaker. The third part notes the feelings that the speaker has as a result of the behavior. Here are examples of I-messages that a teacher may use in the classroom:

> When I see a lot of students coming to class unprepared (non-judgmental description of the behavior), I know you will not get the most out of the lesson today (tangible effect of the behavior), and this worries me because I want all of you to have a good understanding of how to write persuasive essays (feeling caused by behavior).

> When I hear a lot of talking during my lessons (non-judgmental description of the behavior), it frustrates me (feeling caused by the behavior) because I can't present the lesson that I spent a lot of time preparing for you (tangible effect of the behavior).

Teachers should take care to present their I-messages in a non judgmental way. It is especially important to make sure that I-messages do not become diatribes in which teachers angrily denounce the students' misbehavior.

I-messages are not only for teachers to use. In recent years, there has been a strong push to encourage students to use I-messages with each other (Elias & Schwab, 2006; Brophy, 1996; Brophy & McCaslin, 1992). In fact, I-messages are integral parts of many conflict resolution and peer mediation programs used in many classrooms. Instead of responding to insults or taunts by fighting, students learn to use I-messages such as: "When you insult my family, it upsets me because I know that what you're saying is not true."

The effectiveness of teacher's use of I-messages depends on the level of interpersonal relationships that exist in the classroom. If students do not feel that their teacher cares about them, then they are unlikely to care about how their teacher feels, and I-messages will not be effective. On the other hand, if teachers foster caring relationships with students, then most students will care if their teacher is worried, upset, or frustrated. Thus, I-messages work best when teachers promote good classroom relationships.

Problem 11.5 Evaluating Teaching: The Tally System

James Montgomery, a ninth grade science teacher, uses the following management system: whenever a student commits a minor infraction of any kind (chewing gum, daydreaming, doodling, whispering or talking, calling out answers, etc.), James writes the student's name on the board, with a tally next to it. A second infraction prompts a second tally. If there is a third tally, the student must come to the teacher's room for after-school detention. Evaluate this teacher's system.

Response: A main difficulty with James's system is that his system gives him no way option to handle minor misbehaviors in a private way that minimizes class disruptions. His system involves making every misbehavior, no matter how minor, public. He also must frequently pause the class while he writes names and/or tally marks on the board. This could lead to serious fragmentation of the lesson. Because James does not opt to use I-messages or to provide explanations for the reasons behind the rules, he may fall short of encouraging students to regulate their own behavior.

Students may also learn that it is all right to engage in misbehavior in this class up to getting caught two times, because it is only the third time that will result in any consequences.

Responding to more serious misbehavior. Serious misbehavior requires more than a nonverbal and/or verbal response. Instead, teachers must impose a consequence. Unlike the responses to minor misbehaviors discussed in the previous section, consequences are more intrusive and therefore should be used only when addressing more serious misbehavior. Recall that when students persist in minor misbehaviors despite the teacher's warnings, the teacher can treat this as more serious misbehavior.

When developing and selecting a consequence for more serious misbehavior, a general guideline for teachers is to be sure that the consequences are logically related to the misbehavior. A consequence is logical if it meets three criteria known as the three R's (Nelsen, 1996). First, the consequence is directly **related** to the child's misbehavior. Having a student stay after school to write a summary of lecture material missed while talking is directly related to the misbehavior of talking; staying after school to erase the chalkboards is not. Second, the consequence is **respectful** to the student and to the rest of the class. The consequence is not intended to hurt or humiliate the student. Indeed, the teacher may give the misbehaving student or students input into possible consequences. Third, the consequence is a **reasonable** consequence that help students correct their mistakes and learn what to do next time, not merely make them feel bad. Reasonable consequences are not also excessively severe given the nature of the misbehavior. Some examples of reasonable consequences that meet these three criteria are described below:

- Amanda, a third-grade student, draws all over her desk during seatwork time. As a consequence, her teacher requires her to stay in the classroom during recess. The teacher expresses disapproval of Amanda's actions and explains why it is important to treat school property with respect. Then Amanda is required to clean all the writing off the desk. This consequence meets the three-R's criteria. Cleaning off the desk is related to the misbehavior of defacing the desk; Amanda must undo the harm that she did. The consequence is respectful because the teacher spoke with Amanda privately and didn't demean or embarrass Amanda. Finally, having Amanda stay in and clean off her desk is a reasonable response to the misbehavior, whereas having her clean all the desks in the classroom would have been excessive.
- At the end of the school year, Josh, a seventh grader, writes mean comments about Billy in Tom's yearbook when they are in the hallway. Billy finds out and tells the teacher because he is very upset. The teacher requires Josh to cross out the comments in the yearbook and write a note of apology to Billy, making it clear that he understands that the note was hurtful and inappropriate. Again, this consequence also meets the three R criteria. The consequence is related to the misbehavior, as the teacher requires Josh to try to undo the harm that Josh did. The consequence is respectful to Josh in that she did not humiliate him (or Billy) in front of the entire class or school; rather, only those involved with the situation (Josh, Billy, and Tom) are affected by the consequence. And the consequence is reasonable in that it is an appropriate fit to the misbehavior.

Some teachers are comfortable relying solely on the concept of logical consequences for dealing with more serious misbehavior. Other teachers prefer a plan with a little more structure. There are many effective classroom managers who develop a **hierarchy of consequences—**a sequence of consequences of increasing severity that the teacher uses with repeated serious misbehaviors. The goal of a hierarchy of consequences is to allow the teacher to strike a balance between being consistent yet flexible enough to consider the situation and the particular child. An example of a hierarchy of consequences appropriate for elementary age students is: (1) warning the student (2) assigning the student to a 10-minute time out, (3) having a conference with the student after school and applying a logical consequence, (4) a note or phone call home, and (5) sending the student to the principal's office. The teacher initially responds with the lowest consequence in the hierarchy. After a second misbehavior, the teacher applies the second consequence, and so on.

A slightly different hierarchy that is more appropriate for high school is as follows: (1) warning the student, (2) having the student stay one minute after class, (3) having a conference with the student after school and applying a logical consequence, (4) a note or phone call home, and (5) assigning a student to after-school detention. A consequence does not need to be severe to be effective. Although requiring a middle or high school student to stay one minute after class is not a very severe punishment, it has the effect of minimizing time that students can socialize between periods, and thus it can be effective for the majority of students.

EXTENSIONS

Developmental Changes

The five components of classroom management apply to classes at all age levels. There are some differences in how elementary versus secondary teachers will apply some of the principles we have discussed in this chapter. The differences are relatively modest in comparison to the commonalities in the core principles that are applicable at every grade level. The commonalities and differences are summarized in Table 11.4.

Culturally and Linguistically Diverse Students

Effective classroom managers reflect on how to adapt principles of classroom management to culturally and linguistically diverse students (Gay, 2006). Below we discuss implications of culturally and linguistic diversity for classroom rules, developing effective relationships, and preventing and responding to behavior problems.

Rules. Teachers should take students' cultural backgrounds into account when developing rules (or guiding students as they develop rules). Some rules that might make sense within one cultural group will not make sense with another cultural group. For instance, in some cultural groups there is a strong expectation that people learn by helping each other. A rule that forbids these students to help each other with homework would likely be counterproductive (e.g., Gay, 2006).

In Hawaii, a common form of discourse among native Hawaiian children involves a great deal of interruption; it is normal for family conversations to involve a great deal of interruptions as adults and children collaborate in building up ideas. For instance, people may jump in to help tell a story started by one person. With these students, "Respecting others" means caring about their ideas enough to join in on what they are saying. If a teacher interpreted the rule "Respect others" to mean that everyone should listen quietly while one person is speaking. she would create a classroom environment at odds with Hawaiian culture (Gay, 2006). Researchers have found that when teachers lead discussions in accordance with Hawaiian culture, students are much more engaged and participate at a higher cognitive level (Au & Mason, 1981).

Students who have not yet mastered English will often need to consult with other students to make sure they understand what the teacher has said. Therefore, teachers should probably not strictly enforce rules against talking in class when ELL students are conferring with their peers; indeed, teachers may want to assure these students and the classmates around them that it is all right for ELL students to quietly double check what has been said as long as the talk is quiet and doesn't distract others. These students' side conversations are likely to be critical in helping them learn from the lesson.

In a multicultural classroom, where students are from cultures with different norms, it will often be impossible to formulate rules that are compatible with every student's family norms. Therefore, teachers should invest extra time to discuss and explain the rules and routines, especially if these rules and routines are in contrast with what many students are accustomed to.

Table 11.4: Adjustments in applying principles of classroom management to different ages

Component of classroom management	Commonalities across ages	Adjustments for teachers teaching different age levels
Physical design	The principles of arranging desks according to the instructional goals, designing space to allow students to move to needed places easily, and allowing students adequate space to work are common to all ages.	Teachers of younger students are more likely to create special areas such as carpeted reading areas and learning centers. Student involvement in designing the physical space is most workable when teachers teach just one group of students, as in elementary school.
Rules and procedures	All the principles we discussed regarding rules and procedures are common to all ages. Students of all ages can be involved in establishing or helping to establish the rules.	Elementary school teachers are likely to need to plan for even more procedures than secondary teachers are, as they teach multiple subjects and are also responsible for taking students to recess and other locations (e.g., the gym for physical education).
Relationships	All the principles we discussed regarding teacher-student, student-student, and teacher-parent relationships are applicable generally to all ages. It is critical for teachers to be caring, to promote student-student appreciation, and to cultivate positive relationships with parents.	Relationships may be especially important at transition periods, such as when students move from elementary school to middle school. In addition, the community-building activities that teachers use in higher grades may become more complex and sophisticated. Secondary teachers have more parents to communicate with and will need to plan systematically in order to reach all parents. Websites, newsletters, and class newspapers can help the secondary teacher reach a large number of parents on a regular basis.
Well-organized, engaging instruction	It is equally important at all ages to develop engaging instruction and to organize instruction well (preparing activities and materials, providing training, providing clear instructional signals, monitoring students, and following up appropriately).	The nature of instruction that students find engaging at different levels will of course vary from age to age, as we discussed in Chapter 10. Because elementary school teachers plan a full day of lessons (in contrast to secondary teachers, who may have just one or two different lessons that are repeated across different periods), elementary school teachers must work especially hard to ensure that the full day of lessons is carefully planned and organized.
Discipline	Kounin’s principles of preventing misbehavior (including withitness, overlapping, signal continuity) apply broadly to all ages. The Principle of Least Invention, the idea of respecting students when disciplining them, and the use of logical consequences also apply at all age levels.	There is one verbal response to minor misbehavior that is extremely effective at younger ages but not advisable to use with older students: praising good behavior by other students. In addition, the logical consequences that are best suited for differing ages may differ. Some consequences, such as in-school and out-of-school suspensions, are likely to be set by school policy.

Developing effective interpersonal relationships. In multicultural classrooms, one critical ingredient in developing effective interpersonal relationships between teachers and students and between teachers and parents is that teachers come to understand and appreciate the cultural backgrounds of their students and their families. It is not possible for teachers to build caring relationships that support good classroom management if students (or parents) believe that the teachers dislike their cultures or are disinterested in them. When teachers are organizing and decorating the physical environment, teachers should ensure that all cultural backgrounds are represented in classroom displays such as posters and bulletin boards. When talking with students, teachers should show a genuine interest in who they are, which includes an interest in their cultural heritage.

In underperforming schools, it too often happens that teachers blame students' poor performance on families' values that they believe to not support educational achievement (e.g., Thompson et al., 2004). In contrast, in schools that are effective with at-risk students, teachers do not dwell on blaming families for students' performance. Instead, they attribute their students' successes and failures to their own efforts as teachers (e.g., Hall et al., 1989). If students are underperforming, the teachers in these schools search for better ways of teaching and better ways of reaching students (Pressley et al., 2007). A good policy for teachers and administrators to follow is never to say anything to each other about students' families that they would not say to the families themselves (Meier, 2008). If a teacher would not say to a parent's face that "Our parents just don't care about education," they should not say this to each other. On the other hand, teachers can say to each other that they need to find ways to work with parents to strengthen learning, because this is something that they would be able to say directly to the parents, as well. Students can sense when they are not respected, and it becomes impossible to build caring relationships in which students are willing to cooperate with teachers if students sense that the teachers disrespect their families.

Respecting students also entails maintaining high academic standards (Pressley et al., 2007). Teachers who fail to hold students to high academic standards communicate to students that they do not think that they can succeed. Indeed, teachers who care about students will not accept that students are achieving at a low level.

Some studies have shown student differences in a preference for academic versus personal caring. Teacher educator Kate Bosworth (1995) found that some students viewed caring teachers as those who were willing to help with personal problems and willing to provide guidance on these problems. In contrast, other students cited the teacher's willingness to provide help with schoolwork as a sign that a teacher cared. However, the critical point for teachers to remember is that teachers should realize that there are different forms of caring and that different students may respond to different forms of caring. Indeed, the same student may respond to different forms of caring at different times, depending on personal needs at that time. It is important for teachers to be prepared to offer caring of both types to all students.

Verbal responses and directions. It is important to understand that different cultures have different ways of giving instructions and directions. For instance, in White middle-class families, parents often use indirect statements such as the ones below to give instructions to their children:

- "Your room is getting really messy" (intended to communicate that the child should clean up the room).
- "Could you pass the salt?" (intended as directions to pass the salt).
- "I see some hands that need washing" (intended as directions to wash hands).

In contrast, in some other cultural groups, parents may avoid using indirect statements to give instructions and instead make direct statements such as "Clean your room before dinner," "Pass the salt," "Get upstairs and wash your hands before you sit down to dinner." When children who are accustomed to very direct commands enter the classroom of a teacher who gives indirect commands, there is a cultural mismatch in language use. When the teacher says, "This class is getting really noisy," she expects that the students will interpret her statement as a command to quiet down. However, students who are unaccustomed to indirect commands will *not* interpret this statement as a command to be quiet, because in their own families, no one ever gives commands in this way. It is important for teachers to understand that their students may interpret their requests very differently from what they expect. Teachers should pay attention to how students talk to each other, and they should try different ways of making requests to make sure all students understand what they are requesting.

SUMMARY

CHALLENGES IN MANAGING CLASSROOMS

Beginning teachers often mistakenly equate classroom management with discipline. In fact, effective classroom managers are more focused on preventing misbehavior so that discipline is seldom necessary.

GOALS OF CLASSROOM MANAGEMENT

There are two goals of classroom management: academic learning and social-emotional learning. Effective teachers manage classes so as to maximize time for these two types of learning.

The five components of classroom management are (1) the physical design of the classroom, (2) rules and routines, (3) relationships, (4) engaging, well-organized instruction, and (5) discipline, which includes actions to prevent misbehavior as well as to respond to misbehavior.

ORGANIZING THE PHYSICAL DESIGN OF THE CLASSROOM

Well-designed physical layouts can encourage student learning.

Arranging Students' Desks. Students desks should be arranged to give ample space for teachers and students to move around. Teachers should ensure that they are interacting equally with all the students in the class, not just those whose desks are nearest to the teacher. The best arrangement of desks depends on the instructional goals of the class and the learning activities that the class is engaged in.

Arranging Other Furniture, Equipment, Supplies, and Décor. Other furniture should be arranged to create as much space as possible for students to work and for students and teachers to move around easily. The layout should minimize traffic problems in the classroom. The décor should make the room an inviting, personable place. Teachers should adjust the room layout to their instructional goals and activities.

Students' Perceptions of the Physical Environment. Students perceptions of the physical environment may differ from teachers'. When possible, teachers may want to have students help design the physical layout.

ESTABLISHING THE RULES AND ROUTINES OF THE CLASSROOM

Classroom rules specify general norms for overall conduct. Routines specify how to carry out the many different repeated activities that teachers and students do every day.

Rules. Teachers should develop 4 to 6 rules, which are congruent with school-wide rules. Rules should be worded positively. Teachers must decide whether to use general or specific wording. Teachers should post rules in a salient location. They should not assume that students will remember and understand the rules but instead teach and explain the rules to be sure that students understand them as intended. Many teachers find it effective to give students a voice in developing the rules.

Routines. There are three types of routines: movement routines, lesson routines and general procedures. Teachers must specifically plan *many* different routines to keep the classroom running smoothly. Routines should be developed to minimize wasted time and to maximize learning time. Teachers will often need to teach routines explicitly and have students practice them.

DEVELOPING EFFECTIVE INTERPERSONAL RELATIONSHIPS

Developing effective interpersonal relationships is important to classroom management.

Teacher-Student Relationships. Teachers should express both academic and personal caring to students.

Student-Student Relationships. It is important to encourage positive student-student relationships. One way to accomplish this goal is to use community building activities and collaborative academic tasks.

Teacher-Parent Relationships. Teachers can use a variety of specific methods to encourage strong teacher-parent relationships. Teachers should strive to have many positive interactions with parents, not just negative interactions in response to a student problem.

PLANNING ENGAGING, WELL-ORGANIZED INSTRUCTION

Effective classroom managers develop instruction that is both engaging and well-organized.

Developing Engaging Instruction. When instruction is engaging, students are focused on learning tasks and are less likely to misbehave. All of the instructional strategies that promote student engagement (discussed in Chapter 10) will also promote better student behavior.

Developing Well-Organized Instruction. Teachers develop well-organized instruction to make sure that students spend their time on learning tasks rather than wasting time on transitions. In developing well-organized instruction teachers (1) organize the instructional activities and materials carefully before the lesson, (2) provide the students with any needed training to make sure they know how to carry out the activities, (3) provide clear instructional signals during the lesson, (4) monitor students' behavior during the lesson, and (5) follow up appropriately on the lesson.

PREVENTING AND RESPONDING TO BEHAVIOR PROBLEMS

Discipline includes both preventing and responding to behavior problems.

Preventing Behavior Problems. Effective classroom managers exhibit withitness, overlapping, and signal continuity and moment. They also plan for variety and challenge in designing assignments, and they teach students to regulate their own behavior by encouraging them set goals for their behavior and to monitor how well they are doing in achieving their goals. Conflict resolution programs are designed to help students learn to regulate their own behavior when conflicts arise.

Responding to Behavior Problems. Teachers should respond to behavior problems in a way that preserves the dignity of the students and minimizes disruption to the lesson. Teachers should respond to minor misbehaviors using the Principle of Least Intervention. Teachers will need to apply consequences in the case of more serious misbehaviors. Using the criteria of the three R's, consequences should be *related* to the child's misbehavior, *respectful* to the student, and *reasonable* in that they help students correct their mistakes.

EXTENSIONS

Developmental Changes. The principles of classroom management discussed in this chapter apply generally to classes at all age levels, although there are some differences in the details of how elementary versus secondary teachers will apply some of the principles.

Culturally and Linguistically Diverse Students. Effective classroom managers take students' different cultural and family backgrounds into account when managing their classrooms, including the development of rules and methods of giving verbal responses and directions. In multicultural classrooms, teachers will be more successful in building effective interpersonal relationships if they understand and value the cultural backgrounds of their students and their families.

CHAPTER 12
Teaching for Understanding and Belief

Chapter 12a
Discussions and Questioning

A. Recitations

Ideally, discussions give learners an opportunity to be active agents in their own learning. To construct new conceptions and acquire new ways of thinking, students need a chance to express their ideas and hear others' ideas. But much research suggests that discussions often fail to achieve these goals. During the typical discussion, teachers play a dominating role. Teachers do most of the talking and tightly regulate the content of discussion. In her book *Classroom Discourse*, Courtney Cazden (1988, p. 134) wrote that "teachers give directions and children nonverbally carry them out; teachers ask questions and children answer them, frequently with only a word or a phrase. Most important ... the roles are not reversible. Children never give directions to teachers, and rarely even ask them questions except to request permission."

Most discussions in most classrooms are less "discussion" than they are "recitation." Recitations are deeply entrenched in classroom practice. During a Recitation, the teacher maintains continuous control of the topic by asking a seldom-broken string of assessment questions. An assessment question quizzes students about a matter already known to the teacher. Students who have become accustomed to Recitation as a form of discourse are well aware that the teacher has predetermined what will be counted as an acceptable answer. The assessment question is different from a genuine request for information, in which the questioner does not already know the answer.

Recitations have a predictable, repeated IRE pattern -- teacher Initiation, student Response, followed by teacher Evaluation (Mehan, 1979; Sinclair & Coulthard, 1978). Here is an example:

Initiation	Teacher	So why do you think that Amy let the goose go?
Responses	Student	Because she knew that the goose needed to return to its mate.
Evaluation	Teacher	OK
next Initiation		Anybody else?

In the Recitation, the teacher controls turntaking. Following a teacher question, students typically bid for turns by raising their hands. The teacher nominates the student who will respond. This student has the floor until the teacher takes control again, evaluating the response of the student who has just spoken, and then initiating the next IRE cycle. During Recitation, most of the talk is teacher talk; students collectively express from a fifth to a half of the words (Almasi, 1995; Beck, McKeown, Sandora, Kucan, & Worthy, 1996; Cazden, 1988).

Researchers have found that most teacher questions in Recitations are lower-level questions. Most commonly they are questions that can be answered directly by repeating words from the text. Higher-order questions that require student thinking and inferences are less common.

Much existing research suggests that Recitations remain worldwide the most common form of teacher-led discourse. However, as usually practiced, Recitations lack four key characteristics that are important for promoting student learning and motivation. Specifically:

1. In Recitations, students have little control over the discourse.
2. In Recitations, students do little of the talking.
3. In Recitations, teachers usually ask low-level questions.
4. In Recitations, teachers tend not to provide much structure that helps students integrate ideas.

I will elaborate on each of these points in the next section.

B. Characteristics of Productive Discussions

Teachers would like to hold discussions that engage students' interest and that promote learning. Amazingly, despite the fact that class discussions are one of the most common classroom activities—perhaps *the* most common—we know relatively little about how students learn from discussion or what they think about different kinds of discussions. However, existing research supports the idea that discussions that promote learning and motivation have four characteristics, which are the opposite of the characteristics listed above as common features of recitations. These four characteristics are:

1. Students have control over important aspects of the discourse.
2. Students do well over half of the talking.
3. Teachers pose higher order, thought-provoking questions.
4. Teachers provide structure that helps students see what was accomplished in the discussion.

I will discuss each of these characterstics below.

B1. Student Control and Open Participation

Discussions that give greater control to students are often described as having more *open participation.* Under open participation, the teacher cedes considerable control to the students. The children may not have to raise their hands and be acknowledged by the teacher in order to speak, and overlapping speech is sometimes allowed. Importantly, students have control over the content of what is said. Au and Mason (1981) and Chinn and Anderson (2001) found that under open participation the children performed better on several measures of quantity and quality of discussion contributions.

Teachers can increase student control over discussions in at least three ways: by increasing students' *control over interpretation*, by increasing students' *control over topic,* and by increasing students *control over turntaking*. When students have more control over one or more of these aspects of the discussion, they will feel a greater sense of autonomy, which should of course enhance their motivation.

Control over interpretation. First, teachers can give students more control over interpretation. In recitations, teachers ask questions and accept only those answers that they believe to be right; this means that the teacher has complete interpretive authority. When students evaluate each others' statements for accuracy or plausibility, without guidance from the teacher, then students hold interpretive authority.

When teachers control interpretation, we should see teachers asking lots of assessment questions (that is, questions that the teacher knows the answer to). We should also see clear evidence that teachers are evaluating students' answers.

When students are more in control of discussions, then teachers should ask more open-ended questions, and fewer assessment questions. Teachers will ask frequently students what they think about ideas instead of telling what they themselves think.

Control over topic. Second, teachers can give students more control over the topics under discussion. Control of topic is complex, because topics exist at multiple levels. At one extreme, teachers may control the topic to the extent that the exact words used by students are prescribed, as when students in the U.S. recite the Pledge of Allegiance. At the opposite extreme, teachers may exert no control at all over the topic, as when students are talking among themselves at recess. In between, there are many ways for teachers and students to share control. In almost all discussion formats, teachers retain global control to ensure that students stay on the general topic. Even in teacherless discussions, teachers set an expectation that the discussion is to fall within certain boundaries. Different discussion formats differ largely in who has local control--that is, control over exactly what to say moment by moment as the discussion proceeds. In Recitations, students have little local control, as they are constrained to answer the questions posed by the teacher. In discussions with more open participation, students have much more local control, since they are free to respond to another student's comment, ask a question, extend another student's idea, or introduce new topics.

When teachers control the topic, they ask a lot of questions, and the questions that they ask have only one correct answer (or at least a limited number of correct answers). So students don't have much control over what to say.

When students have more control over the topic, we should see students starting up new topics that the teacher didn't first ask questions about.

Control over turntaking. Teachers can maintain complete control over turntaking by calling on students to speak. In contrast, in peer-led discussions, the children themselves must regulate their own turntaking. Teachers and students may also share responsibility for turntaking. For instance, a teacher may allow students to speak without being called upon but intercede if some students monopolize the floor. It is obviously easier to give up control over turntaking in small group discussions led by a teacher than in whole-class discussions led by the teacher.

When teachers have control over turntaking, we should see (a) teachers choosing who gets to speak next and (b) a teacher comment after every student comment. Teachers take about half the turns.

When students have more control over turntaking, we should see (a) fewer occasions in which the teacher nominates the next speaker and (b) runs of turns in which students talk right after each other. Students take well more than half of the turns.

When students have more control over turntaking, we may also see evidence that the students are more likely to interrupt each other, and they may even be more likely to interrupt the teacher.

Of course, in many situations it may not be feasible for students to be in complete control over turntaking. If students cannot manage their own turntaking well (e.g., they interrupt each other, and some hog the floor), the teacher will need to assume at least some control over turntaking. (The teacher may also want to teach students norms for turntaking and help them practice so that they can eventually assume greater control themselves.)

B2. Proportion of Student Talk

Teachers talk a very large proportion of the time in recitations, often over 70% of the time. This leaves very little opportunity for students to talk. Imagine a teacher who is leading a 20-minute recitation in a class with 20 students. This teacher utters two thirds of all words in the discussion. In a recitation, there may be about 70 words spoken per minute. Out of the 1400 words spoken in 20 minutes, the teacher is responsible for 980 words, and the students utter just 420. On average, each of the students utters just 21 words, which is 2% of the amount of talking that the teacher does.

Why is this a problem? Students learn by actively processing ideas. As you learned in the chapter on metacognition, students learn the most when they are explaining and elaborating ideas. A student who utters just 21 words during a discussion is not doing a lot of explaining or elaborating, and therefore she will learn less than if she had more opportunities to speak.

In addition, if students have more opportunities to talk, they will say things that will help the teacher understand their preconceptions and misconceptions. And students will likely articulate ideas in ways that other students find helpful.

In addition, when teachers talk less, they will give students a chance to work to explain themselves. As other students observe this, they will likely learn something about how to think about hard questions. To see this, consider these two brief transcripts, a traditional recitation transcript and a transcript in which the teacher aims to get the students to do more of the thinking and talking.

Recitation:

Teacher: What is the answer to the next problem: 1 / 2 + 3 / 4 = ?
Student: Five fourths.
Teacher: Right. You convert the half to two fourths so that you can add them together and then add the 2 and the 3.

Alternative Discussion:

Teacher: What is the answer to the next problem: 1 / 2 + 3 / 4 = ?
Student: Five fourths.
Teacher: How did you get that answer?
Student: Um. … I made two fourths and added it to three fourths.
Teacher: Why did you decide make two fourths?
Student: Well, I didn't think I could like add the numbers together if they were different. Like you can add 1/8 and 1/8, because they have the same bottom numbers, but you can't add 1/8 and 1/9 without changing one of the bottom numbers. So I had to change the bottom numbers to the same, so that I could add them.

By encouraging the student to articulate her thinking, that student has of course benefited from the opportunity to engage in explanation. Other students have noticed that the teacher cares so much about why one carries out a particular step that she will ask for an explanation, so they will be encouraged to pay attention to explanations as they continue to work on math problems. They have also had a chance to observe a successful student explanation, which gives them insights into how to construct explanations themselves.

We will explore many of these ideas later when we talk about teaching cognitive strategies.

You have probably noticed that even if a teacher speaks just 25% of the time, each student in a class of 20 will still only be able to speak a few times in a 20-minute discussion. This is one reason why researchers recommend extensive use of collaborative groups in schools. In a group of two, three, or four students, each student will have many opportunities to explain, elaborate, and use other cognitive strategies during the conversations. You will learn more about this in the chapter on Collaborative Learning.

B3. Higher-Order Questions

Teacher questions drive much of what goes on in classrooms. Not surprisingly, researchers have been interested in the effects of teachers' questions on what students learn.

Two important findings about teacher questions are these:

1. When teachers ask questions, they should give several seconds (3 to 5 seconds) of wait time.

2. When teachers ask higher-order questions rather than lower-order questions. One way to think about this is that teachers should ask questions that are higher on Bloom's taxonomy, student achievement is higher than when teachers ask questions that are lower on Bloom's taxonomy. In particular, teachers should avoid asking too many knowledge-level questions, which simply require students to read answers directly out of texts.

Most of this research involves questions within traditional recitations. Much less is known about discussions involving more open participation and more student talk. There is some evidence, however, that it is productive for teachers to have students back up their answers with evidence, and to have them encourage students to give reasons and evidence to support their positions on issues.

Another way to think about teacher questions is to use the following taxonomy:

Low Level Questions

Low level questions include three main types of questions:

1. Tangential questions. Tangential questions are questions that are only tangentially related to the topic. For example, when discussing a story about a raccoon family that has been treated anthropomorphically like a human family, a teacher might ask students questions about raccoons. Because the raccoons in the story are not behaving as raccoons at all, these questions distract from the actual story (Anderson et al., 19xx).

2. Vocabulary questions. Occasional questions about vocabulary are not harmful, but vocabulary questions often make up a very high proportion of questions in discussions. This can also detract from understanding the central ideas, and it can also convey to students the mistaken idea that understanding a text just means memorizing the vocabulary words (xx).

3. Knowledge-level questions. Knowledge-level questions are questions whose answers do not require much thinking. One kind of knowledge-level question can be answered by reading a word or phrase right out of the book. For instance, if the text says, "Sarah left the party because she felt ill," the question *Why did Sarah leave the party?* is a knowledge-level question.

Another variety of knowledge-level question is the question that students who answer definitely know the answer to. For instance, if you ask, when was the Declaration of Independence signed, and a student answers "1776," this is a knowledge-level question for that student. There was no thinking or inferencing involved; the student simply retrieved an answer from memory.

<u>High Level Questions</u>

High-level questions are questions that require reflections and inferences from what has been learned. High-level questions cannot be answered simply be retrieving the responses from memory or from the textbook.

High-level questions include questions at the comprehension, application, analysis, synthesis, and evaluation levels of Bloom's taxonomy.

High-level questions also include questions about reasons and evidence (which can be viewed as a special kind of evaluation question). These questions would include questions such as "What is your reason for viewing that as unethical?" or "What's the evidence that tells you that the forces are equal?"

<u>Metacognitive Questions</u>

A type of higher-order question that is so valuable that it merits is own category is the metacognitive question. A metacognitive question asks students to explain their own thinking. (Sometimes these overlap in particular with questions about reasons and evidence.) These questions are designed to encourage students to make their thinking public, or make their thinking overt. Here are some examples:

Why did you come to that conclusion?
How did you get that answer?
Explain what led you to that idea.

When teachers shift to what I've called *high-order questions* and *metacognitive questions*, they are likely to promote greater student learning.

B4. Structure

It is very well established that writers can make what they write more understandable and more memorable by using a clear structure and highlighting the key features of that structure. It is likely that the same is true of discussions, though the research supporting structure in discussions is less extensive than the research supporting structure in written texts. (This doesn't mean that there is research that contradicts the value of highlighting structure in discussions; it just means that there is little research on this topic at all.)

One way to add structure to a discussion is to tell students the instructional goals for the discussion and then to summarize the key points at the end of the discussion. As you learned earlier in the chapter on Instructional Goals, highlighting key learning goals in this way is a good way to promote student understanding from discussions.

Another way to add structure is to use chalk boards, whiteboards, or other visual displays to highlight key points raised in the discussion. There is recent research that indicates that highlighting key points in discussions by using concept maps can be a very productive way to promote uptake from a discussion. Interestingly, some of the most interesting research is with counselors who are leading group discussions with clients in a drug treatment program. A summary of one study can be found in the box below.

Study

Czuchry, M., Dansereau, D. F., Dees, S. M., & Simpson, D. D. (1995). The use of node-link mapping in drug abuse counseling: The role of attentional factors. Journal of Psychoactive Drugs, 27, 161-166.

In this study, the researchers hypothesized that recovering drug addicts would have more success at staying off drugs if their counselor used concept maps during group therapy sessions than if the counselor did not. The researchers also hypothesized that this effect would occur because the concept maps help the clients maintain attention and to maintain a focus on the key ideas during wide-ranging, divergent discussions.

The study included 93 clients in two methadone treatment clinics in Texas. These were outpatient clinics in urban areas and were of diverse ethnicity. At the outset of the study, 14% reported at least weekly use of cocaine, and 20% reported using both heroin and cocaine.

Some of the counselors working with these clients were taught how to use concept mapping during their therapy. Clients who were assigned to these groups were also given a brief demonstration of how concept mapping during therapy session works. Other counselors provided “standard services.” They were “given a training workshop on group counseling and dealing with special issues, but they were not instructed in the use of mapping techniques.” All counselors in both conditions “operated on a brief therapy model emphasizing problem solving and case management.”

Measures included the following:

1. Measure of attentional difficulties. The researchers developed a 30-item nine-point Likert-scale questionnaire. The items addressed issues such as whether the clients had troubles paying attention during long talks, whether they could pay attention, whether they could sit still, and whether they got bored easily.

2. Client evaluation of the treatment program. Clients assessed the program with 12 five-point Likert-scale items. The items addressed overall satisfaction with the program, progress in making changes in life, whether clients felt the program was helping them with drug use, and whether the program was helping with nondrug problems.

3. Urinalysis. The research team collected weekly urine samples.

4. Client commitment was assessed by using the number of sessions missed during July and August.

In their results, the researchers found that clients in the mapping condition had fewer positive drug tests in the urinalysis. Although there was no difference in client evaluation of the treatment program, those clients in the mapping group who were classified as having “low attention” reported much greater therapeutic progress than a similar group in the non-mapping group. These “low attention” clients were also less likely to miss sessions when they were in the concept-mapping group than when they were in the control group.

This study powerfully shows the benefits of concept mapping at promoting not only better understanding but actual behavioral change.

CHAPTER 12b
Belief

People Do Not Readily Change Their Beliefs

You are undoubtedly aware that people often do not change their beliefs in response to new ideas or new evidence. Obviously, this is true about deeply held beliefs about topics such as beliefs about religion or politics. I recall that as an undergraduate I had many fascinating, stimulating discussions with other students about politics. All the participants in these discussions advanced their best arguments to try to convince others that their positions were the best. But to my knowledge, no one ever made any major changes in their beliefs as a result of their arguments. Certainly no Republicans became Democrats, and no Democrats became Republicans. I am sure that all of us made some relatively minor modifications to our beliefs here and there, but we all basically maintained our basic framework of beliefs about politics.

Another example of strongly held beliefs that are resistant to change are stereotypes. For example, suppose that a person believes that lawyers are introverted, and then that person meets a number of lawyers who are very extraverted. Do you think that the person would change her stereotype, getting rid of the idea that lawyers are typically introverted? Social psychologists have found that stereotypes seldom change in response to such experiences. Instead, the person might retain her belief that lawyers are introverted by reasoning that these lawyers are just exceptions to the rule. The person might even reason that these lawyers are exceptions that prove the rule!

Beliefs about teaching appear to be very strongly resistant to instruction. Teacher education programs are designed to encourage teacher education students to adopt beliefs about teaching and learning that are often very different from the beliefs that the students have when they begin their teacher education program. Unfortunately, it appears that teacher education programs typically have only a very small effect on changing these beliefs. For example, most teacher education programs have for many decades encouraged teachers to ask challenging questions in class that require higher-order thinking. However, research on teachers' questions has continued to show that many teachers tend to ask lower level, factual questions rather than higher-level questions that require more thinking. ##

As one more example, I recall an episode in a high school social studies class in which I was giving a guest presentation. At one point in the presentation, I displayed a chart that showed the relationship between growth in GNP and the proportion of GNP spent on military defense. The chart indicated that nations that spent a smaller proportion of GNP on military defense had larger growth in GNP. One student raised his hand and loudly asserted that he didn't believe this chart, and he had seen a chart last week that showed just the opposite. What this story shows is that when you, as a teacher, present evidence that contradicts what students believe, they will try to find various ways to explain your evidence away. They will discount your evidence.

All of these examples support the conclusion that students' preinstructional conceptions will have powerful effects on what they believe in your class. There is powerful research support for this conclusion. The conclusion is certainly valid for topics such as religion, politics, and stereotypes. But the conclusion is also valid for topics that involve less emotional or deeply held beliefs. You might think that students would readily change beliefs about science, but scientific beliefs are also resistant to belief change. As you read earlier in the text, many children resist changing their beliefs about the earth's shape. Similarly, students who think that heavy objects fall faster than light objects are not convinced when they watch a demonstration in which a heavy book and a coin fall at the same rate and hit the ground at the same time. The article by Chinn and Brewer presents many examples in which science students resist changing beliefs in response to new evidence.

How People Discount Anomalous Evidence

When people encounter evidence that contradicts their current beliefs, we can say that this evidence is *anomalous* for their current beliefs. When people encounter anomalous evidence, they tend to resist changing their beliefs. Chinn and Brewer (1992, 1993, 1998; Brewer & Chinn, 1994) have investigated the different ways in which people can respond to information that contradicts what they currently believe. According to the most recent version of their analysis, there are eight ways in which people can respond to anomalous data (i.e., data or evidence that contradicts their current beliefs).

The eight responses are:

1. ignoring
2. rejection
3. uncertainty
4. exclusion
5. abeyance
6. reinterpretation
7. peripheral theory change
8. theory change

Notice that theory change is only one of the eight possible responses. If you are trying to lead your students to change their theory about something, your students have seven responses to the information you present besides changing their theory! As you can easily see, the odds are stacked against you.

Here is an example from social studies. Suppose you have discovered a male middle school student who thinks that rivers run from north to south. You show the student on a map of North America that the MacKenzie river in Canada flows from south to north. According to the chart below, there are eight possible responses the student could make to this anomalous evidence. The chart shows that you can ask yourself three questions in order to figure out how to classify each response.

Response	Does the individual accept the data as valid?	Does the individual offer an explanation for the data?	Does the individual alter the current theory?
Ignoring	no	no	no
Rejection	no	yes	no
Uncertainty	unsure	no	no
Exclusion	yes, no, or doesn't care	no, because it's irrelevant	no
Abeyance	yes	not now, but possibly later	no
Reinterpretation	yes	yes	no
Peripheral theory change	yes	yes	yes, partly
Theory change	yes	yes	yes, completely

Here are examples of the seven responses for the example of the MacKenzie River in Canada.

Response type	Example	Does the individual accept the data as valid? (In this case, does he think that the map is drawn correctly, since that is the data shown to him.)	Does the individual offer an explanation for the data?	Does the individual alter his/her current theory?
Ignoring	The student hears the information about the MacKenzie River but doesn't pay much attention to it, except to think that there must be something wrong with it. The student still believes that all rivers flow from north to south.	No, he thinks there is something wrong with it.	No, he doesn't even think about why the map might show the MacKenzie River to be going northward.	No, he still thinks that rivers flow from north to south.
Rejection	The student declares that the map maker has made a mistake--it's impossible for a river to be going that direction.	No, he thinks there is a mistake on the map.	Yes, he thinks that the map shows a river going north because the map maker made an error.	No, he still thinks that rivers flow from north to south.

Uncertainty	The student looks confused when seeing the map. He says, "I don't know what to make of that. I don't know whether I believe it or not."	He is unsure about whether to believe the map.	No, he hasn't tried to explain why the map shows a river going from south to north.	No, he still thinks that rivers flow from north to south.
Abeyance	The student says, "Well, I guess there must be a river there if the map shows it there. I still think that rivers in general flow from north to south, but I can't explain why the river looks like that on the map right now."	Yes, he believes that the map is drawn correctly.	No, not yet. He seems to leave open the possibility that he will be able to explain the data later without totally giving up his theory."	No, he says he still thinks that rivers flow from north to south.
Reinter-pretation	The student agrees that the line of the river has one end in the Rocky Mountains and the other end in Hudson Bay, but he says, "It's obvious that the water in this river must be flowing from the Hudson Bay to the south."	Yes, he agrees that the map is drawn correctly.	Yes, he explains why it is that the river is drawn the way it is: there is water flowing from the Hudson Bay to the other end of the river.	No, he still thinks that rivers flow from north to south.
Peripheral theory change	The student says, "OK, it's possible that rivers could occasionally go from south to north, but that's only when they start out really really high in the mountains. Otherwise, they flow from north to south."	Yes, he agrees that the map is drawn correctly.	Yes, he explains the map by saying that water can flow from south to north under a certain circumstance.	Yes, but only partly. He still thinks that rivers flow mainly from north to south, but he is willing to make an exception if the river starts out at a very high elevation.
Theory change	The student says, "I guess I was wrong. Rivers can go any direction."	Yes, he believes the data he sees.	Yes, he thinks that the river is drawn as it is because water is flowing from south to north.	Yes, he abandons his original theory.

Implications for Teaching

One very important implication for teachers is this: Once you realize that students have strong beliefs that are relevant to what they are learning in school, it becomes clear that sometimes good teaching will involve trying to persuade students to change their beliefs. As a teacher, you will frequently have to make ethical decisions about how to deal with students' beliefs.

In many instance, you may rightly decide to try to persuade students to change their beliefs. Here are some examples of situations in which you might attempt to persuade students to change their beliefs.
--A student believes that he can never be good at math. You want to persuade the student that he can be good at math.
--Students believe that heavy objects fall faster than light objects. You want to persuade the students that the objects fall at the same speed.

--Students believe that plant food, rather than light, is the ultimate source of plants' energy. You want to persuade them that light is the ultimate source of plants' energy.
--Students believe that literature is irrelevant to their lives. You want to convince them that literature *is* relevant.
--Students believe that using integration strategies such as elaboration and explanation will not help them do better on tests. You want to persuade them that these strategies will in fact help them.
--Students believe that it is all right to respond to insults by hitting or pushing the insulter. You want to convince students that it would be better to respond by going to elected student mediators than to engage in violence.

In other instances, you may decide that you do not have an ethical right to try to change students' beliefs. But you may decide that you have a right to expose students to arguments on both (or all) sides of an issue to help them make up their own minds. For example:
--A science teacher may believe that the evidence strongly supports the existence of global warming, whereas some students do not believe that global warming really exists. But the teacher opts to allow students to debate this issue without giving any hint of his/her own position on this issue.
--A social studies teacher might believe that the U.S. could not have won the Vietnam War even if it had used different tactics. But the teacher decides not to give any indication of his/her beliefs when the class discusses this issue.

In other instances, you may decide that an issue is so controversial that you do not even want to discuss it in your classes, even when you give no hint of your own position. Possible examples of such topics are abortion and the truth of religious tenets.

In instances when you decide to attempt to persuade students to change their beliefs, you need to understand how students are likely to respond to the evidence that you present to them. As a teacher, you will often be presenting information and evidence that are incompatible with your student's current beliefs. You will be a more effective teacher if you can anticipate ways in which students will respond to different kinds of evidence that are presented in your class. At this point, you should have two skills. You should be able to predict whether or not students will believe information you present to them. And you should be able to predict the different ways in which students will try to explain away the information you present to them. After making these predictions, you can better adjust your instruction to make it more likely that students will change beliefs.

For example, suppose you are planning to try to convince students that heavy objects fall at the same speed as light objects (excluding objects that "float" on air such as feathers and sheets of paper). You prepare an experiment in which you stand on a sturdy table, drop a heavy book and a light book onto the ground at the same time, and have students observe what happens. Each time that you practice doing this experiment, you clearly observe that they hit the ground at the same time. However, because you have learned about different responses to anomalous data, you realize that your students will probably discount this experiment in some way. So now—before you ever go to class to do this experiment—you brainstorm some of the ways in which students might discount the data. You consider several possibilities:
--reinterpretation #1: "You didn't really drop them at the same time."
--reinterpretation #2: "The heavy one really did hit a fraction of a second faster."
--peripheral theory change: "OK, this experiment works, but only for books."

Because you have anticipated possible responses to the data, you can now think of ways to make your experiment better or to add new data that would help rule out these different ways of discounting data. You can rule out the peripheral theory change response by doing the experiment with lots of different pairs of heavy and light objects. You can rule out the first reinterpretation response by bringing in a device that can release the objects without question at exactly the same time. You can rule out the second reinterpretation response by videotaping the experiment so that students can analyze frame by frame when the objects hit so that they can see that they really did hit at the same time.

Notice that if you didn't know that students were likely to respond to your experiment by discounting it in some way, and if you hadn't tried to anticipate how they would try to discount the experiment, you would have never thought of these ways to make your experiment better, nor would you have thought about other experiments you could do or other data you could bring in.

When you decide to try to persuade students to change their beliefs about a topic, you should think about data that you could use to try to make the persuasion successful. But then you must anticipate how students might discount the data. By anticipating their various responses, you can proactively devise ways to make the evidence that you have stronger, and you can think of different evidence that you can bring in that will counter the particular criticisms that students have.

CHAPTER 12c
Teaching for Belief Change

A. Instructional Techniques that Promote Belief Change

Here are five main methods that are effective in promoting belief change (Chinn & Brewer, 1993). To illustrate these methods, I'll provide an examples from a high school English teacher who is teaching a unit on critical reasoning and wants to convince students that psychic detectives are not for real.

1. Foster a general commitment to making beliefs consistent with evidence.

This means pointing out that our beliefs are often wrong, so that it's important to make good decisions about what to believe, based on the best available evidence. We just can't believe what we want to believe.

It will not be easy to foster this general commitment in students. It has to be a constant focus of your teaching.

EXAMPLE. Throughout the school year, the teacher demands that students back up what they say with evidence. She often makes the point that beliefs that are not supported by evidence are likely to be untrue, and so are not very reliable as a guide to behavior. She often points out cases in which her own beliefs turned out to be wrong, and when she gave up faulty beliefs whenever the evidence suggested they were incorrect. She encourages them to bring up cases in which they found out that their beliefs were faulty.

2. Teach students about the principles of reasoning that they need to know to evaluate evidence properly. This, too, is a long-term project that begins the first day of school and must continue throughout the new year. The teacher teaches principles of evidence so that students can distinguish between good and poor evidence.

EXAMPLE. The teacher focuses throughout the school year on principles of evaluating evidence about social phenomena. One particular focus is that single cases should be given less weight than evidence from many cases, so a single vivid case should carry little weight in comparison with a study of many cases.

A second focus is the importance of considering control groups. For instance, before concluding that a psychic made correct predictions because of psychic powers, one needs to compare the predictions of psychics with the predictions of nonpsychics. Because anyone will get a few predictions correct, either by chance or by making good educated guesses, the fact that a psychic gets a few predictions right doesn't say anything, unless the psychic can get more predictions right than a nonpsychic.

3. Present a clear explanation of a plausible alternative theory. The new theory needs to give a plausible explanation of the evidence that the student believes. The student needs to see that the new theory could be true.

EXAMPLE. The teacher presents the theory that psychics sometimes make predictions that seem impressively correct by making these predictions vague enough so that they would be consistent with a wide range of outcomes. For instance, when a psychic says "The body will be found by water," nearly any place that the body is found will probably be near water of some kind—a river, a lake, a sink, a water pipe, etc. So in fact, the prediction was almost guaranteed to come true, but people just don't notice that almost any outcome would be consistent with the prediction.

4. Provide lots of convincing evidence. (Convincing evidence is both credible and unambiguous.) One or two pieces of evidence never convinces a skeptic. Many, many pieces of evidence are likely to be needed. And the evidence should be, as the Brewer and Chinn article discusses, both as credible as possible and as unambiguous as possible. Remember that credible data have as many as possible of these characteristics:

a. Use credible sources.
b. Use accepted research methods.
c. Replicate studies.
d. Use direct observation.
e. Use data that are already believed.

I cannot emphasize enough that one or two pieces of data are usually NOT enough to promote belief change. You will need multiple pieces of evidence in most cases.

EXAMPLE. The teacher includes the following piece of evidences:
--a videotape of two studies that have been done showing that psychic researchers make no better predictions than nonpsychics.
--an article from a magazine that presents a study similar to the two above.
--an article in which a formerly acclaimed psychic detective has now admitted that he used various tricks and reveals what those tricks were.
--a class experiment in which students first learn how to make vague predictions and then make predictions about a local robbery. When the robbery suspect is caught, they find that their predictions are about as accurate as the typical predictions of psychics.

5. Promote deep processing. Don't just give students things to read if you want them to change their minds about something. You have to have them think actively about the issue—by participating in discussions, by writing about the issue, and so forth.

EXAMPLE. Extended discussions are held over each piece of evidence. At the end of the unit, students write a position paper. Any position is acceptable, but it must be argued by persuasive evidence.

More examples:

Here are two more examples.

a. You are a member of the human resources division in a large, growing technology firm. Most of the employees of the firm are computer programmers. About two thirds are Americans and the other two thirds legal immigrants. There has always been a tendency in this firm for some factionalization among the Americans and legal immigrants. Recently the management has become aware of a serious rift in the firm. A large number of the American programmers believe that the legal immigrants are less productive and less willing to work hard and achieve group goals. Based on the data available, the management believes the American programmers' belief to be false. The management also believes that this false belief is a difference is harmful to corporate morale and productivity. Your job is to devise a plan to change the belief of the American programmers.

b. You are a 5th-grade teacher, and you know that most of your students think that heavy objects fall faster than light objects. You want to show your students that they are mistaken. Develop a lesson plan that will do the trick.

Teaching techniques	a	b
1. Foster a general commitment to making beliefs consistent with evidence.	Hold a workshop. In the workshop, point out instances in which their entrenched beliefs turned out to be wrong. In the workshop, the instructor provides many examples of when people believe things that aren't so. Try to engender a general attitude that recognizes that bowing to evidence is a good idea.	Throughout the school year, the teacher points out instances in which students found that their previous ideas were not correct so that they changed their minds. The teacher spends 25% or more of science time on helping students learn to reason scientifically, in general. Have discussions about issues such as the need to be highly consistent. Teach students that in science, one has to learn to conduct experiments that have the potential to prove your ideas wrong.
2. Teach students about the principles of reasoning that they need to know to evaluate evidence properly.	The workshop instructors teach workers about research design and analysis so that they can evaluate evidence on productivity.	The teacher teaches students about measurement error, so that they can decide whether two objects hitting at the same time can be plausibly attributed to measurement error.
3. Present a clear explanation of a plausible alternative theory.	The instructors make sure that the Americans understand that there is a range of performance in both groups, so that they don't think that the alternative theory is that ALL immigrants work as hard as the AVERAGE American. Rather, the AVERAGE immigrant works as hard as the AVERAGE American. Use conceptual models and other effective explanation techniques to teach the alternative theory.	When teaching the idea that heavy things and light things fall at the same rate, the teacher clearly explains that the theory does not apply to objects that float in air. The teacher explains the role of air resistance clearly so that students understand that theory does allow some light objects to fall slower. The teacher shows how it is that these objects are structured so to float in the air, and that those objects aren't covered by the theory presented today. The teacher uses conceptual models and other effective explanation techniques to teach the alternative theory.

4. Provide lots of convincing evidence. (Convincing evidence is both credible and unambiguous.)	The workshop leaders and the workshop participants work together to define highly objective performance standards (and encourage the use of these standards for promotion decisions, as well). The workshop leaders have a multi-ethnic team participate in the design of the study or studies, and in the design of the measures. They make sure that all the workers agree to the procedures before carrying out the study. They have American representatives and immigrant representatives involved in carrying out the research. They devise a performance system that is public, so that everyone can see how everyone is doing. The workshop leaders don't choose any research design that would yield ambiguous data. They make sure that participants agree in advance what will count as "no difference"; e.g., participants might say that there is no practical difference if the averages are within 5% of each other. In addition, studies of other companies with a similar problem are presented. Workshop leaders also present data that shows how it is that mistaken stereotypes arise. Some of these studies are presented and described. Others are demonstration experiments that can be done right in the workshop sessions.	The teacher does many experiments. She does some; students do others. They use different methods for dropping the ball. First they drop rocks within the room. Then they drop objects from higher up (two or three stories). They use two heavy, streamlined metals that will not be affected by air resistance. They use an automated release system to guard against nonsimultaneous release. They redo the experiment from different heights. The students plan an experiment that would convince them their old idea were wrong. They work out some kind of automatic recording system. The teacher gets students to agree in advance what would count as "close enough to the same" to accept that the time to fall really is the same. They also roll balls down an incline as well as dropping objects. (But to avoid ambiguous data, the teacher makes sure the apparatus is very low in friction.)
5. Promote deep processing.	The company hold workshops afterwards in which participants discuss the research and its implications.	The teacher holds frequent classroom discussions. She has students discuss their experiments in small groups.

PROBLEM SET #1. Evaluating belief change lessons

Based on what you have learned about teaching for belief change, evaluate the following lessons and lesson plans. Focus on how likely they are to promote belief change. Make sure you evaluate the use of each of the 5 instructional techniques.

PROBLEM #1a

A math teacher wanted to convince her students that they would learn more in less time if they studied in a quiet study place. First the teacher polled the students and found that most of them believed that they studied better if they listened to music while they were studying. Then the teacher led a discussion in which she asked students to talk about times when people they knew strongly believed things that were actually wrong. Many students offered examples showing that these people were very resistant even to overwhelming evidence. The class gradually seemed to reach a consensus that it was important to be open-minded and not to hold onto current beliefs too strongly, because those beliefs might well turn out to be wrong. The teacher then turned to the issue of whether it was better to study in a quiet place or to study while listening to music. The teacher asked students to design an experiment that would provide the answer to the question. The students said that everyone should study Chapter 11 (the next chapter in the textbook) in a quiet room and come back the next day and take a test. Then everyone should study Chapter 12 while listening to music or while watching TV, and then again the following day they would take a test. The students then implemented the experiment, and the results showed that the average score was 84% on the Chapter 11 test and 78% on the Chapter 12 test. The teacher assumed that students would now be convinced that they would learn more if they studied in a quiet room than if they studied while listening to music.

MY ANSWER:

A. Foster a general commitment to making beliefs consistent with evidence. The teacher does some of this in the discussion in which students discuss their resistance to overwhelming evidence. It is encouraging that the class raeach a consensus on the importance of open-mindedness. However, it is likely that the teacher will need to have such discussions regularly (not just once) to have any kind of effect.

B. Teach students about the principles of reasoning that they need to know to evaluate evidence properly. There is no indication that the teacher discussed the appropriate way to conduct experiments with students.

C. Present a clear explanation of a plausible alternative theory. Nowhere does it say that the teacher gave a psychological explanation that would seem plausible to the students.

D. Provide <u>lots</u> of convincing evidence. This is just one study—not nearly enough. In addition, it is very ambiguous. Students can reasonably conclude that Chapter 12 was a lot harder, so that the harder chapter (rather than listening to music) is the reason for the lower performance.

E. Promote deep processing. The class discussions are good in that they tend to promote deep processing.

Overall, this lesson is unlikely to promote belief change. The deficiencies in (D) and (C) are overwhelming. The deficiencies in (B) and (A) are also problematic.

PROBLEM #1b

The topic to change is elementary school students' beliefs about students. Students may believe that pollution doesn't really harm anyone or anything.

Do the following activities in class.

1. Hold class discussion to assess preconceptions.
2. Class reads a newspaper article about the harmful effects of pollution. Then there is class discussion.
3. The teacher shows videos and slides showing people and animals affected by pollution. The class discusses these.
4. The teacher invites a guest speaker to speak on pollution and its effects. This is again followed by class discussion.
5. The class takes a trip to a polluted lake/river.
6. The class discusses what was observed.

MY ANSWER:

A. Foster a general commitment to making beliefs consistent with evidence. These lessons have none of this.

B. Teach students about the principles of reasoning that they need to know to evaluate evidence properly. None of this, either.

C. Present a clear explanation of a plausible alternative theory. This is pretty strong. The newspaper article, the videos, and the slides are likely to present a clear and plausible new theory about the harmful effects of pollution. However, although the lesson plan should spell out in much more detail what these articles, videos, and tapes will present. Otherwise, it's impossible to know whether the explanation is clear and plausible.

D. Provide lots of convincing evidence. The only evidence is the trip to the polluted lake or river. This could be powerful evidence, but the lesson doesn't tell any details of what the students will observe at the lake or river or how this will serve as credible, unambiguous evidence. There is only one piece of evidence.

E. Promote deep processing. The class discussions probably accomplish this.

Overall, this is a poor lesson plan. It lacks detail and lacks some key steps. However, because most elementary school students probably are already sympathetic to the idea that pollution is harmful, the lessons may promote belief in the new theory—but only because most students probably aren't against the theory that pollution is harmful in the first place.

PROBLEM #1c

In the first lesson we would begin with a discussion of evidence and beliefs. I would ask the children if they could think of a time when they believed something that turned out to be not true. I would ask how they found out it wasn't true. Did someone show them evidence? Why did they change their belief? Etc. I would try to get them to realize that sometimes we must discard or change a belief if the evidence warrants. We would also talk about what kinds of evidence should persuade us to change our belief. Not all evidence is equal. It has to evaluated based on things like its source, method of collection, etc.

In the next lesson we would discuss research methods of data collection and analysis. I would teach students the skills to conduct their own research. We would talk about the different kinds of research—correlational, experimental, and natural—and the strengths and weaknesses of each. We then would begin talking about our research topic. I would take a vote to see how the students felt and ask them their reasons why. I would keep probing them until I had a sense of the real reason for their belief if necessary. Next I will introduce the alternative theory that there is actually no difference in the ability of girls and boys in general. I will explain clearly to them that our beliefs and expectations affect the way we perform and what we choose to do, etc.

We will use multiple sources for our data—guest speakers (doctors, etc.), SAT national averages, IQ scores. We will hold our own experiments where students collect data themselves—IQ scores, aptitude tests. I will also use any factors listed as prior reasons as variables, as well. Existing data on occupations, etc. will also be presented. The student swill agree in advance how much difference they will need to see before they are convinced either way.

We discuss the implications and reason for the data. I ask questions to get them to think about the data, their previous belief and if they think it should be changed.

MY ANSWER:

A. Foster a general commitment to making beliefs consistent with evidence. This is done in the first lesson. However, it is important that this not be done only once. It must be done repeatedly throughout the school year if students are to become more open-minded.

B. Teach students about the principles of reasoning that they need to know to evaluate evidence properly. This is accomplished in the first part of the second lesson (discussions about research methods), as well as a little bit of the first lesson (when the class discusses the importance of the method of data collection, etc.). I would not expect that half a lesson or so would be enough. Teaching students about principles of gathering and interpreting evidence must occur repeatedly throughout the school year.

C. Present a clear explanation of a plausible alternative theory. This is alluded to in the last sentences of paragraph 2. I would like to see more information to judge whether the alternative theory is actually clearly presented (how about a clear diagram or explanation?) and plausible.

D. Provide lots of convincing evidence. Multiple sources of data are used. This seems good. It's hard to judge, though, whether the evidence is credible and ambiguous without seeing more of the details of the evidence.

E. Promote deep processing. This is achieved through class discussions.

This is a promising start, but more detail is needed. The lesson plan should also mentioned that (A) and (B) are emphasized throughout the course, not just in this one set of lessons.

CHAPTER 12d
Teaching Concepts

When students lack prior knowledge of central concepts, they will have a great deal of trouble understanding new material that requires those concepts. If key concepts in early lessons in the year are taught in a way that many students do not understand these concepts, their understanding of later lessons that employ these concepts will be seriously hindered. This lack of understanding will lead to a lower expectation of success and lower motivation as well as lower achievement.

This chapter gives you ideas about how to address these problems by teaching concepts to students in a way that makes the concepts highly understandable. This method has been developed by researchers including Merrill and Tennyson (1977) and Tennyson and Cocchiarella (1986); the method has been tested successfully in many studies.

A. Preliminary Ideas and Terminology

Before presenting the concept-teaching method, there are some terms that you need to know.

What kind of concept can be taught? A useful way of deciding what concepts can be taught is to think of a teachable concept as a NOUN. You can teach concepts such as CIRCLE, DEMOCRACY, DECLARATIVE SENTENCE, PUNISHMENT, ANXIETY, PRIME NUMBER, DECIDUOUS TREE, and so on. You CANNOT teach procedures such as HOW TO FIND THE AREA OF A CIRCLE with a concept lesson. You can teach the concept of CIRCLE using a concept lesson, but you cannot teach the procedure for finding the area of a circle.

Related concepts. Related concepts are sets of two or more concepts that should be learned together. For example, an English teacher might want to teach different meters (trochaic, iambic, dactylic, and anapestic) together. Similarly, when teaching principles of behaviorism, it makes sense to teach positive reinforcement, negative reinforcement, and punishment at the same time. Related concepts occur when there is a family of kindred concepts.

Single concepts. Single concepts are concepts that do not need to be taught together but can be taught individually, one by one. For example, the concept of cell can be taught individually; there are not any related concepts that need to be taught at the same time.

Constant attributes. Constant attributes are features of a concept that are common to all instances of the concept, or at least to almost all instances. Examples: A constant attribute of the concept UNCLE is that a person's uncle is the brother of the person's mother or father. A constant attribute of the concept REPRESENTATIVE DEMOCRACY is that citizens are free to vote for representatives who choose laws. A constant attribute of the concept EQUILATERAL TRIANGLE is that there are three sides of equal length.

Variable attributes. Variable attributes are features of a concept that are shared by some but not all instances of a concept. Examples: A variable attribute of the concept UNCLE is that an uncle has a beard (some do; some don't). A variable attribute of the concept REPRESENTATIVE DEMOCRACY is the proportion of inhabitants who can vote. In some democracies, any adult can vote; in others, only property owners may be able to vote. A variable attribute of the concept EQUILATERAL TRIANGLE is the color of the lines--the lines may be red or blue; it doesn't matter.

Best examples. Best examples are simple examples that clearly present the key features of the concept.

Expository examples. Expository examples are matched pairs of examples and nonexamples from successive concepts (and matched sets of concepts for coordinate concepts). The expository examples explain to students explain the attributes to students so that students understand why the different instances are categorized differently.

Example: $2x^2 + 3x + 5 = 0$. This equation has an x^2 term, and it is an equality, so it is a quadratic equation.

$2x + 3x + 5 = 0$. Although this equation is an equality, it has no x^2 term, so it is not a quadratic equation.

Interrogatory examples. Interrogatory examples are examples in which students are asked about each constant attribute and then asked to classify the example.

Example:	$2x^2 + 3x + 5 = 0$.	1. Is the equation an equality?	YES	NO
		2. Does the equation have an x^2 term?	YES	NO
		Is it a quadratic equation?		YES
NO				
	$2x + 3x + 5 = 0$.	1. Is the equation an equality?	YES	NO
		2. Does the equation have an x^2 term?	YES	NO
		Is it a quadratic equation?		YES
NO				

Interrogatory examples should gradually include some complex examples that are not so easily classified.

Practice examples. These are examples that the student classifies (without the interrogatory questions shown above). The student is given feedback after each classification.

B. Designing a Concept Lesson

Here are the key steps in designing a concept lesson.

1. Decide if a concept lesson is needed.

You need a concept lesson in any of these situations:

a. if the material involves new terms that you want the learner to understand, know how to use, or know the meaning of (e.g., mitosis, acid, sonnet, cubism, political neutrality, equilateral triangle).

b. if you want the learner to learn a definition

c. if you are teaching a rule. Rules typically employ concepts, and students need to know each concept. For instance, if you are teaching the rule for calculating the area of a triangle, you need to teach the concepts base and altitude and possibly even one-half and times.

d. if the material requires students to learn parts, such as the parts of a cell. You may need a separate concept lesson on each part.

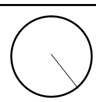
2a. For related concepts, use the following steps:

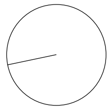
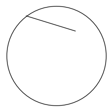
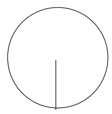
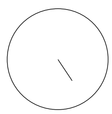
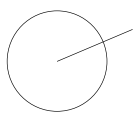
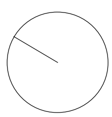
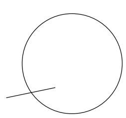
a. Present labels and definitions.
b. Present the best examples of each concept.
c. Present expository examples in matched sets.
d. Present interrogatory examples and give feedback after each example.
e. Give practice examples and give feedback after each one.
f. Test students' performance by having them classify new examples.

2b. For single concepts, use the following steps:

a. Present labels and definitions.
b. Present the best example of the concept.
c. Present expository examples/nonexamples in matched sets.
d. Present interrogatory examples/nonexamples and give feedback after each example.
e. Give practice examples/nonexamples and give feedback after each one.
f. Test students' performance by having them classify new examples.

To illustrate, here is an example of instruction of a single concept. Here is an example of a concept lesson to teach the concept of a RADIUS of a circle.

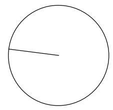
Step	Example
a. Present label and definition.	The radius of a circle is a line segment from the center of the circle to the edge of the circle.
b. Present the best example of the concept.	 The line from the center of the circle to the edge of the circle is the radius.

c. Present expository examples/non-examples in matched sets.	 Here is an example of a radius.
	 This is not a radius, because the line does not start at the center, although it does go to the edge.
	 Here is another example of a radius. The line starts at the center and goes to the edge.
	 This is not a radius, because although the line starts at the center, it does not go to the edge.
	 This is not a radius either, because this line goes past the edge, even though it starts at the center.
	 Here is one more example of a radius.
	 This is not a radius, because the line does not start at the center, and it doesn't end at the edge.

d. Present interrogatory examples/non examples and give feedback after each example.

As you answer the questions, cover up the answer to each problem until you finish the problem. Then you can check the answers.

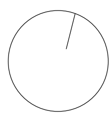
1. Look at this picture.



a. Does the line start at the center of the circle? YES NO
b. Does the line end right at the edge of the circle? YES NO
c. Is the line a radius? YES NO

Answers:
a. YES. It starts at the center.
b. YES. It ends at the edge of the circle.
c. YES. Because the line starts at the center and ends at the edge, the line is a radius.

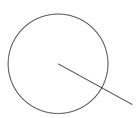
2.



a. Does the line start at the center of the circle? YES NO
b. Does the line end right at the edge of the circle? YES NO
c. Is the line a radius? YES NO

Answers:
a. NO. It does not start at the center. It is a little bit off of the center.
b. YES. It ends at the edge of the circle.
c. NO. Because the line does not start at the center, the line is a not radius.

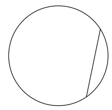
3.



a. Does the line start at the center of the circle? YES NO
b. Does the line end right at the edge of the circle? YES NO
c. Is the line a radius? YES NO

Answers:
a. YES. It starts at the center of the circle.
b. NO. It goes past the edge of the circle.
c. NO. Because the line does not end at the edge of the circle, the line is a not radius.

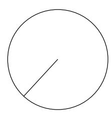
4.



a. Does the line start at the center of the circle? YES NO
b. Does the line end right at the edge of the circle? YES NO
c. Is the line a radius? YES NO

Answers:
a. NO. It does not start at the center. It starts at the edge of the circle.
b. YES. It ends at the edge of the circle.
c. NO. Because the line does not start at the center, the line is a not radius.

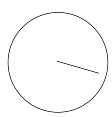
5.



a. Does the line start at the center of the circle? YES NO
b. Does the line end right at the edge of the circle? YES NO
c. Is the line a radius? YES NO

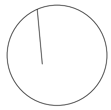
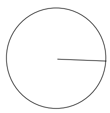
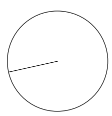
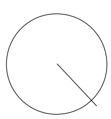
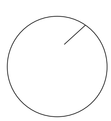
Answers:
a. YES. It starts at the center.
b. YES. It ends at the edge of the circle.
c. YES. Because the line starts at the center and ends at the edge, the line is a radius.

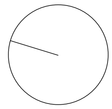
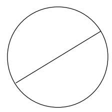
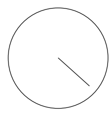
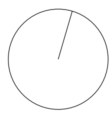
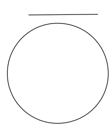
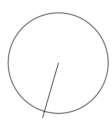
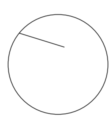
6.



a. Does the line start at the center of the circle? YES NO
b. Does the line end right at the edge of the circle? YES NO
c. Is the line a radius? YES NO

Answers:
a. YES. It starts at the center.
b. NO. It stops before it gets to the edge of the circle.
c. NO. Because the line does not end at the edge of the circle, the line is a not radius.

e. Give practice examples / nonexamples and give feedback after each one.	As you classify these items, cover up the answers so that you don't check each answer until after you've solved the problem. 1.  Is the line a radius? YES NO It is not a radius because the line does not start at the center. 2.  Is the line a radius? YES NO It is a radius because the line starts at the center of the circle and ends at the edge of the circle. 3.  Is the line a radius? YES NO It is a radius because the line starts at the center of the circle and ends at the edge of the circle. 4.  Is the line a radius? YES NO It is not a radius because the line does not end at the edge. It goes past the edge. 5.  Is the line a radius? YES NO It is not a radius because the line does not start at the center.

f. Test students' performance by having them classify new examples.	For each item, decide if the line is a radius.
	1.  YES NO
	2.  YES NO
	3.  YES NO
	4.  YES NO
	5.  YES NO
	6.  YES NO
	7.  YES NO

A final puzzle from this lesson. There is one respect in which the examples in this concept lesson are inadequate. Can you think what is wrong with the examples? (The answer is on the next page.)

Answer to question on previous page: The circles are all the same size. It would be better if they were a variety of sizes, so that students don't get the mistaken idea that only circles of about this size have radii.

CHAPTER 12e
Teaching Complex Ideas

A. Activating Prior Knowledge

A powerful way to improve learning is simply to get students to activate their old knowledge before they begin learning the new knowledge. Most of these studies have focused on learning from text. For example, many studies of how students learn from text have showed that getting students to reflect on what know about a topic before they starting reading new information about that topic helps them learn much more than if they do not activate their old knowledge.

In classrooms, one effective way of activating old knowledge is to hold a class discussion in which students share what they know about a topic before learning new information about that topic. In some studies, teachers write down students ideas on the board in the form of a concept map (see a later section of this supplementary reading for more information about concept maps). When students' ideas are expressed and written down in this way, they learn more from reading a text than they do if they read the text without the discussion.

Other ways of activating prior knowledge include providing students advance outlines of the idea they will be reading and learning about and providing written questions designed to get students thinking about relevant knowledge that they already have.

There is one important caveat about activating old knowledge. When the new information contradicts the old knowledge, it may be better not to activate prior knowledge. In a study by Donna Alvermann and her colleagues, sixth graders read about a series of four scientific topics. Some topics were consistent with their prior knowledge. For example, one passage provided information about rattlesnakes. Although the information was new to most students, it did not conflict with any of their basic knowledge of reptiles, snakes, or rattlesnakes. Other topics were inconsistent with students' prior knowledge. For example, one passage that discussed characteristics of light that were at odds with most students' understanding of light. The results were that on passages that were consistent with prior knowledge, activating knowledge improved learning. However, on passages that were inconsistent with prior knowledge, activating knowledge actually impeded learning.

B. Teaching Cognitive Strategies

A second set of techniques for improving learning focuses on cognitive strategies. If students use effective learning strategies, they learn more.

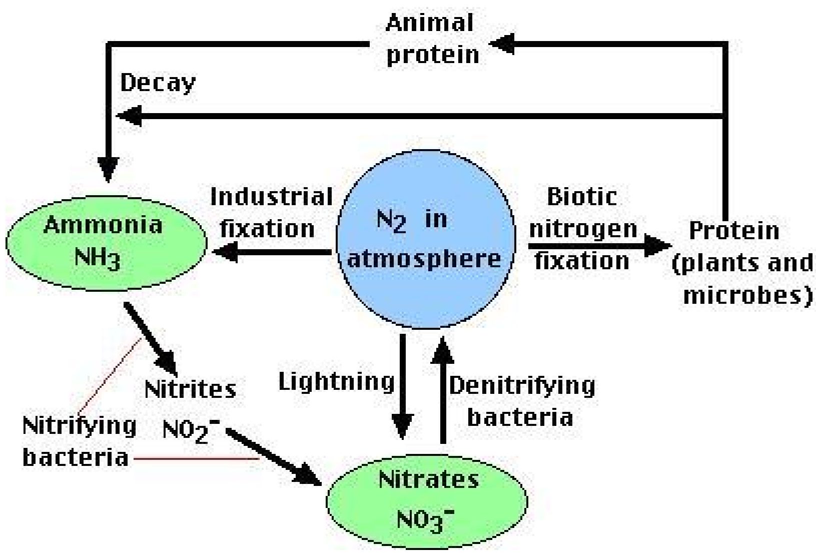
You have already learned about several effective cognitive strategies for memory. These include outlining, summarizing, classifying material, explaining ideas, elaborating ideas, comparing and contrasting, using the keyword method, and so on. These are all the techniques for getting information from STM to LTM.

You will learn about research that provides guidance on how to teach cognitive strategies in a later chapter.

C. Presenting Conceptual Models

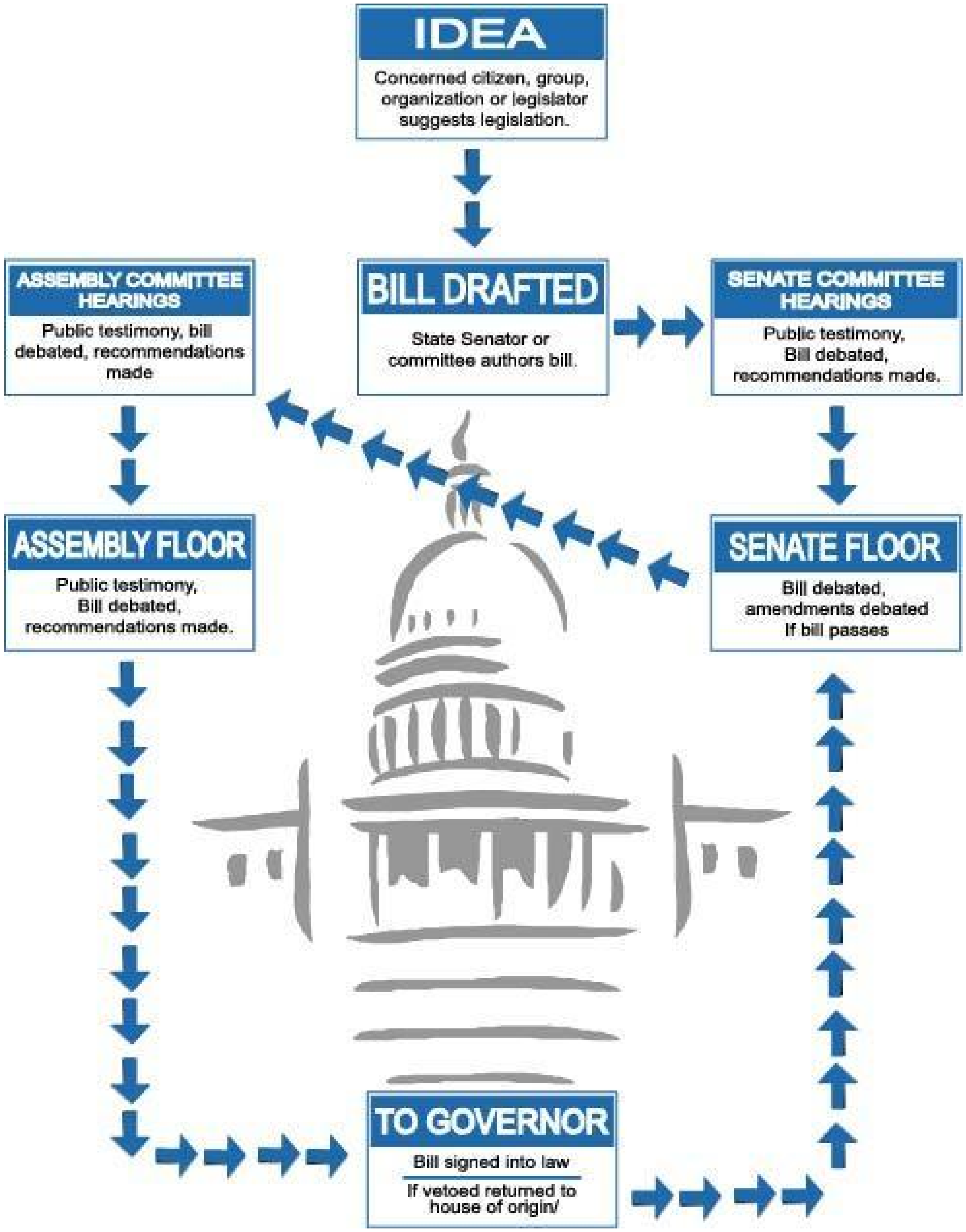
A conceptual model is a diagram that summarizes the important information in a text. Here are two examples of conceptual models, found on the internet.

This conceptual model presents the nitrogen cycle.



(from http://www.ultranet.com/~jkimball/BiologyPages/N/NitrogenCycle.html)

This conceptual model shows how a bill becomes state law in Wisconsin (from http://www.legis.state.wi.us/senate/sen18/news/_borders/how_bill_becomes_law.jpg).



The research on conceptual models can be thought as falling into several “rounds” of research.

1. The first round of research on conceptual models contrasted these two situations:

conceptual models alongside original texts	**versus**	**original texts only**

An example of this kind of model would be the nitrogen cycle model that you see
For example, in one study, half of the subjects read an encyclopedia passage on brakes. The other half of the subjects read the same passage but <u>also</u> received a conceptual model showing how brakes work. (I will show you this model in class.) Students who received the encyclopedia text plus the conceptual model were better at remembering key explanatory information, and they were also better at answering problem-solving questions such as these:
--Why do brakes get hot?
--What could be done to make brakes more reliable, that is, to make sure they would not fail?
--What could be done to make brakes more effective, that is, to reduce the distance needed to bring the car to a stop?
--Suppose you press on the brake pedal in your car but the brakes don’t work. What could have gone wrong?
--What happens when you pump the brakes (i.e., press the pedal and release the pedal repeatedly and rapidly)?

So the first round of research established that adding conceptual models to texts is helpful.

2. A second round of research on conceptual models contrasted these two situations:

conceptual models with text integrated into the models	**versus**	**conceptual models with the text written at the side**

An example of a conceptual models with text integrated into the model is the model of how a bill becomes law in Wisconsin. All of the key information is written in sentence form right onto the diagram. You need not read anything else to understand the diagram. An example of a conceptual model with the text written at the side would be the same diagram with all the text moved off in paragraphs to the side instead of being placed within the diagram.

This round of research consistently found that conceptual models with text integrated into the models were more effective at promoting understanding and ability to answer problem solving questions than the same models with the text written in paragraphs at the side. So—conceptual models are good, and they are even better when the text is put right on the model instead of at the side of the model.

3. A third round of research on conceptual models contrasted these two situations:

conceptual models with text integrated into the models	**versus**	**conceptual models with the text integrated into the models PLUS an additional text at the side**

For example, a hypothetical study might have students in one condition read only the diagram of how a Wisconsin bill becomes law. In a second condition, students would receive the exact same diagram, but they would also read some additional text at the side of the diagram explaining the information in a little more detail. The question is whether it is better to learn by studying only the diagram, or is it better to have the diagram plus some additional elaborative text.

This round of research found that it was better not to have the additional text. The conceptual model with text integrated into the model by itself was more effective at promoting understanding and ability to answer problem solving questions. So—conceptual models alone (with text written on the models) are enough to promote learning.

Research by Richard Mayer, John Sweller, and others shows conceptual models are most effective when they have the following characteristics. You will see examples of conceptual models with these characteristics in class.

--Effective conceptual models organize ideas in a clear, step by step fashion.
--Effective conceptual models provide all the crucial information necessary for understanding.
--Effective conceptual models provide thorough explanations.
--Effective conceptual models integrate graphics or drawings with the text. There is no separate text.

D. Presenting Understandable Explanations

In most real-world situations, people need to learn knowledge that does not neatly fit into an already-existing schema, and it may be too complex to fit neatly into a conceptual model. The question is: How do people learn such knowledge. For example, how does a fifth grader who knows nothing about the American Revolution build up a body of knowledge about the American Revolution?

Clear, understandable explanations are one important way in which these ideas are learned. In this section, I will summarize some of the main findings about presenting understandable explanations to students. Most of the relevant research is based on research on revising texts to make them more understandable. Although I think it is reasoable to think that most or all of these ideas are generalizable to oral explanations, there is less research on learning from oral explanations.

D1. How to Make Text Explanations More Understandable

The following table points out some problems with most texts and how to resolve them. The first three are undoubtedly the most important, but after that, the issues are presented in no particular order.

Issue	Problem with existing texts	Solution
Students' incomplete prior knowledge.	**The text assumes that students know a lot more than they really know. The texts have lots of informational gaps that students can't fill in.**	**Use highly explicit explanations, following the examples in your outline. (You have 2 history examples and two science examples.) The key is to anticipate what background knowledge students have and then present information that will help fill in the gaps in their background knowledge.**
Students' contradictory prior knowledge.	**The text does not take into account the fact that students' knowledge contradicts what is in the text.**	**When new ideas contradict old ideas, present information that clearly states which old ideas students have that are incorrect.**
Excessive abstraction	**The text is all abstract and lacks concrete examples.**	**Give lots of concrete examples.**

Organization	The ideas are not organized in a logical manner. They jump around. For instance, a text may jump around from one time period to another.	In social studies texts, present clear statements of goals and motivations, actions, and outcomes. Present events sequentially in chronological order.
Headings	The headings are nonexistent, confusing, or haphazard.	Use clear, logical headings.
Signal words	The text doesn't clearly signal the relationships between one sentence and another, and between one paragraph and another.	Use clear signal words, such as: then, after that, because of that, as a result, the consequence was . . ., first, second, third, and so on.
Confusing sentences	The text's sentences are so convoluted that students have a hard time understanding them.	Use clear sentence structure.
Overloaded sentences.	Each sentence is jam packed with information.	Present different information in different sentences.
Extraneous details	The text has extraneous details that don't have much to do with the main point.	Make sure that all the information presented is integral to the overall main ideas.
Vocabulary	The vocabulary used is too difficult.	Control the vocabulary (but not excessively—you want to give students a chance to learn new words, too).
Pronouns	It's hard to figure out what pronouns refer to.	Use pronouns only when it is clear what the pronouns refer to.

One interesting and important point about extraneous details: Lots of texts insert neat little facts about something or other in order to make the text more interesting to students. For instance, a science text might have a few sentences about the Curies in the chapter on radioactivity, or a history text might have a box at the side with some interesting tidbits of information about a particular battle. Many research studies have now resoundingly reached the same conclusion: <u>These interesting but only tangentially related details detract from understanding and remembering the main points of the text.</u> If you apply this point to your own oral explanations, you can see that the teacher who goes off on interesting tangents is actually decreasing student recall of the main points! The same is true for humor that is not central to the main point. (The research on humor that is central to the main point has yielded conflicting results.)

D2. Examples of Making Text Explanations More Understandable

In this section, I will provide two detailed examples of how to make explanations more understandable. Both examples strongly emphasize the following ideas:

1. Traditional texts are poor because they assume that students' have more background knowledge than they do, or because they do not address possible misconceptions that students have.

2. As a corollary, traditional texts are written in a very sketchy way that fails to address gaps in students' background knowledge or any discrepancies between their prior knowledge and the new information.

Example #1. Improving historical explanations

Beck et al. (1991) rewrote a textbook passage on the Revolutionary War. Their revision was much better at promoting learning by elementary school students than the original text was. The table below shows the original text, the revision, and the rationale for the revision.

Original Text, Sentence by Sentence	Revised Text	Rationale for revisions provided by Beck, McKeown, Sinatra, & Loxterman (1991)
In 1763 Britain and the colonies ended a 7-year-war with the French and Indians.	About 250 years ago, Britain and France both claimed to own some of the same land, here, in North American. This land was just west of where the 13 colonies were. In 1756, Britain and France went to war to see who would get control of this land. Because the 13 American colonies belonged to Britain, the colonists fought on the same side as Britain. Many Indians fought on the same side as France. Because we were fighting against the French and Indians, the war has come to be known as the French and Indian War. The war ended in 1763.	Two problems with the original: It begins at the end of the war instead of the beginning. And it is too dense in the information it contains. (Highly dense sentences are harder to understand.) The first sentence contains 5 different ideas: --there was a French and Indian war. --the war lasted 7 years --the war ended in 1763 --the British and their American colonists fought together on one side --the French and the Indians fought on the other side Too much information is implicit. Also, there is no elaboration that lets readers connect the ideas to background knowledge. Students might not know why Britain and the colonies would fight on the same side, why Britain and France were fighting at all, why the French and Indians were on the same side. The revision included all of this information. The revision stays in chronological order and tries to give needed background information. It omits an explanation of why the French and Indians sided together because the explanation is too complex. Such an explanation would be a distraction and get in the way of comprehension. The first sentence in the revision activates a "conflict schema." The first sentence in the original seems to set the reader up to hear about the winner but instead talks about the loser.
As a result of this war France was driven out of North America. Britain would now rule Canada and other lands that had belonged to France.	Britain won the war. Now Britain had control of North America, including Canada. The French had to leave North America.	The sentence "Britain won the war" fills an important slot in the conflict schema: "a winner." Once students learn who won, they are told what was gained from winning, another important slot in the conflict schema. The sentence about France is more familiar.

This brought peace to the American colonies. The colonists no longer had to fear attacks from Canada.	The colonists were very glad that Britain had won. They now felt safer in their homes. Before the war, Indians had often attacked colonists who lived near the borders. Now Britain owned these lands where the Indians lived. The colonists were sure that Britain would protect them.	The original sentences present solutions to problems that had not yet been explained. The original text implies a contrast, but the state of nonpeace was never explicitly described. The original doesn't explain why the colonists had been afraid. In the revision, the last four sentences provide an explanation for the first sentence. "Before" and "Now" are used as explicit signals.
The Americans were happy to be part of Britain in 1963. Yet a dozen years later, these same people would be fighting the British for independence, or freedom from Great Britain's rule.	The colonists were happy to be a part of Britain, but that was about to change. They began to decide that they would rather have their own country, independent from Britain.	Again the original does not explain the relationship between key pieces of information. The original text does not explain at all what motivated the fight for independence: the desire to have their own country. This sentence provides a context that helps readers understand the next sentences.
This war was called the War for Independence, or the American Revolution. A revolution changes one type of government or way of thinking and replaces it with another.	So a dozen years later, the colonists would be fighting the British for freedom from Great Britain's rule. This later war would be called the War for Independence, or the American Revolution.	The word "so" in the revision is another explicit signal word, to help relate the motivation in the previous sentence to the event of fighting. The references are clearer too. The revision clearly states that it was the colonists who were fighting, instead of "these same people," which appeared in the original; students might have a hard time figuring out which people are being talked about. Overall, the revision uses more signal words. It avoids unclear pronouns. It provided lots of background information. It presented information more in chronological order (but not completely). It explicitly aimed to activate a conflict schema and systematically fill one slot at a time.

Notice that in making the revision, the researchers were concerned with issues of clear structure, coherence, and so on. But they were most of all concerned about addressing gaps in students' prior knowledge.

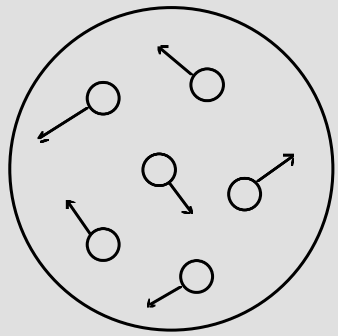
<u>Example #2.</u>

Here is a textbook passage that explains liquids to middle-school students. Obviously, it is so sketchy that students are bound to misinterpret it.

> Liquids
>
> A liquid does not have a definite shape, but it does have a definite volume. So a liquid flows and takes the shape of its container. However, like solids, liquids can't normally be squeezed to a smaller volume. If you push down on a quart of water with a moderate amount of force, its volume will remain a quart. The molecule theory explains the properties of liquids. Because a liquid can't be squeezed, its molecules must be very close together, like those of a solid.

Because its molecules are held very close together, almost as close as those of a solid, liquid matter does have a definite volume. If you pour 1 quart of orange juice into a 2-quart bottle, it will not spread out to fill the bottle. Likewise, you couldn't force the quart of juice into a half-quart container.

You can pour water because the molecules have enough speed to vibrate over and around each other. This movement of molecules lets a liquid flow and take the shape of its container. Thus, orange juice poured into a glass will take the shape of the glass.

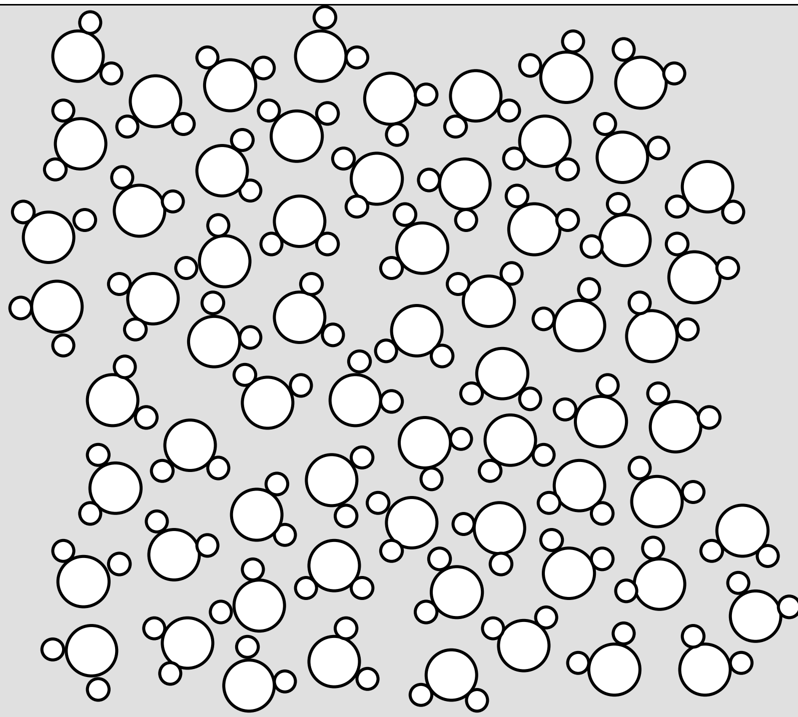


This text is problematic because it fails to explain many things about molecules and how they interact to create properties that you can observe.

Here is a revised text, with detailed, highly explicit explanations. This text produces dramatically greater student learning. All of the new ideas were designed to address gaps in students' prior knowledge as well as possible misconceptions about matter that they might have. Students who have been successful in high school and college chemistry courses have read texts like these and then told me that they wish that they had read this before taking their chemistry courses, because it makes everything so much more easily understood.

Liquids

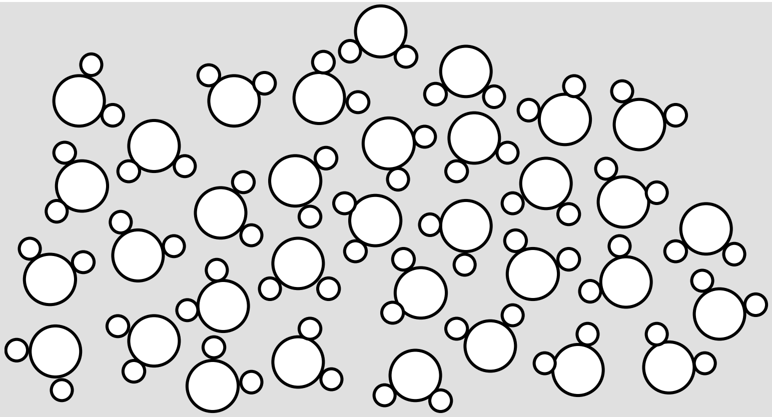
All liquids are made of molecules. We'll use water as an example. Here is a picture of what some water molecules look like:



You know that water feels wet and soft. You might think that each molecule is wet and soft, too. But that is not true. Each molecule of water acts as if it was quite hard and dry. Molecules bump into each other and slide past each other as if they were very hard.

Why does water feel wet and soft when each molecule is hard and dry? The answer is that the water molecules are so very very small. When you touch water, you are touching billions and billions of molecules all at the same time. All of these billions of molecules together feel wet and soft. But if you could become incredibly small, almost as small as a water molecule, you would see that each individual molecule is hard and dry.

Think about a bowl of bird seed. Bird seeds are very very small. You can stir a bowl of birdseed and pour it. You can easily move your finger around in the bowl of seeds, and all the seeds together feel smooth and soft as you move your finger. Each seed by itself is hard. If you touch one seed by itself, it feels hard. But thousands of seeds together feel very different. When you stir water with your finger, it is the same thing. You are feeling billions of molecules at the same time. All together, they feel soft and wet and smooth. Each one alone, though, would feel hard, if you were small enough to feel it.



The molecules of water are always moving. The molecules in the water are moving all around, and they never stop moving. They are always sliding past and bumping into each other.

Except for when they bump against each other, the water molecules do not touch each other. There is nothing at all between the water molecules, just empty space. There is no air. There is no water. There is just absolutely nothing. It might seem strange to you that there could be lots of empty space in water. But of course, we can't see the spaces because they are so very very small.

You know that water stays together. A drop of water doesn't suddenly, all by itself, fly apart and break into lots of littler drops. Water, like other liquids, stays together because there are weak electrical attractions between the molecules. The weak attraction is like an extremely weak magnet, much weaker than the magnets we use every day. As the water molecules constantly move around, they form temporary electrical attractions to each other. Each molecule makes and breaks many different electrical attractions every second as it moves around. The molecules are like very very weak magnets that keep moving around all the time.

So scientists are saying that every liquid you've ever seen is made of molecules--water, soda pop, lemonade, melted butter, rubbing alcohol, melted steel, motor oil, cooking oil, and so on. All of these liquids are made of little tiny molecules moving all around with empty space between them. It may seem strange, because water doesn't LOOK like it's made of tiny molecules moving all around. Neither does cooking oil or any other liquid. But scientists think that even though we can't see the molecules, all liquids are made of molecules moving all around with empty space between them.

Why can you pour water? The answer is that the water molecules have only weak attraction for each other. Since the attraction is very weak, they can always moving around all around each other and all over the place. So when you pour water, the water molecules just slide past each other in the same direction that you're pouring.

E. Instructional Skills

In this chapter, you have learned different ways to make new information more understandable to your students, by activiting prior knoweldge and teaching strategies, by presenting general schemas, and by developing conceputal models and clearer explanations.

Regardless of which methods you use, the crucial thing to remember is that all efforts to make information more understandable must begin with an analysis of students' current knowledge. In general, you should always follow these steps in this order:

Step 1. Determine where students may have gaps in background knowledge.

Step 2. Determine where students' background knowledge may conflict with the new information.

Step 3. Outline an explanation (or conceptual model, etc.) that will address the gaps and conflicts.

CHAPTER 14
Learning Environments that Promote Self-Regulated Learning

Chapter Outline	Applied goals
Reflecting on Students' Thinking **Goals When Promoting Self-Regulated Learning** **Features of Effective Strategy Instruction** Multiple Strategies Embedded within Regular Instruction Explaining What the Strategy Is, How to Use It, Why It Is Useful, and When It Can Be Used Teachers modeling strategies Extensive, Varied Practice Students Making Thinking Visible Goal Setting and Evaluation Scaffolding Strategy Use and Fading Scaffolding Over Time Incorporating Effective Motivational Techniques **Learning Environments that Integrate Features of Effective Strategy Instruction** Reciprocal Teaching Learning to Write: Self-Regulated Strategy Development **Chapter Summary** **Application Problems**	Design instruction to promote strategy development in your students. Develop effective explanations of strategies Provide effective teacher models. Encourage students to make their thinking visible. Provide students with appropriate hints. Develop appropriate scaffolds Evaluate teaching by teachers who are trying to promote strategy development.

Reflecting on Students' Thinking

Two sixth-grade teachers have been working to teach their students to summarize textbook passages that they are reading. Emily Thompson, the first teacher, has had only fair success. Many of her students are still struggling to generate good summaries. Ruth Brooks, the second teacher, has been very successful; all of her students have shown very strong improvement in summarization and are summarizing very well.

The six short dialogs below show Emily and Ruth interacting with students in their classes. Analyze what the two teachers and their students say. How do the two teachers' questions and statements differ? How do the two teachers' students differ in what they say? How can these differences explain why Ruth's students are learning to summarize more effectively?

Dialogues in Emily Thompson's class:

A. Emily is leading a class discussion about a text on global warming.

Teacher: Would you summarize these three paragraphs for us? Jenny?

Jenny: Um… I'd say…it's saying that global warming is going to be hard to solve, because it's easy for countries to be selfish and hope that other countries will solve the problem.

Teacher: That's a good summary. Jacob, would you do the next section?

Jacob: It's about global warming, too. About actions on global warming.

Teacher: That's a very good start. But we should be a little more specific. How about this: We can address global warming by cutting down on various emissions of carbon dioxide. Can you see why that is a little clearer?

Jacob: Yeah.

B. Emily is working individually with another student, Amanda, as she summarizes a newspaper article she has read.

Teacher: What is your summary for this article?

Yulissa: The school district is facing a big budget problem, and they may even have to stop hiring new teachers. They can also save money by cutting out extra activities like sports.

Teacher: Very good! That's a really good summary of this article.

Dialogues in Ruth Brooks's class:

C. From a class discussion about a text on global warming.

Teacher: Let's summarize these three paragraphs. Everyone think about it for a minute…..

Teacher: Amanda, what is your summary?

Amanda: Maybe…. Global warming is a hard problem because every country is motivated to be selfish.

Teacher: How did you come up with that summary?

Amanda: Well….the first sentence was kind of like a topic sentence for the first paragraph. It said that global warming will be hard to solve.

Teacher: You also said that countries will be motivated to be selfish. Why is that part of the summary?

Amanda: It's because it listed several examples of how countries have been selfish. It seemed like all together, it was saying generally that they were selfish.

Teacher: OK—that's a good reason. You used a topic sentence for part of your summary, and you generalized from several examples to get another part of your summary.

B. Ruth is working individually with a student on an assignment in which the students are summarizing a newspaper article they have chosen.

Teacher: How have you summarized this one?

Alex: This is about our school. It says that principal is planning after-school programs to help students do better on the tests.

Teacher: Tell me how you came up with that as a summary.

Alex: It starts by saying that the school needs to do better on its state test scores. That's what the first paragraph is about.

Teacher: Why did you decide not to include that in your summary?

Alex:	Because …. Hmmm. Maybe that *is* important to include. Because it makes sense to say what the problem is, and then what the principal is doing about it. ….

In this Reflection, we see two teachers endeavoring to teach students the strategy of summarizing texts. Both teachers devote class discussion time to try to help students learn to summarize effectively. Both give assignments focused on summarization and work with students to try to help them summarize better. But Ruth is much more effective than Emily because she employs many principles of effective strategy instruction.

- Ruth asks students to explain how they came up with their summaries. Emily, in contrast, seldom asks such questions.
- Ruth tries to avoid telling students directly what to include in and exclude from their summaries. Instead, she gives hints to help them decide what to include and exclude (e.g., "Why did you decide not to include that in your summary?"). In contrast, when Emily's students initial attempts at summarizing are not right, Emily tells them directly what they should include or exclude (e.g., "I would add that it's because gas prices have risen and so it costs more.")

In asking the questions she asks, Ruth aims to have students think about *how* to generate a summary—that is, *how to decide what to include in and exclude from their summaries*. Emily's questions ask students to tell her what their final summaries are, but they do not direct students to think about how they have generated their summaries.

In Chapter 7, we discussed the importance of self-regulated learning and the strategies that students need to learn to become self-regulated learners. In this chapter, we will learn about designing learning environments that are effective in helping students learn these strategies. Along the way, we will learn more about why Ruth's instruction is more effective than Emily's. We will also learn about other effective instructional techniques.

GOALS WHEN PROMOTING SELF-REGULATED LEARNING

Throughout this textbook, we have repeatedly noted the importance of helping students become self-regulated learners (Schunk, 2005a, 2005b; Souvignier & Mokhlesgerami, 2006; Winne, 2005). Self-regulated learners are capable of using strategies to perform well on their own, without a teacher or instructional materials to aid them. In chapter 7, we discussed five general types of strategies that self-regulated learners know: general-purpose strategies, comprehension strategies, writing strategies, problem-solving strategies, and reasoning strategies. Self-regulated learners learn more, write more effectively, solve problems better, and reason more accurately (Azevedo & Cromley, 2004; Chinn, in press-a; C. Glaser & Brunstein, 2007).

To become self-regulated learners, students must gain the following types of knowledge and dispositions (Kuhn, Katz, & Dean, 2004):

1. They learn how to use a broad range of strategies. Self-regulated learners know how to use strategies that are needed to succeed at academic and real-world tasks. Self-regulated readers know how to use valuable strategies such as summarizing what they are reading, elaborating on what they are reading, using text structure, and monitoring their understanding. Self-regulated writers can generate and organize their ideas while planning what they are writing; they can revise their ideas effectively. These are the strategies that are needed to be successful, so self-regulated learners need to learn them.

2. They develop metacognitive understanding of the strategies they use. Effective self-regulated learners know more than just how to use effective strategies. They know what these strategies are used for, and when they are useful. They can say to themselves, "Summarization is a useful strategy for most of my classes, but Professor Smith asks about a lot of details on his exams, and summarization is not useful for learning details. So I had better use a different strategy such as detailed outlining and elaboration." As learners reflect on their strategy use, they can refine their strategies and use them more effectively. The self-regulated writer who gets a B on a composition can reflect on her strategy use; she notes that if she had planned more extensively, her paper would have been better organized. She resolves to plan more extensively in the future.

3. They develop flexible control over strategies. Self-regulated learners have many different strategies at their disposal, and they use the right strategies at the right time. When strategies need to be used in a particular order, they use the strategies in the right order. They know when to use different strategies in different situations. They know when strategies are useful and when they are not. An effective self-regulated writer knows that generating ideas usually precedes trying to organize ideas, but that it is often good to go back and generate some more ideas later on in the planning process. An effective self-regulated reader summarizes the chapter she is reading before she goes back to check understanding of some of the more important details. She also knows there is no need to summarize or elaborate on the novel she is reading for fun, because she does not care if she remembers this novel or not.

4. They gain a disposition to use the strategies on their own outside of the classroom. The ultimate goal of instruction to promote self-regulated learning is to promote transfer of strategy use to real-world settings. Students must become disposed to actually use the strategies when it is useful to do so, without needed prompting from others. If students know how to plan for writing but choose not to do so unless the teacher prompts them to plan, then they are not disposed to use the strategies they have learned. In effective instruction, students become convinced that the strategies they are learning are worth the time it takes to use them because the strategies help them perform better.

In this chapter, we will examine eight features of effective instruction that promotes these instructional goals. Then we will examine in detail two learning environments that incorporate these features of effective instruction.

FEATURES OF EFFECTIVE STRATEGY INSTRUCTION

Strategy instruction is instruction that helps students learn to use strategies effectively and thus to regulate their own learning and thinking. Effective strategy instruction is a critical component of successful teaching. Highly successful schools and teachers strongly emphasize strategy instruction (Chinn, Duschl, Duncan, Pluta, Buckland et al., 2008; Gaskins, Anderson, Pressley, Cunicelli, & al., 1993; Gaskins et al., 1997; Langer, 2001; Pressley, Mohan, Raphael, & Fingeret, 2007; Pressley, Raphael, Gallagher, & DiBella, 2004; Pressley & Woloshyn, 1995). Effective strategy instruction in classrooms can substantially improve student learning and achievement (Davis, 2003; Graham, Harris, & Mason, 2005; Guthrie et al., 2004; McNeill & Krajcik, 2008; Pressley & Harris, 2006). Therefore, it is important for teachers to become skilled at providing effective strategy instruction to their students.

Educational researchers have found that effective methods of strategy instruction tend to share a common set of features. In this chapter, we discuss eight features of effective strategy instruction. If you as a teacher design learning environments that incorporate these features of effective strategy instruction, you should be highly successful in helping your students become self-regulated learners.

1. Multiple strategies are taught, and strategy instruction is embedded within instruction of content.
2. Teachers explain what the strategy is, how to use it, why it is useful, and when it can be used.
3. Teachers model use of the strategy, showing students how to use it.
4. Students have many varied opportunities to practice using the strategy.
5. Students make their thinking visible as they use the strategy, and they talk explicitly about strategy use.
6. Students set goals and evaluate whether they have attained these goals.
7. Teachers provide a variety of scaffolds and fade scaffolds over time.
8. Teachers incorporate effective motivational techniques.

Multiple Strategies Embedded within Regular Instruction

As teachers plan their curriculum for the year, when should they teach strategies? There are two broad approaches to answering this question (Pressley & Harris, 2006; Pressley & Woloshyn, 1995). One approach is to teach strategies separately from regular instructional units. Teachers offer special lessons focused on strategy instruction, and these lessons are separate from the regular topics of the class. Using this approach, a high-school history teacher might plan instruction in the following sequence:

2 days	--	Special instruction on note-taking
2 weeks	--	Unit on Explorers in the New World
3 days	--	Special instruction on summarization
3 weeks	--	Unit on Colonial American before the Revolution
1 day	--	Special instruction on elaboration
2 weeks	--	Unit on the American Revolution
2 days	--	Special instruction on outlining
2 weeks	--	Unit on the development of the Constitution

In this sequence of lessons, strategies are taught in special lessons that are separated from the regular topics of history (explorers in the New World, colonial American before the revolution, and so on).

The second broad approach to teaching strategies is to embed strategy instruction in the regular units. Strategies are taught in special lessons; strategy instruction is integrated into the regular topics covered in the class. A history teacher using this approach might plan instruction in this sequence:

3 weeks	--	Unit on Explorers in the New World. During this unit, students are introduced to note-taking and summarization. They practice note-taking during lectures the teacher gives on explorers and they practice summarization while reading the textbook chapter on the explorers. Some of the class discussions focus on the students' notes and summaries.
3 weeks	--	Unit on Colonial American before the Revolution. During this unit, students continue to discuss and practice note-taking and summarization during lectures and readings on Colonial America. Students are also introduced to the strategy of elaboration, which they practice while reading texts on Colonial America that are part of this unit. The teacher continues to discuss all the strategies with the students.
2 weeks	--	Unit on the American Revolution. Students continue to practice and discuss all the strategies they have learned so far as they read these texts and watch a short film on the Revolution.
2 weeks	--	Unit on the development of the Constitution. Students continue to practice and discuss the strategies learned so far, and the teacher also introduces a new strategy of outlining, which students practice on the current textbook chapter.

This history teacher is focusing on multiple strategies at the same time, and the instruction is embedded within the regular curriculum. Students are constantly using and talking about a broad range of strategies while they study the regular topics covered in history. The teacher continues to focus on these and other taught strategies in all history units throughout the entire school year.

There is general consensus in the research community that strategy instruction is most effective when teachers use the second approach—embedding strategy instruction within the regular curriculum topics and sustaining the focus on strategies throughout all the curriculum the entire year (Graham et al., 2005; Guthrie et al., 2004; National Research Council, 2007; Pressley & Harris, 2006; Pressley & Woloshyn, 1995; Shanahan & Shanahan, 2008). When teachers emphasize strategies constantly throughout the year, students come to view strategies as a central part of learning—not as something mentioned briefly at the beginning of the year and then to be forgotten or ignored. As students keep practicing the strategies throughout the year, with teacher guidance and feedback, they will have many opportunities to attain a high level of mastery of the strategies. By emphasizing multiple strategies, teachers can encourage students to be reflective about which strategies to use in different situations. Teachers can discuss with students, for example, when it is better to summarize and when elaboration is more fruitful.

Explaining What the Strategy Is, How to Use It, Why It Is Useful, and When It Can Be Used

When teaching a new strategy, effective teachers tell students what the strategy is, how to use the strategy, why the strategy is useful, and when the strategy can be used (Duffy et al., 1986; McNeill & Krajcik, 2008; Pressley & Harris, 2006; Pressley & Woloshyn, 1995). When a student learns what the strategy is, students understand what they are learning—what the goal of instruction is. When teachers explain and demonstrate how to use the strategy, students get a head start on learning how to actually use them. When teachers explain when and why strategies are useful, students gain an awareness of when they can productively use the strategies.

Here is an example of a teacher explaining a new strategy to her fifth grade class. The strategy is inferring the meaning of new words from context (Duffy et al., 1986).

- *Explaining what the strategy is.* The teacher says, "Today we're going to learn about the strategy called, "infer the meanings of new words." When we use this strategy, we try to figure out what a word means by looking at all the words around it. We call the words around it the *context*. We're going to use the context to work out what new words mean, without having to look up the word in the dictionary." When students hear this explanation, they will understand clearly what they will be learning about, and they will have learned a label for the strategy they are learning (*inferring the meaning of new words*).
- *Explaining how to use the strategy.* The teacher explains, "When you use this strategy, you look at the sentences around the new word that you don't know. These sentences give you clues to what the word might mean. You can use these clues to make a good guess about what the word means." This explanation gives students an initial idea about how to use the strategy. They will need more instruction than just this explanation to learn how to use the strategy fluently, but this gets the students off to a good start.
- *Explaining why the strategy is useful.* The teacher explains, "Sometimes when you see a new word, you don't have a dictionary, so you can't look up the word. Then it would be good if you can infer the meaning of the word without using the dictionary. And sometimes you can figure out what the word means just from the context. Then you don't need to use a dictionary! You can learn the meanings of lots of words this way." When students hear this explanation, they gain metacognitive understanding of why it can be helpful to use the strategy. They may also be persuaded that the strategy really is a useful tool to improve their vocabulary.
- *Explaining when to use the strategy*. The teacher completes her explanation by saying, "You can infer the meanings of words in lots of different places—not only at school. Of course, you can use this strategy when you are reading books for school. But you can infer the meanings of new words when you read a magazine, or an email from your grandmother, or when you read your favorite website. You can use it when you read a billboard. You can use it when you are *listening* to things, too. If you hear a word on a TV show that you don't know, you can use this skill to try to figure out what that word means." This explanation helps students understand the broad range of situations to which they can transfer the strategy of inferring the meanings of new words. They now have metacognitive awareness of when they can use the strategy. The teacher's explanation may also help encourage students to actually use the strategy outside of school.

Teachers can help students understand what strategies are by giving examples (Gagné, Weidemann, Bell, & Anders, 1984; McNeill & Krajcik, 2008). Examples can help students see what good strategy use looks like. A fourth-grade teacher explaining what elaboration is could say, "Let's look at an example of elaboration. Suppose Crystal reads in her textbook, 'Columbus discovered America in 1492.' Crystal wants to elaborate this information, so she says to herself, 'Columbus came from Europe, so he most likely sailed west to America because the shortest way to get to Europe from Portugal is to go west.' This is a good elaboration because Crystal connected the information in the text to her own knowledge about geography."

The teacher can contrast this example of good elaboration with an example of poor elaboration. "Now suppose that Samantha reads the same sentence, 'Columbus discovered America in 1492.' Samantha says to herself, "OK, so Columbus discovered American in 1492." This is *not* elaboration because Samantha is not bringing in any new ideas. She is just repeating the text." The teacher can go on to write other examples on the board and have the students evaluate them.

Effective teachers explain strategies when they are first introduced, but teachers should keep discussing with students why they are important and when they can be used. Even after students have been working on summarization for several months, teachers can still remind them that the strategy is useful whenever they want to remember important information in any class or at home.

Problem 14.1. Evaluating Teaching. Teacher Explanations of Strategies
An elementary school teacher is explaining to students the strategy of checking whether the answer makes sense. Evaluate what the teacher says:
"When we check whether the answer makes sense, we look at the answer, and we say, "Does this answer seem about right? Is it about what we were expecting?" Checking your work is something you can do on any kind of math problem. If you're checking prices at the supermarket, you can check your work. If you're taking a math test in this class, you can check your work, too. Or you can use this strategy when you're figuring out how many pizzas you need to buy for your birthday party to make sure that everyone gets at least 2 slices of pizza.

Response: The teacher has told what the strategy is, and when it can be used. But the teacher has not explained how to do the strategy, or why it is valuable.

Teachers Modeling Strategies

Effective teachers model the strategies they are teaching (A. Collins, Brown, & Newman, 1989; Duffy, Roehler, & Herrmann, 1988; R. Friend, 2001; Graham et al., 2005; McNeill & Krajcik, 2008; Schoenfeld, 1985). Teachers **model** cognitive strategies by thinking aloud to show students how to use the strategies. In other words, teachers who model cognitive strategies to their students articulate their thought processes out loud as they demonstrate for students how to use the strategies. For example, here is a high-school social studies teacher modeling the strategies of thinking open-mindedly and thinking about counterarguments before reaching conclusions.

Teacher model	Analysis
"As we've all read, this article is trying to persuade us that the U.S. will have more influence in the world if it exercises diplomatic power rather than emphasizes military power.	
Well, I have to say, the author's arguments are pretty persuasive to me. So shall I reach the same conclusion that the author does? Well, before I do that, even though I think I agree with this author, I want to make sure I'm being open-minded here.	The teacher acknowledges her initial evaluation, but rather than jump into a conclusion, she asks herself if she is really being open-minded.
I really want to see if I can think of any good counterarguments to the author's arguments. So I want to look at her first argument—that U.S. military presence usually does more harm than good. Is that a good argument?	She now models the strategy of trying to think of counterarguments. She examines the author's first argument and starts there.
Hmmm. It seems pretty good to me. But is it? Let me think…. Can I think of any counterexamples? Are there any counter-examples from South America? No—I don't think so. I can't think of any really positive military interventions in South America.	She models the process of trying to think of counterexamples.
Panama? Well, that's a controversial military intervention. Not a clear-cut counterexample. Some people would say that was a positive military intervention; others would disagree. Anything in Africa? Not that I can think of…. Wait a minute.	She considers a possible counterexample but rejects it as controversial.
Here's a possible counterexample. The U.S. has had	She thinks of a possible counterargument and

troops in South Korea since the end of the Korean War, and there hasn't been a war between South Korea and North Korea since then. It seems to me that having 50,000 American troops in Korea might be helping to preserve peace there. So her argument is only partly right….."	elaborates on that. She concludes that this is a good counterexample.

Notice that the teacher is modeling a realistic thinking process. She is demonstrating how she *really* thinks, the actual stream of thoughts through which she uses the strategy. She demonstrates how she asks herself questions to see if she can generate a good counterexample. She demonstrates how she struggles to try to find a counterexample, thus modeling for students that it is effortful to try to think of counterexamples. She demonstrates how she searches through memory for a counterexample (South America, Panama, Africa, and then Asia) before thinking of one. She shows herself coming up with one possible counterexample and then rejecting it. These are the processes that are needed to think of counterexamples, and students should learn that thinking of counterexamples takes some time, and it requires searching memory in this way. The teacher thus models the stream of thoughts that people really engage in when they are using cognitive strategies effectively.

Modeling actual thought processes during strategy use is important so that students can understand how to really use the strategies (Chinn, 2008a; A. Collins et al., 1989). If teachers do not demonstrate the real steps that real self-regulated learners and thinkers use when using strategies, students will not learn how to actually use the strategies. Effective teacher models show not just the final products of thinking but the actual processes of thinking. For example, a good model of summarization does not just present the final summary (the final product of summarization). It shows the cognitive processes by which the teacher generated the summary (the actual process of producing the summary). Students learn how to use a strategy when they see the actual cognitive processes of using the strategy.

Below are examples of two teachers modeling summarization. The first teacher's model is unsuccessful because she shows just the final product of summarizing. The second teacher's model is successful because she models the actual cognitive processes she uses to summarize. Both teachers are summarizing the following textbook passage from a social studies textbook:

> The people of Illinois live in many different kinds of places. There are people who live in the large city of Chicago, which has a population of almost 3 million people. Another 6 million people live in the many Chicago suburbs. Over 9 million people live in the Chicago area. Smaller cities are found in the southern and western parts of the state. And in these areas, there are rural areas with many farms and smaller towns.

Teacher #1 says, "I'm going to summarize this paragraph now. I've read the paragraph, and I think that a good summary is: The people of Illinois live in many different kinds of places—Chicago, its suburbs, smaller cities, and rural areas." This teacher has shown students the final product of her thinking—her final summary. She does not actually show students how to develop a summary. A student who does not already know how to generate a summary would not be able to learn how to generate one from what the teacher said. For these reasons, the model is not effective at helping students learn to summarize.

In contrast, Teacher #2's model, shown below, explains much more about the process of generating a summary.

Teacher #2's Model	Analysis
Teacher #2: Let me try to summarize this paragraph. Let's start with the first sentence. "The people of Illinois live in many different kinds of places." Hmmm. We've talked about how the first sentence in a paragraph sometimes tells us what the paragraph is about. Is that true in this paragraph? Let's keep reading and see. Let's see if each of the sentences in this	The teacher reminds students that the first sentence sometimes tells what the paragraph is about, but she doesn't stop there. She points out that she will keep reading and see if this is true for this paragraph.

paragraph is about the different kinds of places where people live in Illinois. I'm wondering if I can just list the different places where people live in Illinois and make that my summary.

The second sentence says that many people live in Chicago. Well, that's a place, isn't it? Then it says that 6 million people live in the suburbs. That's another place. We have cities and suburbs so far. So far, we could say that people live in many kinds of places, including Chicago and its suburbs. Then the paragraph says that 9 million people live in the Chicago area. Is this a new idea? We already know that 3 million people live in Chicago, and 6 million people live in its suburbs, so that's not a new idea. I'm going to leave that out of the summary, because it's not a new idea.

Next, we read that "Smaller cities are found in the southern and western parts of the states." And then the last sentence says, "And in these areas, there are rural areas with many farms and smaller towns." OK—that's two more places, farms and small towns. So we see that this whole paragraph really *is* about the different places where people live in Illinois.

Now, what can I do with all this information? Every single sentence was about the different places people live in Illinois. Now I know that the first sentence really tells the main idea of the paragraph, so I will start my summary by repeating the first sentence: The people of Illinois live in many different kinds of places. Shall I stop there? Well, I *could* stop there, but if I added a few more words, I could tell a lot more about the different kinds of places where people live in Illinois. I could just add those words where they live. So I can make this my summary: The people of Illinois live in many different kinds of places—Chicago, its suburbs, smaller cities, small towns, and farms.

If the rest of the paragraph is all about places where people live in Illinois, the first sentence could become the summary.

She goes through the next sentences and show that these both fit the first sentence.

She explains why she thinks that the sentence about 9 million people in the Chicago area is not important—it does not state a new idea.

As she reads the rest of the paragraph, she continues the list of different places where people live.

She confirms that the whole paragraph is about where people live in Illinois.

She explains why she has decided to use the first sentence of the paragraph to start her summary.

Then she explicitly addresses a question that might be confusing to students: should they stop the summary with the first sentence, or should they add more information?

Teacher #2 models the process of generating a summary, not just the product (i.e., the final summary). She explains why she decides to include some ideas in her summary and why she excludes other ideas. This helps students who do not already know how to generate a summary learn how to do it.

When teachers model strategies, it is good to show that good thinkers sometimes stumble and flounder as they try to employ strategies. Expert thinkers often do flounder and run in to dead ends and have to start over. Strategies sometimes fail (A. Collins et al., 1989), and it is important for students to see that good self-regulated learners do not give up when strategies fail but instead try new strategies. As learning scientist Allan Collins and his colleagues explain in a classic paper, "Even experts stumble, flounder, and abandon their search for a solution until another time. Witnessing these struggles helps students realize that thrashing is neither unique to them nor a sign of incompetence."

Problem 14.2. Evaluating Teaching. Teacher modeling
A high school history teacher wants to model for students the process of evaluating the credibility of historical documents. The issue the students are considering is which side (American revolutionaries or the British) fired the first shot at Lexington Green on April 19, 1775, in the first battle of the American Revolution. Students read the following document, among several others (Wineburg, 1991):

> 19th. At 2 o'clock we began our march by wading through a very long ford to our middles; … about five miles on this side of a town called Lexington, which lay in our road, we heard there were some hundreds of people collected together intending to oppose us and stop our going on; at 5 o'clock we arrived there, and saw a number people, I believe between 200 and 300, formed in a common in the middle of the town; we still continued advancing, keeping prepared against an attack though without intending to attack them; but on our coming near them they fired one or two shots, upon which our men without any orders, rushed in upon them, fired and put them to flight; several of them were killed, we could not tell how many, because they were got behind walls and into the woods; we had a man of the 10th light Infantry wounded, nobody else hurt. We then formed on the Common, but with some difficulty, the men were so wild they could hear no orders; we waited a considerable time there and at length proceeded on our way to Concord. Entry for April 19, 1775, from the diary of Lieutenant John Barker, an officer in the British army.

Here is the teacher's model: "The first thing I do is check the source. It's a diary written on the 19th of April by a lieutenant in the British army. Is he an eyewitness? Yes. The next thing I will do is to ask if it this account is plausible. And overall, I would say that it is pretty plausible. Now I'll compare this account to the other documents we've read so far. I'd say it's pretty consistent with those documents. So overall, I would judge that this is a fairly credible source."

Response: This model describes very little of the teacher's actual thought processes, which will make it very difficult for students to understand how to use the strategy. The teacher does not explain why it's important that it's a diary rather than an official report or why it's important that he wrote it soon after the event. She doesn't explain why she thinks that this document is plausible or why it is consistent with other documents. Without any explanations, students are unlikely to be able to see how to do evaluate the credibility of sources on their own. In addition, the teacher does not model any process of struggling to reach a judgment. In fact, it is not easy to evaluate the credibility of sources, but the teacher makes it seem as if it is a trivially easy process.

Extensive, Varied Practice

In Chapter 13, we learned that one feature of learning environments that promote transfer is extensive, varied opportunities for practice. It takes a great deal of practice to learn challenging strategies, so students will need many opportunities for practice and feedback. Moreover, as we also learning in Chapter 13, transfer is most likely when practice settings are similar to settings to which transfer should occur. Thus, if we want students to transfer strategies, we should give them *many varied opportunities to practice the strategies* in situations like the situations in which we want them to use these strategies in the future (Chinn, Duschl, Duncan, Pluta, & Buckland, 2008a; Chinn & Malhotra, 2002b; Graham et al., 2005; McNeill & Krajcik, 2007; Pressley & Harris, 2006). If a high-school English teacher wants her students to use the strategy of summarizing outside of English class, she could work with her students' other teachers so that teachers are having the students summarize in all of their classes. The teachers could have students summarize newspaper and magazine articles out of class. They could have students practice summarizing movie and TV plots and TV news. By practicing summarizing in many contexts outside of English class, students become more likely to use strategies outside of their English classroom.

Students Making Thinking Visible

When students practice strategy use, it is important that they *make their thinking visible* (John D. Bransford et al., 1999; J. S. Brown et al., 1989; Duschl & Osborne, 2002; Linn, Davis, & Bell, 2004a; Ritchhart & Perkins, 2008). As we have discussed in previous chapters, **making thinking visible** refers to students speaking aloud or writing their thought processes. While using cognitive strategies, students make their thinking visible when they write or say the thought processes they are using. Teachers make their thinking visible when they provide good models of strategy use. Students should also make their thinking visible when they use strategies. This enables the teacher to evaluate how well they are using strategies and to give them any needed feedback. Students can also learn about how to use strategies from each other as they reflect on each others' visible thinking during strategy use.

Here is an illustration of a high-school student making his thinking visible as he uses the strategy of thinking about the audience when writing:

> "I want to make sure that I am considering the audience as I write this commentary on school cell phone policy. I'm hoping that my commentary will be printed in the school newspaper, so the audience is going to be the whole school—the teachers, the administration, and the students. The *main* audience is probably the administration, because I would actually like to encourage a change in the policy, but I have to be careful not to write anything that is so inflammatory that the administration will censor it. Since I want to challenge the school's current policies, I am going to have to make it really fact-based, using lots of evidence, or else the administration and teachers will just say that I'm a crazy student…..

The student does not just say that he is going to take the audience into consideration. He makes his thinking clear about who the critical audience is, and how he will have to tailor his piece to be persuasive to his critical audience. The teacher can see that the student is using the strategy well, and any classmates who have not mastered the strategy of considering the audience have profited by hearing a good example of how to implement this strategy.

When holding class discussions focused on strategies, teachers can encourage students by giving directions such as "Be sure to explain your thinking to us" or "Don't forget to make your thinking visible." They can also ask questions such as "How did you get that answer?" or "Why do think that?" Here is a teacher who uses a question like this when working with fifth-grade students on the strategy of making predictions about what will appear next in a text, a comprehension strategy that has been recommended by some researchers (e.g., van den Bos, Nakken, Nicolay, & van Houten, 2007). The students are reading a geography textbook chapter on Australia.

Transcript		Analysis
Teacher:	Damian, what do you think the text will talk about next?	The teacher prompts Damian to provide a prediction.
Damian:	I'd say the next section would talk about, like, the climate.	Damian gives a response, but without any explanation of how he thought of this response.
Teacher:	How did you come up with that idea?	The teacher prompts Damian to make his thinking visible. Damian explains his thinking, thus making his thinking visible.
Damian:	Well, it just talked about the mountains and stuff. And that's geography. And climate is usually covered as part of geography, too, and it hasn't talked about climate yet. So I think climate might be next.	
Teacher:	That's good thinking. You're thinking about what country topics have already been covered, and which haven't been covered yet. That prediction makes sense.	

Several good outcomes ensue from the teacher asking Damian to explain his prediction. First, the teacher can be sure that Damian really understands how to generate a good prediction and did not just make a lucky guess. Second, Damian has probably benefitted from actually explaining his thinking. As we have learned, explanations promote memory and understanding, so explaining his thinking will help Damian solidify his own understanding of how to make good predictions. Finally, *other* students in the class who do *not yet know* how to make good predictions will benefit from hearing Damian's explanation. When students who do not know how to generate a good prediction simply hear Damian's final prediction, without an explanation, they will not grasp how Damian thought of that prediction. But when Damian explains how he generated his prediction, they will now have a better idea of how to make predictions on their own. They may now understand that one way to make a prediction is to consider what topics have been covered, and then predict that a topic not yet covered could be next. Damian has provided a model, much like a teacher's model.

Consider now how the teacher might respond to a student who makes a poor prediction.

Transcript		Analysis
Teacher:	Before we turn the page, let's predict what the next section will be about. Briana?	The teacher again focuses on the target strategy of making predictions.
Briana:	Maybe…it'll be about koalas.	Briana makes a prediction without explaining her thinking (that is, without making her thinking visible).
Teacher:	Explain your thinking there.	The teacher asks Briana to make her thinking visible.
Briana:	I know there are koalas in Australia, and the chapter hasn't talked about them yet.	Briana explains her thinking.
Teacher:	Do you think that the authors would start right in with koalas, or would they start talking about animals first?	The teacher asks a question to encourage Briana to think about more general topics.
Briana:	[Pause] Probably, first they talk about all the animals, and give koalas as an example of animals. So maybe the next section would be about *animals*.	Briana sees what the teacher is getting at, and she revises her prediction based on the teacher's question.
Teacher:	Why do you think that animals might come next?	The teacher asks Briana to explain her thinking further.
Briana:	This section is about the land and climate, so the next section could be about plans and animals that live on the land.	Briana has now given a good explanation for a good prediction.

By asking Briana more than once to explain her thinking, the teacher gains insights into Briana's thinking that enables the teacher to decide how to give hints to Briana. (We will discuss giving hints in a later section.)

Teachers can encourage students to make their thinking visible when students are participating in class discussions, when the teacher is working individually with a student, and when the teacher is working with a group of students. Teachers can also encourage students to make thinking visible to each other when they work in groups. Teachers can instruct students that when they work in groups, they should regularly ask each other to explain their thinking (Chinn, 2006; Chinn, O'Donnell, & Jinks, 2000).

When teachers encourage students to make their thinking visible, they can encourage explicit talk about strategies. Here is a class discussion with middle-school students that shows students who are highly competent at discussing the strategies they use to understand and remember text (Gaskins et al., 1997, pp. 59-62). In this discussion, the students exhibit a high degree of metacognitive understanding of strategies.

Transcript		Analysis
Teacher:	We've discussed our content objective – to understand weather and how it affects our lives. We've done some brainstorming to activate background knowledge, and now we need to begin to gather information. What is the first thing we do to begin to our search? What do we need to know first?	Teacher explicitly mentions three strategies: setting a content objective, brainstorming, and gathering information.
Student 1:	We need to know what weather is.	
Student 2:	We need to know some of the vocabulary that goes with weather.	
Teacher:	What is the most efficient way for us to get that information? . . .	
Student 3:	We need to take notes. . . .	Students bring up the note-taking strategy they have learned in another class—thus transferring what they have learned from one class to another.
Student 4:	We could use the note-taking strategy we learned in social studies.	
Teacher:	Okay, so we need a method for note taking that will allow us to focus on the vocabulary words. Can we use the same strategy you use in social studies? What are the steps you use for that strategy?	
Student 5:	Survey to figure out what the book is about and to decide if it will help us get the information we need about weather.	Students can explicitly discuss the steps they use in the note-taking strategy. They bring up several sub-steps that are part of the note-taking strategy. These substeps include using main ideas to set purposes—a goal-setting strategy. Students can explain several good reasons to set purposes for reading.
Student 3:	Read carefully to find out what the main ideas are. We use the main ides to set purposes for reading.	
Teacher:	Why do we set purposes for reading?	
Student 6:	To keep us involved in what we read.	
Student 7:	To help us sort out what is important in the book, and what is interesting but not useful. We keep track of the important information that helps answer our purpose questions.	
Student 5:	To record important information in an organized way. Information to answer each purpose question is written under the question.	
Teacher:	After we set purposes for reading, what is next?	
Student 7:	Reread the material to take the notes.	
Student 5:	In social studies we write the purpose questions on notebook paper and take notes under each question.	
Teacher:	Those are all excellent suggestions for note taking, and it sounds as if that process works in social studies. Information in science books is organized a little differently, and our purpose for reading these easy science books is a bit different from your purposes for reading in social studies, so I have designed a note-taking sheet for taking notes in science class. Let's take a look at it. It has three columns – a column for key	

	words, a column for explanations or information from the text or diagrams of the concepts, and a column for questions that we have about the vocabulary or the concepts we read about. Does this note-taking sheet accomplish the same things as the note-taking step in the social studies process?	
Student 4:	It does. It's just a different way to record the information. It seems weird to do it this way instead of just on a piece of paper.	
Teacher:	What are the advantages of using a format like this when we are reading an easy-reading book?	
Student 1:	You can see the key vocabulary words because they are in a separate column.	Students can discuss advantages and disadvantages of different ways of implementing the note-taking strategy.
Student 3:	In social studies we don't write down questions that we have. We write down important information from the book.	
Teacher:	You're right. This part of the note-taking process is different than the format you use in social studies because it helps to highlight the important vocabulary we need to identify at this early stage in our search, and it gives us an opportunity to generate questions that we think about as we are doing the easy reading. Let's experiment with this different format for recording notes as we go through the first easy-reading book together.	

This transcript shows students who have a great deal of metacognitive knowledge about strategies. The students demonstrate an impressive ability to discuss what strategies they use, how to use them, and why they are useful. When teachers engage students in discussions about strategies, students can attain this high degree of metacognitive knowledge of strategies.

Problem 14.3. Designing instruction. Making Thinking Visible

A high school literature teacher is working with students on summarization. Students have read the text below.

> Women in American Literature
>
> In the latter half of the nineteenth century, women became the nation's dominant culture force, a position they have never relinquished. Ladies' journalism began to flourish. In 1891, *The Ladies Home Journal* (founded in 1883) became the first American magazine to exceed a circulation of half a million; by 1905 it had reached a million. A new generation of women authors appeared whose poetry and fiction enlivened the pages of popular ten-cent monthly and weekly magazines. The greatest woman writer of her age, Emily Dickinson, was almost completely unknown; her first collection of poetry was not published until 1890, four years after her death. The American reading public's visible appetite for sentiment and sensation was constantly fed by such writers as Mrs. E.E. Southworth, who filled uncountable numbers of novels with romantic extravagance; ancestral curses, sudden passions, villains blasted, and heroes triumphant. Sales of such "molasses fiction" far exceeded the sales of works by such highly regarded writers such as William Dean Howells, Edith Wharton, Henry James, and even Mark Twain.

The teacher asks one of her students, Aimee, to summarize the text. This is the first time that the teacher has heard Aimee provide a summary in class. Here is Aimee's response: "Well, I think that the main idea is that ladies' journalism began to flourish." How should the teacher response to Aimee's summary?

Response: Aimee has certainly picked out a sentence that more than any other presents the main idea of this paragraph. But a good summary could include more information. It could mention the time period (the latter half of the 1800s). It could also note that women who wrote sensationalist fiction for popular magazines were better known than women (and men) who wrote more serious literature. But regardless of whether this is an ideal summary or not, the teacher needs to know more about why Aimee decided to pick out the second sentence as sufficient summary. An ideal first follow-up question would be something like "Why do you think that is a good summary of this paragraph" or "Tell us how you decided on that as your summary" or "How did you come up with that answer?" When Aimee gives her answer, then the teacher will have a better understanding of what she was thinking, and then she can decide better on the kind of feedback to give her.

Goal Setting and Evaluation

Another effective technique of strategy instruction is to ask students to set goals for strategy use and then to have them evaluate whether or not they have met their goals (Chinn, 2008b; Page-Voth & Graham, 1999; White & Frederiksen, 1998). As we learned in Chapter 7, the hallmark of self-regulated cognition is that students are able to set their own goals and then evaluate how well they have achieved these goals. To encourage students to self-regulate their strategy use, teachers can explicitly direct them to set goals for strategy use and then to evaluate how well they have achieved these goals.

As an illustration, let's look at how goal setting and evaluation can be used to promote better writing. When students are learning to write persuasive essays, they often fail to use two reasoning strategies that we learned about in Chapter 7: They fail to develop more than one or two arguments for their position, and they also do not typically consider or discuss counterarguments to their own position. Students can be encouraged to use more arguments and to consider more counterarguments through goal setting and evaluation. Teachers might ask students to fill out a simple form such as the one in Figure 14.1. Students write down their goals for how many arguments they will include and how many counterarguments they will discuss. Later, they evaluate how well they did on their final persuasive essay. Once students have achieved these goals, teachers can next ask students to set more challenging goals—such as writing four arguments that that are based on sound factual evidence. By setting achievable goals, students understand what they need to do, and (as we discussed in Chapter 10) they become motivated to achieve the goals they have set. Students also learn to regulate their strategy use by setting their own goals and evaluating whether they have achieved them. Special educators and educational psychologists Victoria Page-Voth and Steve Graham (1999) used an instructional method similar to this to improve the persuasive writing of seventh and eighth graders with learning disabilities.

Figure 14.1 Student goal sheet for goal setting and evaluation in a persuasive essay

Name: ________________________ Period: _____

WRITING GOALS

BEFORE YOUR ESSAY:

How many arguments will you include in your essay? ☐

How many counterarguments will you discuss in your essay? ☐

AFTER YOU WRITE YOUR ESSAY:

On your final draft, underline your arguments in green ink, and underline the counterarguments you discussed in red ink.

How many arguments did you include in your essay? ☐

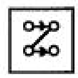
How many counterarguments did you discuss in your essay? ☐

Teachers can productively direct groups as well as individuals to engage in goal setting and self-evaluation (Chinn, Duschl, Duncan, Pluta, Buckland et al., 2008; Y. Sharan & Sharan, 1992; Webb & Farivar, 1994). Learning scientists Barbara White and John Frederiksen (1998) studied classes in which students learned about physics (forces and motion) as they worked in groups with computer simulations and hands-on experiments. Half of the classes were randomly assigned to a condition in which students self-evaluated their work and their classmates' work according to how well they achieved nine strategic goals, including the two goals presented in Figure 14.2 (being systematic; writing and communicating well). Other goals included being inventive (i.e., using strategies to generate creative ideas), reasoning carefully about evidence and explanations, and using good teamwork strategies. Although the researchers initially provided the goals, the students collectively made suggestions to refine and improve the goals; thus, the students were also involved with goal setting. The researchers found that students who participated in these processes of goal-setting and evaluation outperformed students who did not. The benefits of self-evaluation extended both to tests of reasoning and tests of physics knowledge. The students who benefited the most from the self-evaluation activities were lower-performing students. This finding is in line with our conclusion in Chapter 7 that lower-performing students are often poorer at monitoring their work than high-performing students. Self-evaluation criteria help low-performing students monitor their strategy use more effectively, bringing them closer to the level of their peers who have learned to self-monitor on their own.

Figure 14.2: Two Self-Evaluation Criteria

Now you will evaluate the work you just did.

Being Systematic



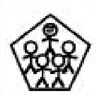
Being Systematic. Students are careful, organized, and logical in planning and carrying out their work. When problems come up, they are thoughtful in examining their progress and deciding whether to alter their approach or strategy.

Circle the score that you think your work deserves

1	2	3	4	5
not adequate		adequate		exceptional

Explain how your experimental work and analyses justify the score you have given yourself. ______________________________

Writing and Communicating Well



Writing and Communicating Well. Students clearly express their ideas to each other or to an audience through writing, diagrams, and speaking. Their communication is clear enough to allow others to understand their work and reproduce their research.

Circle the score that you think your work deserves

1	2	3	4	5
not adequate		adequate		exceptional

Explain how your experimental write-ups justify the score you have given yourself. ______________________________

(From White & Frederiksen, 1998, p. 26.)

Scaffolding Strategy Use and Fading Scaffolding Over Time

Effective teachers provide scaffolds to help students learn to use cognitive strategies effectively. As we have learned in previous chapters, scaffolds are supports that enable students to carry out tasks that they cannot carry out unassisted (A. Collins et al., 1989; Davis, 2004; Puntambekar & Hübscher, 2005; Sandoval & Reiser, 2004; Sherin, Reiser, & Edelson, 2004; Tabak & Baumgartner, 2004). Scaffolding for strategy instruction is support that helps students execute cognitive strategies that they would have difficulty executing without any help; this helps students learn to use strategies more skillfully (Pea, 2004; Quintana et al., 2004; Quintana, Zhang, & Krajcik, 2005; Sherin et al., 2004). We will discuss five kinds of scaffolds to help students learn cognitive strategies: hints, prompts, diagrams, criteria, and feedback. We will also discuss the importance of **fading** scaffolds. As we have discussed before, fading scaffolds refers to providing less and less scaffolding over time until students can execute strategies effectively on their own, without any assistance.

Hints. When a student is having difficulty using a cognitive strategy, teachers can give **hints**. Hints are questions or statements that point students in the right direction of how to use a strategy correctly, but that stop short of telling or showing students exactly what to do. By giving hints, the teacher tries to give the students enough information that they can succeed in using the strategy on their own. The teacher is trying to get the student to do as much of the cognitive work as possible. Effective teachers try to give just enough help to enable the students to do the rest of the work on their own (Azevedo, Cromley, Winters, Moos, & Greene, 2005; D. Wood, Bruner, & Ross, 1976).

The transcript below presents an example of a teacher deploying hints effectively. An eleventh grader is trying to evaluate the credibility of the sources. In this case, the student is evaluating the credibility of the author of a historical document related to the building of the Panama Canal.

Transcript		Analysis
Eva:	Well, I think it's a pretty credible source. The guy who wrote the document was there at the time.	Eva has only considered one factor affecting the credibility of sources—whether the source was an actual eyewitness or not.
Teacher:	Can you say anything more about why it's a good source?	The teacher gives a very general hint—encouraging the student very generally to try to think of more factors that affect source credibility.
Eva:	Well, the author was in Panama at the time that the arrangements were being made, so he should know.	Eva has not yet considered any other aspect of credibility beyond whether the source was an eyewitness.
Teacher:	What else is important in judging credibility, in addition to whether the person was actually there?	The teacher gives a more specific hint to encourage Eva to try to think of other factors that affect credibility.
Eva:	I'm not really sure….	
Teacher:	How about whether the author has biases?	Because Eva has been unable to think of any other factors affecting credibility, the teacher now gives a more specific hint. But Eva still has to take this idea and apply it herself.
Eva:	Oh….well, he was an representative of the U.S…..	
Teacher:	And?	The teacher returns to giving a very general hint to see if Evan can do the rest of the work on her own.
Eva:	He might be biased in favor of the U.S., since this is an official document, and he might have to take an official position, even if he really doesn't think so.	Now that Eva has started thinking about the idea of bias, she is able to correctly reason that this source might be biased.

In this example, the teacher first gives a very general hint, and then a more specific hint, and finally a very specific hint to consider biases. The teacher tries to avoid giving any more help than is necessary.

It is important that when teachers given hints, they give no more information than students need to proceed on their own (Azevedo, Cromley, & Seibert, 2004; Azevedo et al., 2005; Davis, 2003). Scaffolds should provide the least possible amount of support. Teachers want students to do as much of the cognitive work as they can on their own, so that they can learn how to carry out the strategy (Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001).

Problem 14.4. Evaluating teaching: Hints

In each of these problems, evaluate the teacher's hint.

Problem A. A second-grade teacher, Derrek, has been working with his students for five weeks on learning to plan when writing. In particular, he has worked with students on brainstorming ideas and then selecting the most important ones. The students have had extensive, varied practice with a procedure in which they (1) list their ideas, (2) discuss which ideas they want to write about the most, (3) circle the best ideas, and (4) decide the best order. Only then do the students begin to write.

Now Derrek has given his students the assignment to write a travel brochure that will attract tourists to a desert habitat. This is the culminating activity in a three-week unit on deserts. Five minutes after the assignment, most of the pairs are busy at work on the planning procedure they have learned. But Derrek notices that two students—Tina and Madison—seem to be having some difficulty. The two girls are both talking about the desert and about the brochure, but they are not brainstorming reasons to visit the desert or trying to decide which reasons are best.

Derrek approaches and says, ""Remember we've talked about planning when we start writing. And when we plan, we need to start brainstorming ideas. Now, we need to put reasons to visit the desert in our brochure, don't we? So let's write at the top of the page: Reasons to visit the desert. And let's put a line under that. And we'll start writing our reasons here. What would be the first reason?"

Evaluate the hint that Derrek has given.

Problem B. A teacher is working with seventh graders who are working on summarizing each paragraph in a text they are reading. The teacher has joined them and is listening in.

Table salt is made by the third method--artificial evaporation. Pumping water into an underground salt bed dissolves the salt and makes a brine that is brought to the surface. After purification at high temperatures, the salt is ready for our tables.

Ben: To summarize: After its purification, the salt is put on our tables.

Angie: I agree.

David: So do I.

Teacher: That was a fine job, Ben, and I appreciate all that work, but I think there might be something else to add to our summary. There is more important information that I think we need to include. This paragraph is most about what?

Angie: The third method of artificial evaporation.

Teacher: How do you know that?

David: The first sentence says that artificial evaporation is the third method, and the rest of the paragraph tells the details of that method.

Teacher: So, what is the summary? Ben?

Ben? Um… Artificial evaporation is the third method to produce salt.

Teacher: You've all hit it right on the money. The first sentence says that the paragraph is most about the method of artificial evaporation and then everything else in the paragraph is telling us about that process. Okay, next teacher [meaning the next student leader]. Adapted from Palincsar et al. (1986)

Responses:

A. Derrek has given a lot of information in this hint. After five weeks of practicing with a procedure to generate and organize, Tina and Madison should be able to use it without this much help. Derrek should probably try giving less help initially. He might start by asking, "What strategy have we been learning to help us think of new ideas?" Then he could see if the students could come up with the idea of starting their own idea-generation chart. If the students don't see what to do after this hint, he might further ask, "What have we been writing on pieces of paper to help think of new ideas?" If this doesn't work, then Derrek could show them how to get started.

B. The teacher was fairly direct in telling students that there is important information that Ben didn't include. One might argue that she was too direct. Perhaps she should have first asked Ben why he decided that his sentence was the most important sentence. Then she could have seen what Ben was thinking.

On the positive side, once Angie generated the idea that the paragraph was about artificial evaporation, the teacher did ask the students to justify Angie's idea that the paragraph is about artificial evaporation, and David explained why one could say that the whole paragraph is about artificial evaporation.

Cognitive prompts. Cognitive prompts are questions or cues that remind students to use particular strategies. For example, students who are studying for a test could simply be directed to summarize the main point of each section of the chapter as they are studying. This is a very straightforward prompt to "summarize" what they are reading as they are studying. Cognitive prompts are often provided when students are working in groups. As the students work together, the questions remind them of what they should be thinking and talking about. Cognitive prompts are effective at promoting better strategy use (Quintana et al., 2004; Quintana et al., 2005; Suthers & Hundhausen, 2003; Toth, Suthers, & Lesgold, 2002)

Table 14.1 shows two examples of cognitive prompts that have been found to be effective by educational researchers. The first column in Table 14.1 shows a set of cognitive prompts for use in science lessons with sixth graders (White & Frederiksen, 1998). These prompts focus on strategies to design, carry out, and interpret experiments. The researchers specifically prompted students to focus on experimentation processes that they knew to be difficult for students.

Table 14.1: Two sets of cognitive prompts

Cognitive Prompts for Conducting Experiments	Cognitive Prompts for Solving Problems
For each experiment, you need to do the following: 1. Create a plan with: A sketch showing how you will set up the experiment. A description of what you will do and exactly what you will measure. 2. Do your experiment. Record your data in a clear and organized way. Record any problems you had in doing your experiment. 3. Analyze your data and present your conclusions. State any laws you discovered that predict and describe what happens Give an explanation for why this happens. Explain how your results agree or disagree with what you predicted would happen when you stated your hypotheses. Adapted from White and Frederiksen (1998)	PLANNING 1. What is the problem? What are we trying to do here? 2. What do we know about the problem so far? What information is given to us? How can this help us? 3. What is our plan? 4. Is there another way to do this? What would happen if…? 5. What should we do next? MONITORING 1. Are we using our plan or strategy? Do we need a new plan? Do we need a different strategy? 2. Has our goal changed? What is our goal now? 3. Are we on the right track? Are we getting closer to our goal? EVALUATING 1. What worked? 2. What didn't work? 3. What would we do differently next time? King (1991)

The second column in Table 14.1 shows a set of cognitive prompts to teach fifth graders to solve problems (A. King, 1991). Collectively, these questions were designed to promote self-regulated problem solving by encouraging effective goal setting, monitoring, and self-evaluation. These cognitive prompts were designed to be generally useful on a wide range of problems.

The cognitive prompts in Table 14.1 are designed to help students remember to use strategies that they might otherwise forget to use. The prompts also provide useful information about the order in which strategies can be productively used. The prompts are general prompts that can be used with any experiment, not just one kind of experiment. The problem solving prompts can be used to guide problem solving on many different kinds of problems. As students ask each other these general questions, they are learning general questions that they can apply to many similar tasks (Davis, 2003).

Another approach to providing cognitive prompts is called **guided peer questioning** (A. King, 1994; 1999, 2002). In guided peer questioning, students read a passage within a chapter and then question each other about that passage using question stems to generate their questions. A question stem is a question with blanks for students to fill in as they ask each other questions. Examples are "Why is ____ important?" and "How are _____ and ______ different?" Students studying a health textbook might fill in the blanks to ask each other questions such as "Why are lungs important?" and "How are white blood cells and red blood cells different?" When one student asks a question, the other answers, and then together they evaluate the answer—checking whether it is correct or elaborating with more information.

Figure 14.3
Question stem cue cards

Comprehension questions
- Describe _____ in your own words.
- What does _____ mean?
- Why is _____ important?

Connection questions
- Explain why _____.
- Explain how _____.
- How are _____ and _____ similar?
- What is the difference between _____ and _____?
- How could ____ be used to _____?
- What would happen if _____?
- How does ____ tie in with ____ that we learned before?

(A. King, 1994)

Educational psychologist Alison King (1994) had fourth and fifth graders study texts on human body system in pairs using cue cards with the question stems shown in Figure 14.3. These questions directed students not only to think about the current text by itself (e.g., “Describe ___ in your own words”) but also to think about how this text connected with other things they had learned before (e.g., “How does ____ tie in with ____ that we learned before?”) and to apply the text to new situations (e.g., “How could ____ be used to _____?”). Students who used question stems learned more than students who did not; this was true especially for students who used both comprehension questions and connection questions (A. King, Staffieri, & Adelgais, 1998). The connection questions are especially valuable cognitive prompts for students studying textbook passages together.

Problem 14.5. Evaluating teaching. Cognitive Prompts.
A seventh grade teacher has assigned groups of three students to be the “editorial board” for a local newspaper in the year 1832. Their job is to evaluate what they’ve learned about Andrew Jackson’s first term and decide whether to support or oppose Jackson’s reelection bid. The teacher wants students to learn how to write persuasive essays of this sort, so she gives them cards with these cognitive prompts.

1. Decide whether you think that Andrew Jackson should be reelected.
2. Support your ideas with evidence from Jackson’s first term (such as his positions on patronage, the Bank of the U.S., and infrastructure)
3. Think about what arguments on the other side would be, and think about how to argue against those arguments.

Evaluate this cognitive prompt card. Should it be changed? If so, how?

Response: One problem with these prompts is that the first two questions are completely specific to this task. The teacher says that he wants to learn to write persuasive essays of this sort, yet his first two *prompts are applicable only to the single topic of Andrew Jackson. To promote generalization, cognitive prompts are typically worded more generally, such as:*

1. Decide what your position is.

2. Support your ideas with evidence from the material you have read.

Another issue that arises with this set of prompts is whether there are enough prompts to get students to think about a fuller range of writing strategies (recall these from Chapter 7). There are no questions that encourage organization, major revision, minor revision, or audience consideration. In the problems at the end of the chapter, you will see other set of cognitive prompts for a writing task that you can compare with this set.

Diagrammatic representations. Another approach to scaffolding strategy use is to have students use diagrams to organize their ideas. By having students write ideas into diagrams, teachers can ensure that the students are using selected strategies. For example, teachers can encourage students to use the strategy of comparison and contrast by asking students to fill in tables listing similarities and differences. Concept maps, which we have learned about in earlier chapters, are one kind of diagrammatic representation. Concept maps encourage students to organize and elaborate on information that they are learning. As students generate the concept maps, they must connect what they have learned to other knowledge that they have, and they must organize these ideas into a network of concepts.

My own research team has used a diagrammatic representation to help students understand how evidence is related to explanations. In these diagrams, students use different kinds of arrows to link evidence to different explanations that they are learning (Pluta, Buckland, Chinn, Duschl, & Duncan, 2008b). The diagram encourages students to think about how each piece of evidence is related to two or more alternative explanations. Figure 14.4 presents an example of a diagram used by students trying to decide how evidence related to a robbery is related to two possible explanations of what happened—one explanation stating that the suspect (Sam Spade) committed the robbery and the other explanation that the suspect bought a paper at the robbed store but was playing poker at the time of the robbery. Working in pairs, students discuss whether each piece of evidence *supports, strongly supports, weakly supports, contradicts, or strongly contradicts* each explanation. Because students need to decide *how strongly* the evidence supports or contradicts the explanation, the students often engage in extended discussions about just how strong or weak the evidence is. These diagrams have proven to be very effective in encouraging rich student discussion about how evidence links to alternative explanations.

Figure 14.11 An example of an diagrammatic representation. After extended discussion, two students working together have added the arrows shown in red.

Figure 14.4 An example of an diagrammatic representation. After extended discussion, two students working together have added the arrows shown in red.

Key:

? →	Evidence weakly supports the explanation.
→	Evidence supports the explanation
(wavy arrow)	Evidence strongly supports the explanation
(arrow with X)	Evidence contradicts the explanation
(wavy arrow with X)	Evidence strongly contradicts the explanation
(dashed arrow)	Evidence neither supports nor contradicts the explanation

Evidence 1

Sam Spade's blood type is O+, and O+ blood was found on the broken window of the convenience store.

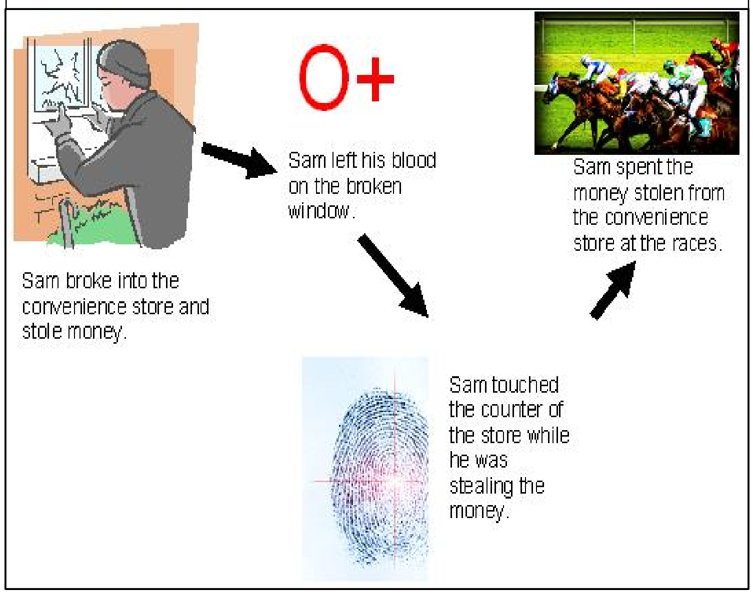
Evidence 2

Sam regularly buys newspapers in this store.

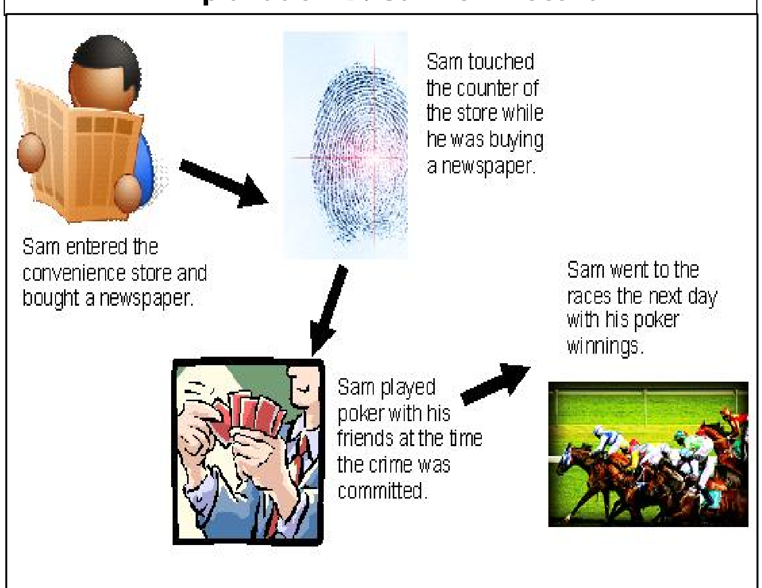
Evidence 3

Sam Spade was observed spending a large amount of money at the horse races the day after the robbery.

Explanation A: Sam is guilty



Explanation B: Sam is innocent



Criteria. Another effective form of scaffolding is the use of criteria. **Criteria** are the standards used to judge the quality of students' work (Chinn, Duschl, Duncan, Pluta, Buckland et al., 2008). Criteria for a good story are standards used to judge whether a story is good (e.g., it has realistic characters, an interesting plot, vivid descriptions, etc.) Criteria for a good trumpet solo are the standards used to evaluate how good the solo is (e.g., the playing is in tune, the tone has a good timbre, the student can play fast passages smoothly, and so on). Teachers use criteria to evaluate students' work. Students can use criteria to evaluate their own and their classmates' work, as well. When students' work falls short on some criteria, teachers can point to the criteria to help students see they are falling short and what they need to do to improve.

For example, suppose that a teacher decides that he will establish five criteria for a good persuasive essay: (1) The position is stated clearly. (2) There are at least 3 arguments for the position. (3) The arguments are strong—that is, they use good evidence and are explained clearly. (4) The essay takes at least two important counterarguments into consideration and explains why these counterarguments are not as strong as the arguments. (5) The grammar, spelling, and word usage are all very good. Teachers can also have students help set the criteria. Through a class discussion, students and the teacher might collectively decide that good essays should have at least four arguments (not just three). They might also agree to add a new criterion–e.g., that the essay is written in an interesting style.

Teacher can then use these criteria to grade students' essays. Students can use the criteria to evaluate their own and their classmates' work. When they know what the criteria are, students will have a clearer idea of what they need to do to write essays that people will evaluate highly. This enhances students' self-efficacy, as they learn what the goals are and what they need to achieve to meet these goals.

One way to present criteria to students is simply to present students with lists of criteria (Chinn, Duschl, Duncan, Pluta, Buckland et al., 2008). A teacher could post these on the board or on the wall or give the criteria to students in a handout. Table 14.2 shows a list of criteria that specify what the teacher will count as a good argument (based on Chinn, Duschl, Duncan, Pluta, Buckland et al., 2008; McNeill & Krajcik, 2008). By handing this list out to students, the teacher helps students learn that their arguments need to include claims, evidence, and reasoning to be judged a good argument. Students can now monitor their own work to make sure that they are meeting these criteria.

Table 14.2:
List of criteria for good arguments

Criteria	Explanation	Examples
The argument includes a **claim**.	A claim is the position that you are taking.	Capital punishment does not deter crime.
The argument includes **evidence**.	Your evidence consists of your facts or data for believing your claim.	A poll of police chiefs showed that police chiefs did not believe that the death penalty deters crime.
The argument includes **reasoning**.	Your reasoning connects the evidence to the claim. It explains in more detail why the evidence supports the claim.	Police chiefs are intimately familiar with what tends to increase or decrease crime levels. The fact that police chiefs do not believe that capital punishment is a deterrent is evidence that the threat of capital punishment does not have a strong influence on crime.

Table 14.3:
Rubric for scoring math problem solutions

Dimension	Score of 0	Score of 1	Score of 2
Represent the problem	There is no problem representation	There is a problem representation, but it is wrong or it is not explained clearly.	There is a problem representation that is explained clearly.
Showing each step in the solution	The step-by-step solution is not shown.	The step-by-step solution is shown, but some steps are missing or not explained clearly.	Each step in the solution is shown, and the steps are shown clearly.
Calculating accurately	Two or more calculations are inaccurate	Most calculations are accurate, but one is inaccurate.	All calculations are accurate.
Checking solution	There is no check to see whether the solution makes sense.	There is a check on whether the answer makes sense, but the check is not clearly explained.	There is a clearly explained check on whether the answer makes sense.

Another way to present criteria to students is through *rubrics*, which we learned about in Chapter 8. A rubric shows the different dimensions along which performance is judged. When students achieve at the highest level in each dimension, they have met the standards for that dimension. Rubrics can be highly effective at promoting student learning (Hafner & Hafner, 2003; M. Wilson & Sloane, 2000). Table 14.3 shows a rubric that a math teacher could present to students to help them understand how to write out solutions to their math problems. The teacher then uses the rubric to score students' written solutions to math problems (and students could use the rubric to score their own and each others' written work on math problems). Students have met the criterion represented by each dimension if they achieve a score of 2 on that dimension.

Problem 14.6. Designing instruction. Developing rubrics.
Imagine a class that you could be teaching in the future (elementary, secondary social studies, mathematics, etc.). Then decide a genre of writing that your students might be doing (e.g., writing stories, writing poems, writing informational essays, writing lab reports, writing explanations of how they solved a math problem). Develop a rubric that you and your students could use to evaluate their planning for writing in the genre you have chosen.

Response: There are of course many possible answers to this question. Your response should include a consideration of the different aspects of planning discussed in Chapter 7. You will also want to tailor the rubric to the age of the students and to the genre.

Feedback. A direct form of scaffolding is feedback. As we have discussed in previous chapters, effective feedback provides students with specific information about what they are doing well, so that they continue doing it, and what they should try to improve. Teachers can scaffold the use of cognitive strategies by directing their specific feedback at the quality of students' strategy use. The teacher can specify what is strong and weak about the student's strategy use so that the student can improve performance the next time. Suppose that a class is working on the strategy of summarization. A teacher could respond to a student's work on summarization by writing, "You are doing well excluding all the unimportant details from your summaries. Sometimes you are omitting some important points, however. In this summary, you didn't mention the civil rights movement, even though 3 of the 8 paragraphs you are summarizing are talking about the civil rights movement." Teachers can also give specific feedback in this manner when they talk with students, when they work with groups, and when they hold class discussions.

Fading scaffolding. Fading scaffolding refers to gradually removing the scaffolding so that students are executing the strategy more and more on their own (A. Collins et al., 1989). The goal of scaffolding is to help students complete tasks successfully that they cannot complete without assistance. But as students become better able to carry out tasks on their own, they will reach a point where they do less scaffolding. Teachers give less and less scaffolding over time, until students are proficient enough at using the strategy that they do not need any scaffolding at all. The goal is for students to become independent, self-regulated users of strategies who can use the strategies without scaffolding. When teachers fade scaffolding, students learn more than when they do not fade scaffolding (McNeill, Lizotte, Krajcik, & Marx, 2006).

As students master one strategy, teachers can introduce a new strategy, for which scaffolding will be again needed for a period of time until students master that more difficult task. At any one time, teachers are providing high levels of scaffolding for some strategies, fading scaffolding for other strategies, and giving no scaffolding at all for strategies that students have mastered.

Incorporating Effective Motivational Techniques

The final feature of effective strategy instruction is the incorporation of effective motivational techniques. There is evidence that strategy instruction is more effective when it is integrated with instruction that incorporates a variety of effective techniques for enhancing students' motivation (Guthrie et al., 2004).

Educational psychologist John Guthrie and his colleagues (Guthrie et al., 2004) compared three forms of instruction to promote third graders' reading proficiency. In one condition, teachers used their traditional methods of reading instruction. In a second condition, teachers provided strategy instruction using many of the techniques that we have already discussed in this chapter—including explaining the strategy to students, modeling, and giving them varied practice. In a third condition, strategy instruction was integrated within reading instruction that incorporated five important techniques to enhance students' motivation.

- The teacher emphasized *content learning goals*. This consisted in part of setting questions that students should find the answers to while they are reading. Goals of understanding content were emphasized, and performance goals, such as performing well on tests, were deemphasized. As we learned in Chapter 10, learning goals tend to support deep learning more than performance goals do.
- *Providing choice and support for autonomy*. Students were allowed to choose texts, what to respond to, and partners during instruction. Choice is, as we learned in Chapter 10, intrinsically motivating according to self-determination theorists.
- *Using interesting texts*. This was accomplished by giving students opportunities to read texts that they found situationally interesting, that were relevant to their other interests and goals, and that were visually appealing in their format. Interesting texts enhance the value of the goal of learning from these texts.
- *Social collaboration*. Many of the reading activities engaged students in group work to achieve joint goals. This also creates situational interest in the reading task, and it also allows students to learn from each other.
- *Incorporating hands-on experiences* into the text. For instance, students combined reading aloud with hands-on activities such as dissecting owl pellets to see what owls had eaten.

Guthrie and his colleagues found that students who learned through strategy instruction integrated with motivating reading instruction gained more in reading proficiency than students in the other two conditions. In fact, strategy instruction was not effective without the motivational components of instruction. This important study supports the conclusion that strategy instruction is most effective when it is integrated with instruction that is designed to enhance motivation.

LEARNING ENVIRONMENTS THAT INTEGRATE FEATURES OF EFFECTIVE STRATEGY INSTRUCTION

In the first part of the chapter, we examined eight features of instruction that help students learn strategies that can make them effective self-regulated learners and thinkers. We focused on each feature of instruction, one at a time, without showing how they can fit together in an integrated learning environment to help students learn strategies. In the second part of the chapter, we examine in detail two learning environments that integrate several or all of the eight features of effective strategy instruction: (1) Reciprocal Teaching (focusing on comprehension strategies) and (2) Self-Regulated Strategy Development (focusing on writing strategies). We will examine these methods so that we can gain an understanding of how teachers can develop extended instruction to promote strategy development.

Reciprocal Teaching

Reciprocal Teaching (Annemarie Sullivan Palincsar, 2003; Annemarie Sullivan Palincsar & Brown, 1984; Annemarie Sullivan Palincsar et al., 2007) is a learning environment designed to promote reading comprehension strategies. Reciprocal teaching is typically implemented in small groups. The small groups may include the teacher, or students may work without a teacher (De Corte, Verschaffel, & Van De Ven, 2001; Rosenshine & Meister, 1994). In groups, students silently read one paragraph at a time. Students lead the discussion, even when their real teacher is with them in the group. After each paragraph, one student acts as the leader (called the "teacher") and leads the group in the following activities:

Activity 1. Ask a question about the paragraph. The question should encourage students to think about the ideas they have just read. Answers may require students to elaborate on what they have read or to explain something in the text.

Activity 2. Seek clarification about something that is not fully understood. This encourages students to *monitor* their understanding, to identify what they do not understand, and to ask questions to help them understand better.

Activity 3. Make a prediction about what will come next.

Activity 4. Summarize the paragraph.

The activities can be done in any order. Through these four activities, the students are prompted to use beneficial reading comprehension strategies. The activities prompt students to practice using the strategies including elaboration, explanation, monitoring, prediction, and summarization. As students gain experience using these strategies, they improve their reading comprehension (Annemarie Sullivan Palincsar & Brown, 1984; Rosenshine & Meister, 1994; van den Bos et al., 2007).

Here is an example of Reciprocal Teaching in action (adapted and expanded from Annemarie Sullivan Palincsar, 1986). The teacher is working with a group of middle-school students who are below-average readers. The students read the text below. Then they begin their discussion.

> Text: The second-oldest form of salt production is mining. Unlike early methods that made the work extremely dangerous and difficult, today's methods use special machinery, and salt mining is easier and safer. The old expression "back to the salt mines" no longer applies.

Transcript		Analysis
Leann:	(Student as teacher): Name two words that often describe mining salt in the old days.	As the teacher leader, Leann asks a question. (This one is a text literal question rather than a question that requires elaboration or inference.) This is activity #1.
Kevin:	Back to the salt mines?	
Leann:	No. Angela?	
Angela:	Dangerous and difficult.	
Leann:	Correct. This paragraph is all about "comparing the old mining of salt and today's mining of salt."	Leanne now summarizes; this is activity #4.
Teacher:	Beautiful!	
Leann:	Does anyone have a clarification question?	Leanne asks if there are clarification

Regina:	I do. I wonder what kind of special machinery they have now.	questions, which is activity #2.
Leann:	I have a prediction to make.	Making predictions is activity #3.
Teacher:	Good.	
Leann:	I think it might tell when salt was first discovered; well, it might tell what salt is made of and how it's made.	
Teacher:	Okay, can we have another teacher?	Now they switch to a new student as leader.

In the example above, the teacher did not provide any specific feedback or other scaffolding. But when students have difficulty applying the strategies, teachers step in to provide scaffolding. Here is an example of a teacher helping a student who is having trouble formulating a question:

Text: Spinner's mate is much smaller than she, and his body is dull brown. He spends most of his time sitting at one side of her web.

Transcript		Analysis
Carl:	[His next task is to ask a question, but he is unable to come up with a question]	When the student cannot answer, the teacher prompts the student to summarize. She begins without giving any specific hint.
Teacher:	What's this paragraph about?	
Carl:	Spinner's mate. How do spinner's mate….	Carl starts a question but cannot complete it.
Teacher:	That's good. Keep going.	The teacher refrains still from giving a specific hint, trying to allow Carl to do everything he can do on his own.
Carl:	How do spinner's mate is smaller than . . . . How am I going to say that?	Carl still struggles to formulate a question.
Teacher:	Take your time with it. You want to ask a question about spinner's mate and what he does, beginning with the word "how."	Carl has shown that he needs more specific help, so the teacher gives a more specific hint, but still does not give him the answer.
Carl:	How do they spend most of his time sitting?	Carl does as the teacher directs but is still not very successful.
Teacher:	You're very close. The question would be, "How does spinner's mate spend most of his time?" Now, you ask it.	The teacher provides a model of a correct answer, following the procedure she explained earlier of starting the question with *how*. She has Carl try saying it, too.
Carl:	How does spinner's mate spend most of his time?	Carl is able to repeat the teacher's model.

Notice that the teacher tries to give Carl as little help as possible and gradually increases the level of help in response to his difficulties. In the end, the teacher tells Carl more directly how to construct a question, and when he needs still more help, she models for him how to formulate this question. Thus, the teacher puts into practice the technique of trying to provide as little scaffolding as possible, but increasing the level of support when needed.

Reciprocal teaching was originally designed for small-group reading instruction with the teacher present. The examples above show the teacher engaged with small groups of students. However, Reciprocal Teaching has also been used as a method of collaborative learning (De Corte et al., 2001; Lederer, 2000; Rosenshine & Meister, 1994; van Garderen, 2004). Teachers work with the whole class to help students learn to do Reciprocal Teaching on their own, and then students work in small groups to ask each other the questions without the teacher present. The teacher goes around and helps groups but obviously can only be with one group in the class at a time. Teachers can provide models and scaffolds either in whole-class discussions or in the briefer times when they are working with particular groups.

Research strongly supports the effectiveness of Reciprocal Teaching (De Corte et al., 2001; Lederer, 2000; Annemarie Sullivan Palincsar, 1986, 2003; Annemarie Sullivan Palincsar & Brown, 1984; Rosenshine & Meister, 1994; van den Bos et al., 2007; van Garderen, 2004). The method appears to work well with students of all reading proficiency levels, and it works with other strategies besides the strategies that were originally used. A reading teacher might use a different set of comprehension strategies, such as activating prior knowledge, clarifying difficult words, making a schematic representation of the text, and summarizing (De Corte et al., 2001). A math teacher might employ a Reciprocal Teaching strategy as students work on word problems in mathematics, focusing on strategies such as understanding the problem, drawing a diagram, making an equation, and checking the answer to see if it makes sense (cf. van Garderen, 2004).

Self-Regulated Strategy Development

Self-regulated strategy development (SRSD) is a highly effective learning environment developed by educational psychologists and special educators Steve Graham and Kathryn Harris and their colleagues (Graham & Harris, 1993, 2003; Graham et al., 2005; Graham, Harris, & Troia, 2000; Harris & Graham, 2007; Harris, Santangelo, & Graham, 2008). SRSD has been used principally to help students learn writing strategies, although its procedures have also been used successfully to promote learning of strategies for solving mathematics problems and reading (Case, Harris, & Graham, 1992; L. Johnson, Graham, & Harris, 1997; L. H. Mason, 2004). SRSD incorporates all eight of the features of effective strategy instruction that we have discussed in this chapter.

The goal of SRSD is to help students master use of writing strategies so that they can and will use them on their own. SRSD has been used successfully with students at many age levels (Chalk, Hagan-Burke, & Burke, 2005; Graham & Harris, 2003; Graham et al., 2000; Harris & Graham, 2007; Lane et al., 2008; Lienemann, Graham, Leader-Janssen, & Reid, 2006; Santangelo et al., 2008). Although designed especially to promote learning of students with learning disabilities, it is generally effective with typical students as well as students with learning disabilities (Graham & Harris, 2003).

In this section, we will illustrate SRSD by describing an application of SRSD to writing in the third grade (Graham et al., 2005; Harris, Graham, & Mason, 2006). As we discuss SRSD, we will examine how SRSD embodies each of the eight features of effective strategy instruction that we have discussed.

Multiple strategies embedded within regular instruction. SRSD helps students learn many different writing and self-regulation strategies that help them become better writers. In the third-grade SRSD program that we are examining (Graham et al., 2005; Harris et al., 2006), students are first taught three basic writing strategies, represented by the mnemonic POW:

1. Pick my ideas. In this step, students are to decide what to write about.
2. Organize my notes. This is the *planning* stage of writing (as we discussed in Chapter 7). It includes generating ideas and organizing them into a writing plan.
3. Write and say more. This is the *revision* stage of writing (as discussed in Chapter 7). Students make any needed changes to their plan and improve their plan while they are writing. The focus is not just on proofreading but also on making changes to the original plan while writing the paper.

SRSD with third graders focuses especially on Step 2: Organize my notes (planning). In Chapter 7 we reviewed research showing that from elementary school through the college level, students tend to plan for their writing less than they should. This is particularly true of struggling writers. To help students plan more effectively, teachers teach students a series of specific steps to plan more effectively when writing two different genres: stories and persuasive essays. To generate and organize ideas for stories, students are taught to ask themselves the seven questions shown in Figure 14.5a. The mnemonic “WWW, What = 2, How = 2” is used to help students remember the seven questions. Teachers first spend several weeks helping students master the strategies for planning stories.

Figure 14.5

a. Seven questions to generate and organize ideas for stories

W	Who are the main characters?
W	When does the story take place?
W	Where does the story take place?
What	What do the main characters want to do?
What	What happens when the main characters try to do it?
How	How does the story end?
How	How do the main characters feel?

b. Four prompts to generate and organize ideas for persuasive essays

T	Tell what you believe!
R	Give three or more Reasons (Why do I believe this?)
E	Examine each reason (Will my reader buy it?)
E	End it (Wrap it up right)

(Graham et al., 2005, p. 217)

After learning the story-planning strategies, students learn about strategies for planning persuasive essays. To generate and organize ideas for persuasive essays, students are taught to ask themselves the four questions in Figure 14.5b, using a TREE acronym to remember the questions.

In addition to learning all the strategies above, students learn about the characteristics of good stories and persuasive essays (Graham et al., 2005, pp. 217-218):

- The purposes of stories and of persuasive writing. For example, an important purpose of stories is to be fun to read.
- The basic parts of a story and a persuasive essay
- The characteristics of a well-constructed story and a well-constructed persuasive essay. A well-constructed story makes sense, is fun for the reader to read, and has seven parts corresponding to the seven questions in Figure 14.5a. A well-constructed persuasive essay also makes sense and is fun to read; it also tells the reader what you believe, gives at least three strong reasons, and gives a conclusion (corresponding to the questions in Figure 14.5b). In this way, students learn *criteria* for good stories and good persuasive essays.
- The importance of using words that make a paper more interesting; these words were called “million dollar” words.

In addition to learning all the writing strategies and about the characteristics of good writing, students learned general-purpose self-regulation strategies including setting goals, self-monitoring, self-instructions, and self-reinforcement. We will discuss these strategies and how teachers promoted their use in a later section.

By teaching all these writing and self-regulation strategies, the teachers aim to help students gain metacognitive control over writing processes over a period of five or more months. By learning about the purposes, parts, and characteristics of good stories and persuasive essays, students gain metacognitive awareness of good writing. They also learn strategies that can help them write stories and essays that satisfy the criteria of good writing. The goal is for students to become self-regulated writers who can use these strategies appropriately to write well on their own, without the teacher or instructional aids prompting them to use these strategies.

Instruction in all these strategies lasts for several months. Students do not learn one or two strategies but many multiple, interrelated strategies that they can combine to become effective writers. Students work regularly with the target strategies whenever they are writing (in literacy classes, in social studies, and so on) through weeks or months of instruction. Thus, SRSD focuses on embedding instruction of multiple strategies in regular writing instruction over an extended period of time.

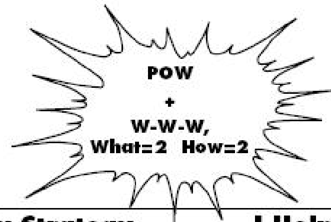
Extensive, Varied Practice. As the preceding discussion indicates, extensive, varied practice is a central feature of SRSD. The teacher works with students to apply all the strategies being learned in writing classes and, as we have seen, in other classes as well. Because the program lasts five months, and because the strategies are used consistently across many, many writing tasks, the students have many chances to master the strategies across many writing contexts.

Explaining what the strategies are, how to use them, why they are useful, and when they can be used. When using SRSD, teachers explain to students what the strategies are, how to use them, why they are useful, and when they can be used. Teachers first tell the third graders about the three POW strategies for writing. The class and teacher talk about what each letter in POW stands for, and why it is important to use each of these strategies when writing. Then students work in pairs checking each other until each student can explain what POW means and why each step is important.

Similar processes are used for the story-planning strategies and the persuasive-essay-planning strategies. Teachers explain the strategies and then discuss the strategies with the class. After students write stories and essays, the teacher leads discussions in which the students tell their classmates how using the strategies helped them write better.

After discussing the strategies in class, teachers encourage students to think about when and how to use the strategies outside of writing class. Students work in pairs to talk about when, where, and how they can use the strategies they are learning in other classes, such as science and social studies. Teachers explain what transfer is, and students talk about how they can transfer the writing strategies they are learning. As they write in other classes, they help each other use the strategies. After writing, they discuss what they have done well and what they had trouble with when applying the strategies to other classes. They use handouts such as the one in Figure 14.6 to record their ideas.

Figure 14.6 A handout to record transfer of story-writing strategies to other classes



I Transferred My Strategy	I Helped My Partner

Source: National Center for Accelerating Student Learning, http://kc.vanderbilt.edu/casl/powwww.html

In later classes, students discussed with the teacher when they used their strategy, how they used them, and how they helped their partner. In this way, teachers keep a strong focus on transfer throughout the instructional period. Students help figure out how they can transfer the writing strategies they are learning. Then they try using the strategies in other classes, and they come back to discuss with the teacher how it went.

As an example, consider how a pair of students might think about transferring the POW strategies to writing reports of experiments they conduct in science class. Students might note that they could use the "Organize my notes" strategy to think up and organize ideas for their lab reports. But they also realize that the questions they have learned for organizing their notes to write stories and persuasive essays do not work for lab reports. (The "WWW, What=2, How=2" strategy is for stories, not lab reports.) So they make a list of new questions to help them organize lab reports:

a. What did you do in the experiment?
b. What happened?
c. What new ideas does this experiment give you?

After trying out these strategies, students discuss what they tried with the teacher, and how well it worked. The teacher may make suggestions at this point, and different student pairs can share their ideas with each other through the class discussion.

Teachers modeling strategies. Teacher modeling is an important component of SRSD. When introducing all the strategies to students, teachers model for students how to use the strategies. For example, when modeling the use of the story-planning questions in Figure 14.5a, the teacher asks herself all the questions that are used to generate good ideas for the writing. The teacher asks herself, “Who are the main characters in my story?” The students contribute ideas for who the main characters might be, but the teacher takes the lead, showing students how to do the thinking needed to generate good ideas for a story. The teacher then asks herself the other questions, and the students contribute answers.

After modeling the strategies, the teacher gives students a chance to try it with her help. The students again work together as a class to write a new story, but this time the students take the lead in the writing, and the teacher acts more as a recorder, providing help only when needed as the class generates a story plan together. Then each individual student writes a story based on the class’s plan. In this way, the students move from the teacher’s model to writing a story with lots of help. After that, they will soon be ready to try writing stories on their own.

The teacher also models for students how to use the general purpose strategies. The teacher makes statements such as the following to illustrate how to set goals, monitor, and self-reinforce.

- Setting goals: “What do I want to do first? As I start writing, I have to think what I want to do here. I certainly want to write a good story that is interesting and has all the parts of an interesting story. Those will be my goals for writing this story”
- Monitoring: “I’ve just written a paragraph. Does that make sense? Will people be able to understand it? I think that maybe this part is a little confusing….”
- Self-reinforcement: “Oh! I really like that part! That’s a really interesting paragraph. That’ll make people wonder what is going to happen next!”

Through modeling the cognitive processes she uses to implement the strategies, the teacher demonstrates for students how to use the strategies in a way that they can try themselves.

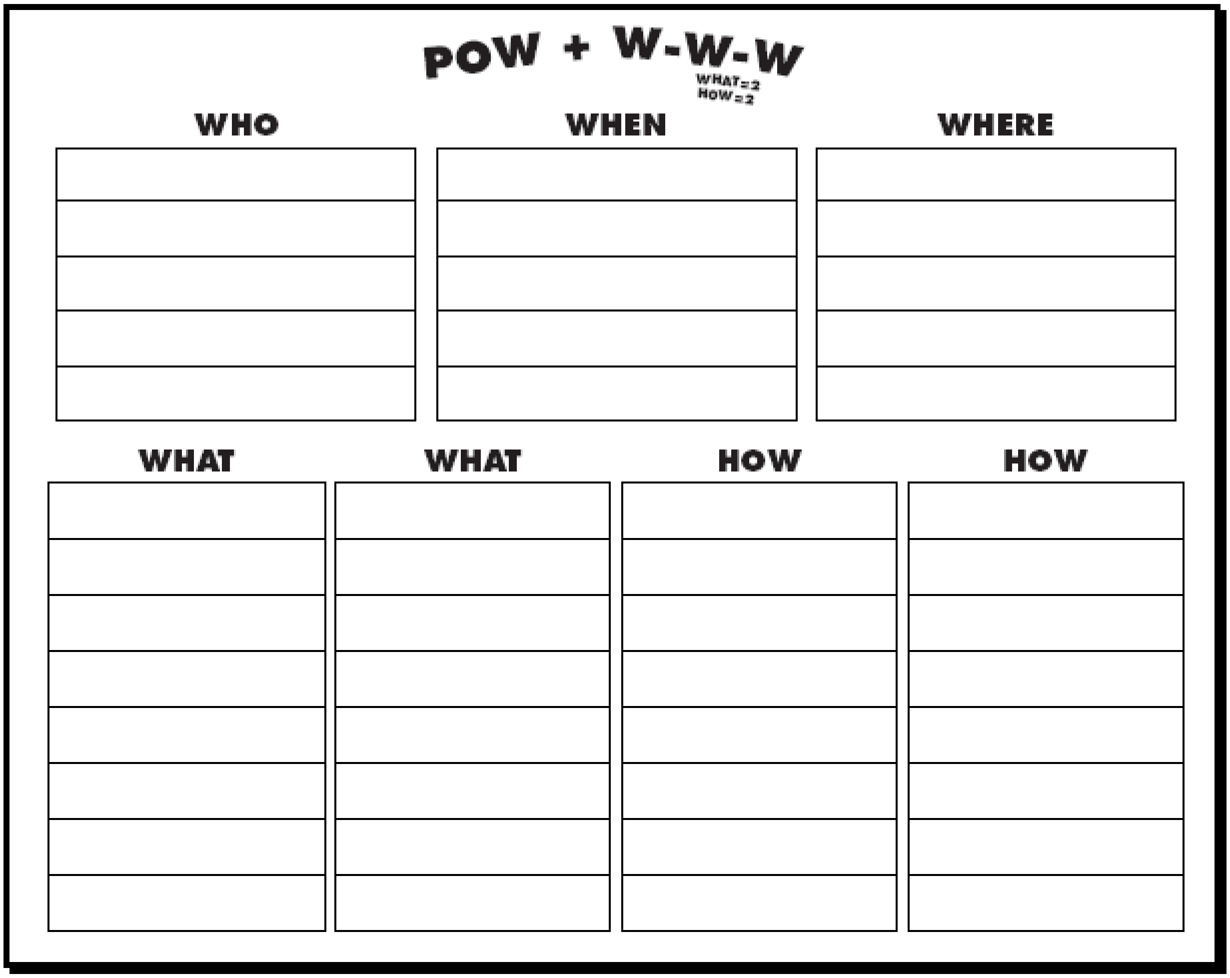
Students making thinking visible. SRSD gives students many chances to make their thinking visible, both in class discussions and in work with peers. In class discussions, teachers ask students to use the strategies as they plan papers together and explain how they used the strategies when writing their own papers. In extensive group work, students talk with each other about using the strategies and help each other use the strategies. Each time that students ask one of the questions out loud, they are making their strategy use visible. Students also make their strategy use visible every time that they make statements such as “Don’t forget that one of our goals is to make the essay interesting,” “Let’s make sure that we tell about where the story is happening,” “Let’s have the story happen in school,” and “Let’s transfer by using the TREE questions when we write a story for our class newspaper.”

Scaffolding strategy use and fading scaffolding over time. In SRSD, teachers employ many forms of scaffolding to help students master the strategies, and they fade their scaffolding over time. One form of scaffolding, as we have seen, is cognitive prompts. Each of the acronyms students learn (such as POW and TREE) prompt students to carry out target strategies such as *picking ideas, organizing notes,* and *writing and saying more* (the POW strategies).

A second scaffolding technique is hints and feedback, which teachers provide as they interact with students and write comments on students’ essays. Teachers work intensively with students—one on one, in groups, and in whole-class discussions—to ensure that each student masters the writing strategies they are learning. This requires that teachers carefully evaluate each day how each student is doing, so that she can give each student the help needed to master the strategies.

A third form of scaffolding in SRSD consists of diagrammatic representations. SRSD employs diagrammatic representations to help students understand the parts of stories and persuasive essays. Figure 14.7 shows a diagram that teachers give students to help them identify the different parts of a story. Initially, teachers work with students in a whole-class discussion to show them how to identify parts of a story they have read. The teacher fills in the chart displayed via a projector so that students see how to use the chart. Gradually, the students learn to fill in the chart on their own for stories they have read. After they have mastered use of the chart for stories they have read, the students start using the chart both to generate ideas for their own stories and to check whether their stories have all the parts they should have. Thus, the chart helps students evaluate their own work as well as generate new ideas.

Figure 14.7 A diagrammatic representation to scaffold students' identification of the parts of stories.



Source: National Center for Accelerating Student Learning, http://kc.vanderbilt.edu/casl/powwww.html

As students master use of the scaffolds, the scaffolds are gradually withdrawn. Eventually, the teacher expects students to be able to write stories and essays without looking at the lists of questions or using the diagrams. After many opportunities to use these scaffolds, students internalize the strategies so that they can use them without assistance.

Goal setting and evaluation. SRSD encourages students, as quickly as possible, to set their own goals and evaluate their own performance. By teaching students the parts of essays and the characteristics of good essays, students gain critical tools that they can use to evaluate their own writing. They learn to set goals to write essays that meet the criteria for good essays ("I'm going to write a story that is interesting, that makes sense, and that has all seven parts that stories should have"), and they evaluate their essays to see if they have met their goals. Working individually or in pairs, they use the diagrammatic representation in Figure 14.7 to check whether their stories and their partner's stories have all the needed parts.

In SRSD, students also compare essays they write after learning to use the writing strategies with essays they wrote at the beginning of the year. In this way, they can clearly see how much they have improved. This practice increases their self-efficacy as a writer, as they see that effort and strategy use have contributed to making them much better writers.

Problem 14.7. Evaluating teaching. Writing instruction.
An elementary school has adopted an approach to writing called "Writer's Workshop." In their implementation of Writer's Workshop, the teachers use the following teaching practices to promote students' writing:
1. The teachers have students follow this procedure when writing essays. Students first plan their composition. Then they write a first draft. After that, they edit the draft. Finally, they "publish" the completed paper in a class publication.
2. The teacher meets individually with students in one-on-one conferences to discuss their writing. Some teachers meet with students daily; others meet less frequently, but at least once a week.
3. The teacher has students share their work with peers and critique each others' work. Teachers vary in how frequently they have students share their work, from daily to about twice a month.
4. The teachers conduct mini-lessons several times a week. The mini-lessons were based on what teachers judged students would profit from learning. For instance, if teachers believed that students would benefit from a short lesson on planning, then they developed a single lesson to cover planning. In that lesson, the teachers explained and modeled the strategy, and then asked students to apply the strategy. In later instruction, teachers sometimes remind students to use the strategy. Teachers offered mini-lessons on topics such as generating main ideas, brainstorming, and constructing concept maps.

Based on what is described here, evaluate this approach to instruction. In comparison to SRSD, how effective will it be?

Response: In the research by Graham and Harris on which this section is based (Graham et al., 2005; Harris et al., 2006), SRSD was much more effective than the Writer's Workshop, which was implemented as described above. Although the Writer's Workshop had many positive features (including teaching planning and other strategies, teachers helping students and giving them feedback, and engaging students in peer evaluation), it is also missing critical features, such as:
1. Teachers did not provide enough varied practice with strategies. Teachers introduced strategies in mini-lessons but have students keep practicing these strategies over and over for weeks and months, as is done in SRSD. One lesson is not enough to master any strategy. It is important to keep using the same strategies repeatedly over a long period of time.
2. Teachers did not use scaffolds such as the cognitive prompts embedded in the POW and TREE acronyms and the diagrammatic representations in Figures 14.7 and 14.8 to promote strategy use.
3. It appears that teachers using Writer's Workshop did not systematically teach criteria of good stories and essays to students. Criteria give students more ideas for goal setting and evaluating performance.

Incorporating effective motivational techniques. SRSD incorporates many motivational techniques. In fact, all of the G^{2}REATEST motivational techniques that we discussed in Chapter 10 are incorporated into SRSD. These include:

- *Goals*. Students set goals and evaluate how well they have achieved their goals.
- *Groups*. Students work regularly in pairs, proving situational interest as well as increasing skills and self-efficacy as students work with each other.
- *Rewards and Evaluation*. Teachers' feedback on papers is specific and closely tied to students' performance. Teachers write specific feedback such as, "Your first reason is very persuasive. You have given clear facts to explain why we need to save grizzly bears. One thing to improve is the number of reasons. You only have two reasons so far."
- *Autonomy*. The topics that students write about are relevant and interesting to them. For example, students write about issues such as whether children should be allowed to choose their own pets.

They sometimes choose their own topics and are sometimes given choices between alternative topics, such as choosing one of the following two topics to write about: “Should children be allowed to choose what shows they watch?” or “Should children be allowed to eat whatever they want?” Of course, once they select a topic and begin writing on one of these topics, students also have autonomy in choosing their position and the reasons that they choose as the best reasons.

- *Tasks*. Students are given writing tasks of moderate difficulty that they can achieve successfully if they work together and use the strategies they are learning. They are also provided with ample scaffolding to help them succeed at these tasks. In addition, teachers work with students individually to ensure that each student achieves mastery before he or she moves on.
- *Environment.* Collectively, the learning activities function to help students gain a sense that they are part of a community of writers, working together to become highly proficient writers who help each other.
- *Strategies.* The strategies that students are learning increase their motivation by increasing their self-efficacy in writing.
- *Teacher expectations.* When teaching the strategies, teachers are setting high expectations. The target strategies are strategies that middle school students and even high school students can profit from learning, and yet teachers are working with students as young as third grade to master these strategies.

Summary. SRSD provides us with an excellent example of how to bring all eight components of effective strategy instruction into a comprehensive learning environment. SRSD also incorporates all the features of motivating learning environments. SRSD is highly effective at helping struggling writers make strong growth in writing (Graham et al., 2005; Harris et al., 2006). Students not only learn to write stories and persuasive essays; they are also able to transfer some of what they learn to write better informative essays and personal narratives about their own experiences (Graham et al., 2005). As we discussed at the beginning of this section, SRSD can be adapted to work effectively with older students as well, including upper elementary, middle school, and high school students (Chalk et al., 2005; De La Paz, 1999; Harris et al., 2006; Santangelo et al., 2008).

EXTENSIONS

In this chapter, we have discussed eight features of effective strategy instruction that should be incorporated into learning environments that promote self-regulated learning. Although these features are generally applicable to a wide range of students, there are nonetheless adaptations that can be made to maximize the effectiveness of strategy instruction with different groups of learners. We will discuss these adaptations in the final section of this chapter.

Strategy Instruction for Students with Learning Disabilities

Much of the research on strategy instruction has focused partly or wholly on students with learning disabilities (e.g., Baker, Gersten, & Graham, 2003; De La Paz, Owen, Harris, & Graham, 2000; Graham & Harris, 2003; Reid & Lienemann, 2006; Shyyan, Thurlow, & Liu, 2008; van den Bos et al., 2007). Self-Regulated Strategy Development was designed for struggling writers, including students with learning disabilities. Reciprocal Teaching and SRSD have both been used effectively with students with learning disabilities (e.g., Case et al., 1992; Chalk et al., 2005; Lederer, 2000; van den Bos et al., 2007). The methods of strategy instruction that we have discussed in this chapter should be highly effective with students with learning disabilities.

Of the eight features of effective instruction, several should be especially emphasized with students with learning disabilities. For these students, it is important to include a heavy focus on explicit explanations, modeling, extensive scaffolding and feedback, and varied practice over a long period of time. As we have discussed in previous chapters, students with learning disabilities benefit from explicit explanations. Teachers may need to explain and model strategy use repeatedly. Students with learning disabilities may need more extensive hints and more extended use of scaffolds before teachers begin to fade the scaffolds. And students with learning disabilities may need more practice than typical students, with much explicit feedback to help them master and retain the strategies.

Strategy Instruction for Students at Different Grade Levels

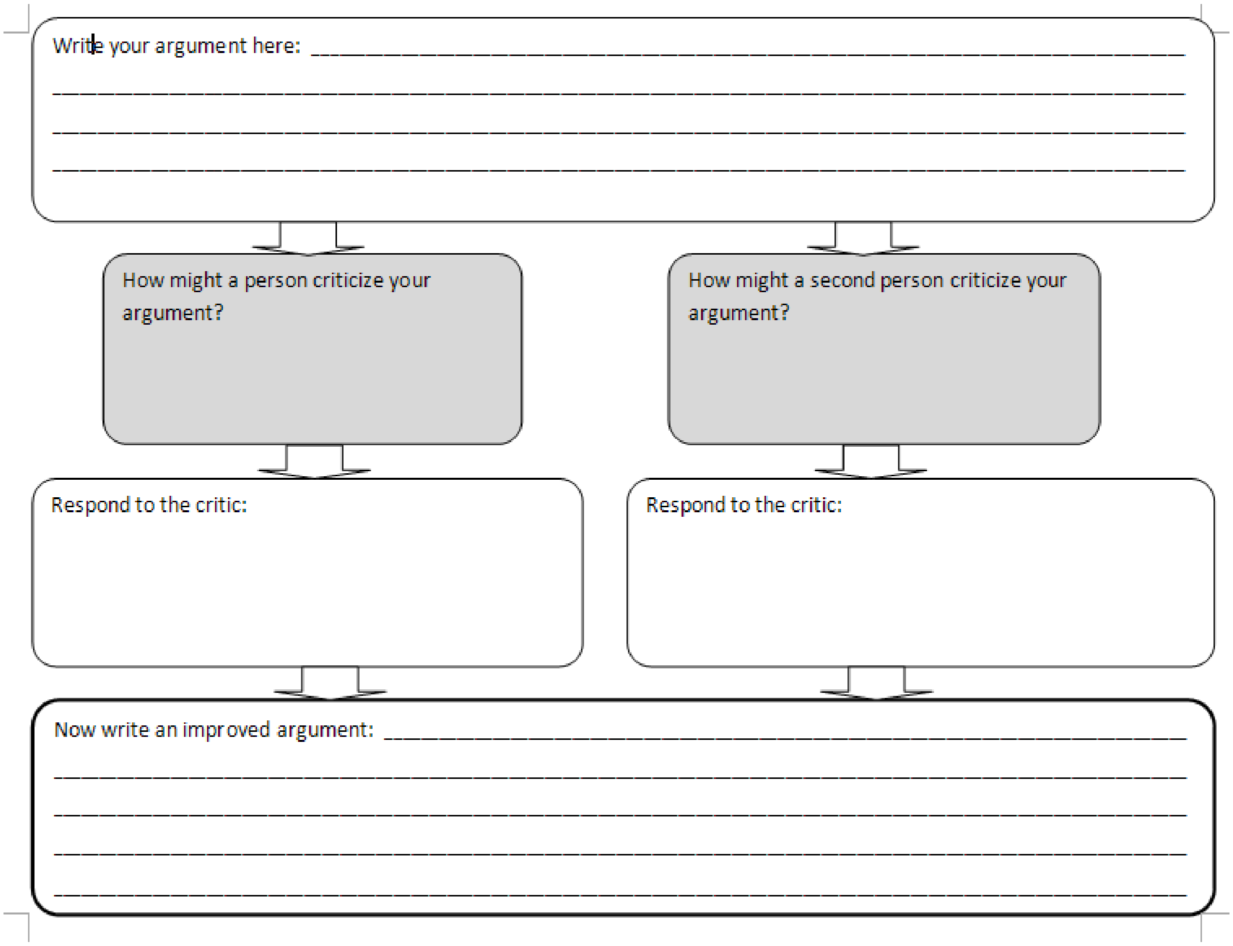
The techniques of effective strategy instruction that we have discussed in this chapter are generally applicable to students from early elementary through high school. We have already noted that SRSD has been used successfully to promote growth in writing among students ranging in age from early elementary through high school and that Reciprocal Teaching has been used with students of differing ages. Other programs use these techniques to promote reasoning in students from kindergarten through high school (Bell, Blair, Crawford, & Lederman, 2003; Chinn, Duschl, Duncan, Pluta, Buckland et al., 2008; Chinn et al., 2000; Cobb, McClain, & Gravemeijer, 2003; Ergazaki et al., 2005; Etkina, Matilsky, & Lawrence, 2003; Ford, 2005; Metz, 2004; Samarapungavan, Mantzicopoulos, & Patrick, 2008). The eight techniques of effective instruction discussed in this chapter are broadly applicable across ages, but there is a need to aWe discuss several of these adaptations below:

- *Implementing varied practice across subjects.* It is easy for most elementary school teachers to implement varied practice by integrating strategy instruction into many subjects. Most elementary school teachers teach most or all subjects to a single group of students and can design their own lessons that encourage students to use target strategies in reading class, math class, social studies class, and science class. In contrast, most secondary teachers teach a single subject to many different groups of students. If secondary teachers want to integrate instruction in common strategies across multiple subjects, teachers of different subjects (math, English, science, etc.) will need to work jointly to decide on target strategies and to develop plans for coordinating strategy instruction across different classes. This requires time to work and plan together.
- *Teacher explanations and modeling.* As students grow older, teacher explanations and modeling should become more and more complex. When elementary-school teachers introduce strategies such as summarization to their students, they will explain it in a simpler way than when middle-school teachers introduce these strategies to their students.
- *Students making their thinking visible.* Teachers of students of all ages should encourage students to make their thinking visible. However, as students grow older, teachers can expect more sophisticated metacognitive talk. As students grow older and gain more experience with strategy use, they should know more strategies, understand their own thinking in more detail, and understand more about how and when to use different strategies in a flexible manner.
- *Scaffolding strategy use and fading scaffolding over time.* As students grow older, scaffolds for strategy use become more complex. For a third grader learning to think about other people's alternative ideas, a simple scaffold such as the one in Figure 14.8a is appropriate. Simply generating three alternative ideas that other people might have is an important achievement at this age. In addition, scaffolds for children are often decorative in a way that older students might find too childish. As students grow older, scaffolds will address more advanced aspects of strategies. For instance, the scaffold in Figure 14.8b helps seventh graders learn to build better arguments by anticipating possible counterarguments to their arguments. When using this scaffold, students first generate a particular kind of alternative idea—counterarguments that other people might make to their own arguments. Then they construct stronger arguments that can anticipate the counterarguments that they have generated.

Figure 14.8a Scaffold to help third graders take others' ideas into account

This figure shows two cartoonish children in colorful clothes. A thought bubble is connected to one child and contains the words: "My ideas." A second thought bubble is connected to the second child and contains the words: "Someone else's *different* ideas."

Figure 14.8b Scaffold to help seventh graders take others' ideas into account (from the PRACCIS project)



Both within and between grade levels, teachers should aim to follow a repeating cycle of introducing new strategies, explaining and scaffolding those strategies, fading the scaffolding, and then starting over with more challenging strategies. At higher grade levels, teachers can introduce entirely new, more difficult strategies. Or they may revisit previously learned strategies in a more sophisticated way. For instance, students can learn how to plan for writing and how to align explanations with evidence at a simpler level in the elementary school grades and then at more complex levels in higher grades.

Strategy Instruction with English Language Learners

Although relatively little research focuses on strategy instruction with English-Language Learners, there is evidence that the features of effective instruction discussed throughout this chapter are effective with English-Language Learners (Atay & Ozbulgan, 2007; Carlo et al., 2004; Carlo, August, & Snow, 2005; Chamot, 2004, 2005). In particular, Reciprocal Teaching is effective with English-Language Learners (Fung, Wilkinson, & Moore, 2003; Salataci & Akyel, 2002).

Strategy instruction can be challenging for English-Language Learners because these students may lack the vocabulary to talk about their thinking or to understand others' metacognitive talk. Teachers therefore need to teach students appropriate vocabulary to make their thinking visible. For instance, a teacher teaching about elaboration may want to teach, in addition to the word *elaboration*, words and phrases such as *knowledge*, *prior knowledge, connect to prior knowledge*, *what I know*, and so on. These vocabulary not only help students make their thinking visible but will also help students understand teachers' explanations, models, and scaffolds. Teachers can also help by simplifying the language they use to explain and model strategies and to provide scaffolding.

Some researchers have found that using the students' first language to explain strategies and allow students to practice strategies can be effective (Chamot, 2005) (cf. Gersten & Baker, 2000). Using the first language may make it easier for students to understand models and explanations provided by teachers as well as to make their own thinking visible. Once students understand what they are doing, the use of the first language can be faded.

Teachers will also want to teach specific language-learning strategies to English-Language Learners, including vocabulary-learning, listening-comprehension and oral-communication strategies (Chamot, 2005). Vocabulary learning is especially critical to learning a second language (Gersten & Baker, 2000), so teachers should teach strategies for learning vocabulary (the keyword method, elaboration strategies, review strategies, using word parts to work out the meaning, and so on).

CHAPTER 15
Collaborative Learning

Chapter Outline

- **Reflecting on student thinking**
- **Collaborative learning: Goals, obstacles, and productive processes**
  - Goals of collaborative learning
  - Obstacles to effective collaborative learning
- **Core processes of effective groups**
  - Engagement
  - Positive interdependence
  - Mutual respect
  - Balanced participation
  - High-quality strategy use
  - Uptake of ideas
- **Instructional methods for promoting effective group processes**
  - Using Rewards
  - Guided cooperation
  - Complex tasks
  - Scaffolding complex tasks
  - Preparing students for group work
  - Reducing status differences
  - What teachers should do as students collaborate
  - Group size and composition
  - Summary
- **Summary**

Applied goals

Central theoretical ideas. You will learn ideas about goals of collaborative learning and core processes in effective collaborative groups that will be crucial to making group work in your future classes effective. You will also learn about potential problems in groups that you will want to avoid.

Useful ways to structure group work. You will learn a range of effective methods for implementing group work. You will learn about research that bears on some of the key decisions you will have to make, such as:
--who to put in groups
--how to set up the task
--how to encourage effective strategy use
--how to reduce status differences
--what to do while the groups are working
--how technology can help
You will also learn about why the instructional techniques you learn about are effective.

What to strive for and what to look for in group work. You will learn about what kind of talk and other processes you should look for in group work, and what kinds of talk and other processes you should try to promote. You will also learn about how to evaluate teacher actions during collaborative learning lessons.

Reflecting on Student Thinking

Rachel Williams, a fifth-grade mathematics teacher, regularly uses collaborative groups in her classes, but she has a lot of questions about whether all of her students are benefiting from collaborative learning, and, if not, why not.

Rachel wonders how to make students' talk during group work as effective as possible. She decided to listen carefully to the students in one group to try to understand what they say during group work and how what they say is related to what they learn. During the first week of a unit on adding fractions, Rachel focused on one of her groups, a group with four students who worked together on the problems at the end of each section. All of the students were average B students in math, and all of them scored between 15% and 25% correct on a challenging pretest assessing their ability to successfully add fractions. She took notes on what the students in these groups were saying during the week. The groups worked on problems silently part of the time, and at other times, they would talk about the problems. Although she wasn't able to write down every word the students said during the times when she was listening to their talk, she is confident that she captured most of what they said. The transcripts below are typical of the talk she recorded for each student. After four days of working together, Rachel had the students take a test very similar to the pretest so that Rachel could see how much they had improved.

Here are the pretest-posttest gains that each student made:

Student A.	20 point gain	Student C.	65 point gain
Student B.	35 point gain	Student D.	55 point gain

Here are some representative discussions:

Tuesday.

Problem #1. 2/5 + 1/4

A: What did you get on this one?
B: 13/20.
A: OK.

Problem #5. 2/3 + 4/5

D: How about #5?
C: I got 8/15.
D: Wait. That's not what I got. How did you get that?
C: You have to find a number that divides by both 3 and 5. And that's 15. So you make a number that equals two thirds that has 15 on the bottom. And that's 10/15. And 4/5 is the same as 12/15. And now you have the same number on the bottom both times, so you can add them. And you get 10 plus 12. That's 22. 22/15.
D: I see. You have to find the smallest number that 3 and 5 will go into, and put that on the bottom.

Wednesday.

Problem #3. 1/4 + 3/8

A: What's for #3?
C: I got 5/8. Did you?
A: Uh…yeah.

Problem #4. 1/6 + 1/3

B: Why isn't this one 9/18?
D: Yeah, that's what I was thinking, too.
C: You don't have to do 18 here. Six times 3 is 18, but you can just stay with 6, because 3 goes into 6. So you can change 1/3 to 2/6, and they're both 6's on the bottom now, so you can add them. Three sixths. But you can reduce that. It's the same as one half.
B: So that's how.
D: So we don't just automatically multiply. See if one goes into the other first. Are there any others like that?

Problem #7. 1/2 + 3/4
A: How did you do #6?
B: Hey, what's #7?
C: 5/4.
B: Oh. 5/4?
C: Yeah.
B: OK.

Problem #10. 2/5 + 4/9
B: #10 is a hard one. What did you get?
D: OK. Five times 9 is 45, and there's nothing smaller that they both go into. So that's 18/45 and 20/45. And add 18 and 20, and you get 38/45. I don't think you can reduce that.
B: All right. I see. This set's done. We're done.

Problem #8. 1/8 + 5/16
A: I think #8 is one half.
B: No. 2/16 plus 5/16. So that's seven 16ths.
A: Let me see. … 7/16. OK.

Problem #11. 3/11 + 1/22.
D: How about #11?
C: 7/22.
D: 7/22….

Problem #14. 5/6 + 1/4
A: Do you use 24?
D: No. 12.
(pause)
D: But I got 1 and one sixth.
C: Five sixths is 10 twelfths, and one fourth is 3 twelfths. Ten plus 3 is 13. That's 13 twelfths. One and one *twelfth.*
D: Oh. I made 1 fourth into 4 twelfths. But that would be one third. I need to be careful when I multiply those out.

Explain the results. Classify the students' comments in a way that can explain why some students in this group learned more than others. Consider both what students say to others and what others say to them.

The case you have just read explores how students learn as a result of **collaborative learning**. In collaborative learning, small groups of students learn by working together productively on an academic task. The groups that work together on collaborative learning tasks are **collaborative groups**. A central goal of collaborative learning is to enhance individual students' conceptual and strategic knowledge. Other goals including improving social skills, promoting prosocial attitudes, and fostering positive attitudes toward peers of differing backgrounds.

This case highlights a very important feature of collaborative learning: the quality of talk within the groups. When students engage in productive talk during groups—when they use effective cognitive strategies such as *explanation*, *elaboration*, and *monitoring* as they speak—they learn more than when they engage in less productive strategy use. This idea will be a main focus of the present chapter. Many of the problems that you will work with in this chapter focus on the *quality* of talk in the groups.

Educational researchers have carried out many studies investigating the effectiveness of collaborative groups, and the results have generally been positive. In well-designed collaborative groups, students learn more when they work collaboratively than when they work individually (Barron, 2003; D. W. Johnson & Johnson, 1991; D. W. Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; R. E. Slavin, 1996). However, there is much that can go wrong if teachers design collaborative group work poorly.

A core rationale for collaborative learning is that students have many more chances to talk productively in small groups than in whole class discussions. In Chapter 13, *Discussions and Questioning*, you learned that in class discussions, each individual student has, at most, a few chances to speak. Even if a teacher reduces her contribution to 25% of all words spoken, the 25 students in her class will speak, on average, only 3% of the time. But in a collaborative group of four, students will be speaking 25% of the time on average; in a group of two, students will speak about half the time. In addition, in smaller groups, there is a greater pressure for students to listen attentively and think about what others are saying.

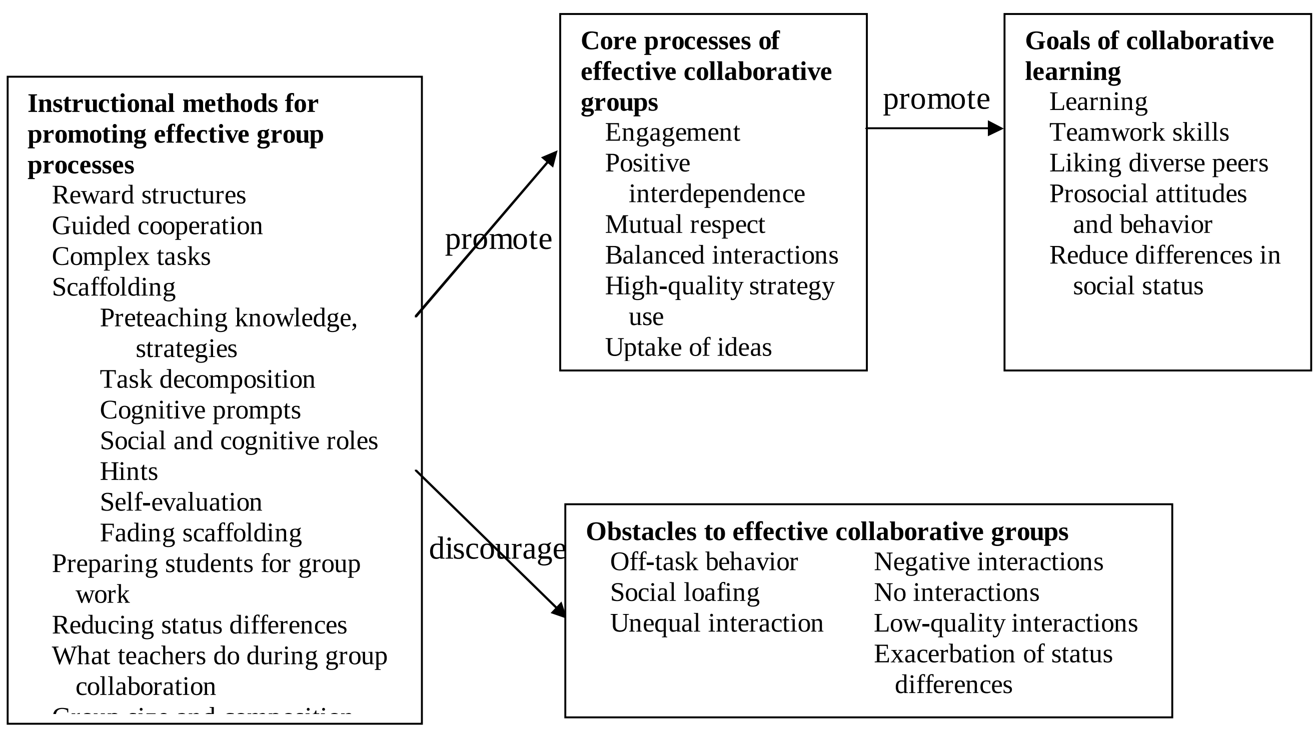
Therefore, students may be more likely to be actively engaged in learning during group work than in whole-class discussions.

Much of the research on what I have been calling collaborative learning has used the term **cooperative learning**. Although some view *cooperative learning* to refer only to some formats for learning in groups, I will use the term *collaborative learning* because it has a stronger connotation of students constructing new ideas together.

COLLABORATIVE LEARNING: GOALS, OBSTACLES, AND PRODUCTIVE PROCESSES

In this section, we will examine the central goals of collaborative lerning as well as some obstacles that can get in the way of achieving these goals. Then we will examine seven productive collaborative group processes that can help groups achieve the goals of collaborative learning while sidestepping the obstacles. Figure 15.1 summarizes the goals, the obstacles, and the processes.

Figure 15.1: Promoting the goals of collaborative learning through effective instructional methods



This figure illustrates that the instructional methods that we will examine in this chapter promote the core learning processes, which in turn promote the attainment of the goals of collaborative learning. These methods also discourage processes that are obstacles to effective collaborative groups.

Goals of Collaborative Learning

A key goal of collaborative learning is to help individual students learn both (1) *academic content* and (2) *productive cognitive strategies*. But there are other important goals as well. Two goals related to improving students' social skills are:

- Promoting students' *ability to work well in groups*, given that working effectively in groups and teams is needed for success in the adult work world (Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Prichard, Bizo, & Stratford, 2006).
- Increasing students' *altruism and prosocial behavior* through cooperative groups (Hertz-Lazarowitz, Sharan, & Steinberg, 1980; Solomon, Watson, Delucchi, Schaps, & Battistich, 1988)

Two goals related to helping students learn to respect others and to appreciate diversity are:

- Encouraging *interaction, respect, and friendships among students of differing backgrounds*, thus reducing racial prejudice, sexism, and so on (D. W. Johnson & Johnson, 1981).
- *Minimizing differences in social status* so that students do not rigidly classify their classmates into "good" students and "poor" students (Cohen, Lotan, & Catanzarite, 1990).

However, it is difficult to achieve these goals. Indeed, many teachers and administrators are unenthusiastic about cooperative learning methods. They worry that groups will waste time or that some students will ride on the coattails of other group members. Indeed, as educational psychologist David Johnson and his colleagues put it: "There is nothing magical about working in a group" (1994, p. 1). Many possible ways of organizing collaborative learning are no more effective, or even less effective, than having students work alone. To implement collaborative learning effectively, you must learn how to structure your groups effectively.

Obstacles to Effective Collaborative Learning

There are many obstacles to making collaborative learning effective. Here are five that are particularly important (see Mulryan, 1992; O'Donnell & O'Kelly, 1994; Salomon & Globerson, 1989; Wiley & Bailey, in press):

- *Off-task behavior*. Instead of focusing on academic tasks in their groups, students spend the time talking about recess, their weekends, or their favorite television shows. In my experience working with middle school and elementary school teachers during the past two decades, this is a main reason why many teachers elect not to use groups.
- *Social loafing*. **Social loafing** occurs when some students in a group do little or no work, allowing the more conscientious or more expert students to do most of the work (North, Linley, & Hargreaves, 2000). At the extreme, one student does all the work, and the others do nothing.
- *Unequal interaction*. In groups, one or two students may dominate the talk, or certain students may be excluded (Barron, 2003; Dembo & McAuliffe, 1987).
- *Negative interactions*. Instead of working productively and cooperatively, students may become angry, make fun of other students, or make racist or sexist comments. For example, in one class I observed, a girl became so angry at a boy in her group who was monopolizing the science equipment that she poked him in the arm with a pencil (and was suspended from school).
- *Absence of interactions*. Students in so-called cooperative groups may simply fail to interact with each other. They may do all the work individually or they may split the work up and each do a part without working together.
- *Low-quality interactions*. Even if students talk about the task at hand, the quality of their interactions may be low. For instance, although students learn a great deal when they give and receive explanations in groups, the natural rate of explanations within groups is often very low (Webb, Troper, & Fall, 1995). Similarly, group members often fail to share all the relevant information they have with their peers in the group (Stasser & Titus, 1987).
- *Exacerbation of status differences*. Although teachers hope that cooperative groups will encourage students to appreciate each other's strengths, the opposite may occur (Cohen et al., 1990). In fact, a

self-fulfilling prophecy can occur. High-status students in a group may ignore the contributions of low-status students who, in turn, withdraw from participation. The high-status students' view that their lower-status counterparts know less and have less to contribute is thus confirmed, and the position of the low-status students is reified (Cohen, 1994a).

A main goal of the rest of the chapter will be to introduce you to a variety of instructional methods for overcoming these obstacles and achieving these goals, as well as to help you to understand why these methods are effective.

CORE PROCESSES OF EFFECTIVE GROUPS

By encouraging six core processes in collaborative learning, the obstacles cited listed above can be avoided. These six core processes are hallmarks of groups that promote student learning. The processes are: (1) engagement, (2) positive interdependence, (3) mutual respect, (4) balanced participation, (5) high-quality strategy use, and (6) uptake of peers' ideas. When you begin teaching, you will see that collaborative groups are more effective to the extent that you can promote these processes. Throughout the chapter, you will learn methods that will help you achieve these core processes in the groups in your future classes.

Engagement

Effective groups are deeply engaged in their task (P. C. Blumenfeld, Mergendoller, & Puro, 1992). They find the task interesting. They may even elect to give up free time to continue to work on the task (e.g., K. Smith, Johnson, & Johnson, 1981). When groups are engaged, they are less likely to be off task, and students will be less inclined to social loafing.

Positive Interdependence

Positive interdependence occurs when students can achieve their goals only by helping each other, not by acting independently (D. W. Johnson & Johnson, 1991). A task with positive interdependence is a task that individual students cannot successfully do alone; input from all the students in the group is needed for success.

As an example of positive interdependence, suppose that students in groups of four are given the task of planning to populate and maintain a 10-gallon aquarium for the class. Students meet in groups to become expert on different topics related to aquariums. Students in each group becomes experts on a different aspect of aquariums. One group learns about water biochemistry, one about aquatic plants, one about scavengers, and the fourth about other fish. To design a thriving aquarium, each student's area of expertise is needed for proper design. Then new groups are formed; each group has one expert in each of the four areas. This is an approach to cooperative learning called **jigsaw** (Aronson, 1978). In jigsaw, students first become experts on a topic, and then they form new groups so that each group has one expert on each of the four topics. Jigsaw establishes positive interdependence because no individual student has enough information to solve the task alone; they must put all the information together (as in the pieces of a jigsaw puzzle) to complete the task successfully. In addition, positive interdependence discourages social loafing, increases interactions, and encourages more equal interactions because all of the students must participate for the group to be successful.

Mutual Respect

Students are more likely to interact well if they respect each other (Cohen, 1994a; D. Johnson & Johnson, 1990). Mutual respect is particularly important in reducing negative interactions. Moreover, when students develop a genuine respect for each other, perceived status differences diminish. Later in the chapter, you will learn several specific techniques for encouraging mutual respect.

Balanced Participation

Participation by students in a group need not be exactly equal to promote learning. However, it is desirable to promote substantial participation by each student because the opportunity to explain their ideas to their peers promotes learning. Balanced participation means that even if participation is not equal, all students make some meaningful contributions, and no student talks all the time. Balanced participation is, by definition, counter to unequal interactions; balanced participation can also contribute to mutual respect.

High-quality Strategy Use

Effective groups engage in high-quality strategy use, including both social strategies and cognitive strategies. Successful group work requires effective social strategies (D. W. Johnson & Johnson, 2004; Krol, Veenman, & Voeten, 2002). For example, students in effective groups take turns in an orderly manner, refrain from hogging the floor, offer encouragement to peers, disagree with ideas rather than attacking people, use I-messages, and ask for the input from students who have not been contributing. (Arbuthnot & Gordon, 1986; Webb & Farivar, 1994). Students who *want* to be helpful group members may not know *how* to be helpful; these students may need to learn skills for smooth group functioning (cf. Gibbs, Potter, Barriga, & Liau, 1996).

Students in effective groups also use high-level cognitive strategies. In a series of seminal studies, Noreen Webb (1982; Webb et al., 2002) investigated middle-school students working collaboratively in math classes. She found that learning was strongly associated with giving certain types of help. The kinds of help that students gave in her studies can be classified into three broad levels: *explanations*, *procedural descriptions*, and *terminal help* (examples from Webb, 1985; Webb et al., 2002; Webb et al., 1995). The three kinds of help are explained in Table 15.1.

In her research, Webb has found that students benefit both from giving explanations and from giving more detailed procedural descriptions (Webb, 1982; Webb et al., 2002). In contrast, students who merely gave terminal help did not benefit from giving help. Moreover, receiving terminal help has strong *negative* effects on learning (Webb, 1982, 1985). Thus, terminal help is a singularly unproductive form of discourse in collaborative groups. Students who give terminal help do not benefit from giving it. Students who receive only terminal help are hurt by receiving it.

The case analysis at the beginning of the chapter was modeled on Webb's research with groups working on mathematics problems. When you look back at those transcripts of the group's interactions, you should consider whether students gave explanations, procedural descriptions, or terminal help. You should also consider which students received terminal help.

Table 15.1
Three Kinds of Help in Collaborative Learning

Kind of help	Definition and examples
Explanations	Explanations describe how to do the problem but also explain why one or more of the steps should be taken. Examples: "Multiply 13 cents by 29, because 29 minutes are left after the first minute." "You see how it has different denominators? [That's why] you have to do common multiples. Go, like, 4, 8, 12. Then the same for 3, 6, 9, 12. The lowest one that you have in common is 12."
Procedural descriptions	Procedural descriptions simply state the steps to be taken, without explaining why. Examples: "This is 30, so you minus 1." "13 times 29." "Oh, you just times them [the denominator]? That's 4 times 3. Equals 12." "Okay, look, 69,000,000 times 8,500,000. This is 63 with 6 zeroes. So, in parentheses, 63 times 10 to the sixth and then times 10 to the fifth . . ."
Terminal help	The student just gives an answer without any explanation or procedural description. "The answer is 10 squared." "That's not right." "The answer should be 55."

Sources: Webb (1985, p. 33); Webb et al. (1995, p. 411)

Problem 15.1 Understanding students' thinking: Identifying kinds of help

When you listen to students in groups, it is important that you can accurately evaluate their strategy use. You began learning this skill in Chapter 6 (Self-Regulated Learning), and you will continue to develop expertise in evaluating strategy use in this chapter. In these examples, identify whether students are giving explanations, procedural descriptions, or terminal help.

Example 1. Mathematics.

A What did you get for number 1?
B 4.
A Oh, OK.

Example 2. Mathematics.

A What did you get for number 1?
B Just add 3 and divide by 2. Like this….

Example 3. History. Answering an end-of-chapter question in the history book. Question #6: "Why did Jackson use the veto more than previous presidents?"

A What did you write for #6?
B I put, "Because he believed that the president was the people's representative to stop laws that were bad for the country."

Example 4. History. Same question as above.

A What did you write for #6?
B I put, "Because he believed that the president was the people's representative to stop laws that were bad for the country."
A Where did you get that?
B I kind of drew a conclusion from that one letter of Jackson's that we read. The one where he said something about it being his duty to make sure that he was the person who stood for the people. I forget the exact words….

Response:
1. B gives only terminal help. "4" is the answer.
2. B gives a procedural description. B tells which steps to follow to answer the question.
3. This one is a bit tricky. It almost looks as if B is giving an explanation, because the response starts with the word because. But the reason given is the answer to the question in the book. B is just stating her answer. She is not explaining where this answer comes from, or how she got it.
4. In this example, B (after further prompting from A) explains where her answer came from. She explains the reasoning that led her to this answer.

The examples you have seen thus far in this chapter have shown that explanations are a productive cognitive strategy in collaborative groups. There is evidence showing that a variety of other high-level cognitive strategies promote learning in a variety of subjects (e.g., Chinn et al., 2000; A. King et al., 1998; Zohar & Nemet, 2002). For example, students learn more in their group discussions when they use strategies such as explanation, elaboration, monitoring understanding, summarizing, representing problems, planning, revising, weighing evidence fairly, and constructing arguments (Barron, 2003; Chinn et al., 2000; Okada & Simon, 1997; Peterson & Swing, 1985; Rosenshine & Meister, 1994; Webb, 1982). In short, each cognitive strategy that you learned about in Chapter 7 is effective when used in small groups.

In addition to the cognitive strategies presented in chapter 7, there is another strategy that is very effective when used in group work: providing **alternative perspectives.** When providing an alternative perspective, one student in a group presents ideas that differ from the ideas held by her peers. When students provide each other with alternative perspectives, they learn about new ideas and ways of thinking that they have not experienced before. As they think about these alternative perspectives, they often develop more sophisticated ideas.

Here is an example of students providing each other with alternative perspectives. The students are discussing a story about a girl named Amy who finds an abandoned gosling and decides to take care of it. Later she is faced with the decision of whether to let the goose go. These fourth graders are discussing this issue.

Jeremy I don't think that she should [let it go], 'cause how do you know he wants to be with his parents? Maybe the parents start biting him in the head …..

Leah But, Jeremy, listen, he's part of nature.

Jeremy Yeah, so's my dog, and I keep him at home.

Sean Well, do you keep him in a pen locked up?

Jeremy Nope.

Leah Well, that's what she's doing to him.

In this discussion, both Sean and Leah present Jeremy with the alternative perspective that keeping the goose is fundamentally different from having a dog because the dog is not penned up, whereas Amy has to lock the goose up to keep it from flying away. Later in the discussion, Jacob shows that encounters with different perspectives have led him to modify his ideas.

> Jeremy Maybe she could like, … let it go and be free, and then when it's a certain like month every month, maybe she could teach it to come back to her and she'd have it like every month and it'd still be free.

Although Jeremy still wants Amy to have the goose, at least partly, he no longer wants to keep it captive and penned up. Thus, encounters with alternative perspectives that challenged his own perspective led Jeremy to change his ideas.

Recall that in Chapter 3 (Theories of Cognitive Development), you learned about Piagetian research on conservation. Piagetian researchers have found that advances in conservation occur when nonconservers (children who cannot yet conserve) work together with conservers on a problem (Perret-Clermont, 1980). The advances arise because the conservers present the nonconservers with a new perspective that they had not previously considered. For instance, consider a six-year old nonconserver who thinks that the amount of water in a glass changes as it is poured from a tall narrow glass to a short wide glass. When working with a peer who can already conserve on this problem, however, the conserver may say something like, “No, it’s the same. Because if you pour it back, it’s just like before.” Encountering new ideas like this frequently leads nonconservers to begin to conserve.

Students can learn from alternative perspectives even when no student’s initial perspective is correct! Developmental psychologists Gail Ames and Frank Murray (Ames & Murray, 1982) conducted an experiment in which they had pairs of nonconservers work together on conservation tasks. Based on pretests, the researchers paired nonconservers who had opposite ideas. For instance, if one child believed that the amount of clay in a ball *increases* when the ball is split into four smaller balls, the paired child believed the opposite—that the amount of clay *decreases* in the same situation. Thus, the students both had incorrect ideas, but they were opposite incorrect ideas. In comparison with nonconservers who did not interact in pairs, these children made strong gains in understanding of conservation. When they encountered conflicting perspectives, they were exposed to new ways of thinking that led them to see that neither initial idea was correct. This led them to explore the idea that the amount of clay did not actually change. Thus, alternative perspectives need not be correct to promote learning in groups (see also Schwarz, Neuman, & Biezuner, 2000).

Uptake of Ideas

When you are observing groups, you want to see **uptake** of ideas. To take up a peer’s idea, students must listen to the idea and then respond to it in some way. Three ways of responding to an idea are acceptance, discussion, and rejection. These three responses are explained and illustrated in Table 15.2.

In a study investigating groups of sixth graders working on a challenging mathematics problem, Brigid Barron (2003) compared successful groups, who were able to solve the problem, with unsuccessful groups, who were not able to solve it. She focused on the three forms of uptake (acceptance, discussion, and rejection) listed in Table 15.2. She found that successful and unsuccessful groups differed strikingly in how they responded to their peers’ ideas. In successful groups, 48% of the peers’ accepted each other’s ideas, 22% discussed each other’s responses, and 30% rejected their peers’ responses. These groups showed a broad range of responses to peers’ ideas. In contrast, in unsuccessful groups, 76% of the responses were reject responses! Here, students often rejected good ideas that were put forward by one of their members. They failed to make progress because they rejected most of their peers’ ideas.

Table 15.2
Uptake of Ideas

Response	Explanation	Examples
Acceptance	The student indicates agreement, possibly with some elaboration.	"Yeah, okay." "24 miles, that means he can make it home before sunset." "Yeah, because that is the distance between the mile markers."
Discussion	The student initiates a discussion about the ideas heard, often by posing a question.	"How did you get that?" "Why are you multiplying?" "Just a minute. Let me think about that." "But how fast does the boat go?"
Rejection	The student rejects the comment without any rationale.	"We're not doing that." "That's stupid, you're wrong." "I know what I'm doing."

Source: Barron (2003, p. 324)

Problem 15.2 Understanding students' thinking: Who will learn the most?

A. Middle school students are solving math problems together. In which pair is the second student likely to learn more?

Pair #1

Jean: How did you do this problem?

Chris: You want to create something on the left side of the equation that is easy to factor. So add 5.

Jean: Why'd you pick 5?

Chris: If you add 5 to both sides, then you get $x^2 + 2x – 1$, and that is something that you can factor. That's why you add 5 to both sides, so that you get an equation that we all know really well, that we know how to factor right away.

Jean: All right. I see. Thanks. That's it then. I'm going to do my Spanish homework now.

Pair #2

Paul: How did you do this problem?

Jada: All right. Add 5 to both sides. Then you get $x^2 + 2x – 1$.

Paul: Why'd you pick 5?

Jada: Because $x^2 + 2x – 1$ is something we've factored a hundred times. We know how to do it. So you see that you can get a really familiar equation if you add 5 to both sides.

Paul: OK. Let me try it on the another one. Then I need to get to my Spanish homework.

B. High school English students are working on an assignment in which answering some questions about how to write a good essay. Since the class has just read Authur Miller's *The Crucible*, the questions focus on how to write an essay about that play. One question addresses whether the statement "There are many examples of panic and frenzy in Arthur Miller's *The Crucible"* makes an acceptable thesis statement for an essay. In which pair is

Student A likely to learn more?

Pair #3

Student A:	I'm not sure about this one: " 'There are many examples of panic and frenzy in Arthur Miller's *The Crucible.*' Is this acceptable as a thesis statement?
Student B:	I'd say it's not, because that's not even an arguable claim. I don't think there's a single person who read the book who would disagree with that.
Student A:	Oh, so that's what she meant when she talked about thesis statements. OK. Now, we have two more questions.

Pair #4

Student A:	Here's the next question. Is this acceptable as a thesis statement?
Student B:	I don't think so. It's not arguable at all. There are so many obvious examples in the play that no one could disagree with that.
Student A:	Oh, so that's what she meant by arguable. So I can ask myself whether just about everyone would agree with a statement, and if they would, if no one would really disagree with the statement, you can't use it as a thesis statement. So what *would* be arguable is something like stating that someone was most to blame, or like that. OK. Now, we have two more questions.

Response: Although there are some interesting differences between each pair of dialogues, a crucial difference in each pair is whether Student A either re-explains or applies the material. Only in Pairs #2 and #4 does Student A try to apply or re-explain the explanation that he or she has just heard. In Pairs #1 and #3, Student A states that he or she understands but does not take the next step to apply or say the ideas out loud in his or her own words. In Pair #2, Student A decides to try out what was learned on a new problem. In Pair #4, Student A paraphrases the explanation that Student B gave. In both Pairs #2 and #4, Student B shows good uptake (applying or re-explaining an idea) that is likely to enhance learning.

Discussing ideas. Let's now look more closely at one of the three types of responses from Table 15.2—the *discussion* response. The discussion response is particularly valuable because it engages students in extended elaboration of ideas that they are studying. Two modes of discussion are *critiquing ideas* and *co-constructing ideas*. **Critiquing ideas** refers to presenting ideas that challenge a peer's ideas in some way. It is closely related to presenting alternative perspectives. **Co-constructing ideas** occurs when one student adds to a peer's ideas in a way that the ideas become more elaborated or complex, without any overt disagreement.

An example of critiquing ideas comes from a study by learning scientists Randi Engle and Faith Conant (2002, pp. 425-426). Students were discussing criteria for distinguishing between dolphins and other whales. The class had visited Marine World, where a trainer had implied that dolphins had dorsal fins, whereas other whales do not.

Toscan:	Do dolphins have a dorsal fin?	
Brian:	No, no. …	
Toscan:	No they don't. Flat. [*starts to gesture back and forth horizontally*]	
Jonah:	Yeah, they do, see? [*holds up book and shows a picture*]	← Jonah effectively critiques Toscan's and Brian's claim simply by displaying a picture.
Toscan:	And they have- [*pause*] okay.	← Toscan responds to the critique by changing his mind.

Samantha: And I don't think whales do usually	← Samantha argues that whales don't have dorsal fins.
Brian: Um, yeah, some do.	← Brian disagrees.
Samantha: No	
Liana: No, only the killer whale has it.	← Liana partly agrees, but qualifies her agreement.
Toscan: The blue whale has one. [*general laughter*] . . .	← Toscan critiques the claim that whales lack dorsal fins by citing the blue whale.
Toscan: The blue whale has a teeny one.	
Brian: Yep, it's like that [*shows size with gesture, seems absurdly small*]	
Toscan: It has a teeny one, at the back of the fin, so the blue WHALE could be a dolphin.	
Samantha: [*laughs*]	← Samantha's laughter (supported by her later comments) indicates that she realizes that blue whales can't be dolphins, so that dorsal fins cannot distinguish between dolphins and whales. Thus, Toscan's critique has been effective.

In this group conversation, by critiquing each others' ideas, the students arrive at the realization that what the Marine World trainer told them is not correct. This was a highly productive discussion that led them to new insights about their topic of study.

An example of co-constructing ideas can be found in this example of thirteen year olds discussing Steinbeck's *The Pearl* in a small group (Barnes & Todd, 1977)

David: Well I, the best part I like were, when, when he went looking for the pearl down isn't sea, did you?	← Presents an initial idea
Marianne: Yeah, it should have … had a bit more description about the actual diving . . . Because if, if he's supposed to be a diver he hasn't spent much time diving has he?	← Takes up the topic of looking for the pearl and moves it in a new direction.
David: He just went down and it were there waiting for him, wasn't it?	← Takes up Marianne's new direction and adds that it was odd that, being inexperience at diving, he found the pearl right away.
Marianne: He should have had to search for it first.	← Makes David's last statement more explicit.
Barbara: It seems a bit funny that as soon as baby gets hurt….	← Builds on the theme of being improbably lucky by noticing another very improbably lucky event
Marianne: That he should find the pearl.	← Completes Barbara's idea when Barbara stops short

The students build on each others' comments, developing turn by turn a more sophisticated understanding of this episode in the novel.

Re-explaining or applying ideas. One form of uptake that we have not yet discussed is for students to *re-explain* ideas or to *apply* the ideas that they have heard. For instance, if a student in a group hears an explanation of how to do a math problem, the student can immediately re-explain it to herself, or she can immediately apply the idea to another problem. In her work on explanations in math classes, Webb and her colleagues (1995) found that hearing an explanation helped students only if the students who received explanations responded in one of the following ways:

1. The student restated the explanation in their own words.
2. The student reworked the problem or part of the problem after having heard the explanation.
3. The student applied the explanation to the next problem.

In contrast, students tended not to learn from explanations if they responded in any of the following ways:

1. The student just acknowledged the help received ("OK. OK. I got it.").

2. The student just copied what the partner had said.
3. The student didn't say anything at all in response to the help.

As a teacher, you will want to encourage students to apply ideas that they have learned from their peers. Students should take the good ideas that they receive from their peers and use those ideas in some way. This can include restating the explanation or using the information to solve the same problem or a new problem.

Using what you have just learned about uptake of ideas, reconsider the *Reflecting on Student Thinking* at the beginning of this chapter. You should pay close attention to how students respond to explanations or procedural descriptions that they hear.

Problem 15.3 Understanding students' thinking: Forms of uptake

As a teacher, it will important for you to be able to routinely identify the forms of uptake you observe in discussions. In each of these short examples, identify the kind of uptake demonstrated by Student B.

1. From a group discussing genetics in high school biology
   A. I would say that this is a recessive gene.
   B. Yeah. It's got to be recessive. It's the only thing that makes sense.
2. From a group discussing a Robert Frost poem in high school English
   A. This line—*But I have miles to go before I sleep*—shows that he doesn't have time to stay and take in all the beauty.
   B. Yeah. It shows how busy he is, and there's a sense of sadness that he has so little time to pause.
3. From a group discussing World War II in sixth grade.
   A. The Americans were pretty much all or the war, especially in Massachusetts. That's where it all started.
   B. Fifteen to 20 percent of the people were Tories. That's a lot. And I bet that some of these were in Massachusetts.
4. From a group discussing a photosynthesis experiment in seventh grade.
   A. I think that plants get their energy from the soil.
   B. No, it's from light.
5. From a group discussing *Jack and the Beanstock* in second gradel.
   A. Jack was foolish to sell his whole cow for some beans.
   B. A cow costs a lot more money than a bag of beans.

Response:
1. This is simple acceptance. B merely repeats what A says.
2. This is discussion of ideas. B elaborates what A said, so this is co-construction. They are building ideas jointly.
3. This is a discussion of ideas in which B critiques A. B presents a counterargument to A's claim that Massachusetts were nearly all for the war.
4. Using the categories in Table 15.2, this is rejection. B rejects A's answer without elaboration. Because there is no elaboration, it is not a critique. Using the categories in Table 15.1, you could also view this as terminal help. B simply provides what he thinks is the correct answer, without any explanation.
5. This is co-construction. B has elaborated on why it was foolish of Jack to sell the cow (the cow is worth more money—it costs more).

Problem 15.4 Understanding students' thinking: Which core processes of effective collaborative groups are present?

Lorena:	8, 9, 9, and 8… how much it is … 17, right?
Elisha:	Yeah, that's what I did.
Lorena:	Yeah, then you carry the 1, that's 9 and 9 is 18.
Kelsie:	*She wrote, "Oh, W…, I like you.*
Lorena:	Carry the 1, is 2…$2.89
Tatiana:	*You like her too?*
Lorena:	$5.00 it says there
Kelsie:	*No*
Lorena:	is 2 dollars 80…89 cents
Elisha:	89 cents?
Kelsie:	*You like, you like Andrea?*
Lorena:	Wait, and that's a … 4 minus 2 equals 2.
Kelsie:	*She lives downtown.*
Lorena:	And 10 minus 7 is 3.
Elisha:	OK.
Lorena:	So, erase the answer, just erase 8 and 7…that's it.
Tatiana:	*I don't want her phone number. I hate…*
Kelsie:	*You goin' crazy. You'all crazy.*
Tatiana:	*Like this. Me and J…we the only people that Andrea likes.*
Lorena:	And then write 13 cents.
Tatiana:	*She don't like you.*
Lorena:	Wait, you don't have to write the cents.
Elisha:	OK, I gotta go.
Kelsie:	*Then why'd she always look at me?*

Response. Let's examine each of the core processes.

Engagement. Two students (Lorena and Elisha) are generally engaged, despite the distraction of Kelsie and Tatiana holding a separate, unrelated discussion. Kelsie and Tatiana are not engaged and instead are *off-task.*

Positive interdependence. There is no positive interdependence. Kelsie and Tatiana feel no need to engage with the group to produce the group produce. Instead, they are *socially loafing*.

Mutual respect. Although Kelsie and Tatiana do not disparage each other, they are speaking disrespectfully of other class members. Their interactions are *negative*.

Balanced interactions. If Lorena and Elisha were working as a pair, their interaction would be balanced. But given that there are four group members, of whom two contribute nothing to the mathematical discourse, the group's *interactions are highly unequal*.

High-quality strategy use. Because Lorena and Elisha are the only ones engaged in any strategy use, we must focus our attention on them. If you follow through Lorena's comments and Tatiana's comments, you will see that Lorena provides procedural help in almost every turn. There are no explanations. For example, she does not explain why she is carrying out each step.

Uptake of ideas. Elisha adds nothing of substance to the discussion with Lorena. She does not co-construct any ideas. She simply accepts most of what Lorena says, without discussion, and with no re-explanation or uptake. As soon as they get the answer, Elisha abruptly leaves, without having tried out any of the procedures on a new problem. Therefore, it is unlikely that Elisha will learn much from this discussion.

Overall, this is a poor interaction all around. Two students were not only nonparticipants but showed a lack of respect toward other class members. The other two students were talking about the math problems, but Lorena's talk was all at a procedural level, and there was no uptake beyond acceptance by Elisha.

INSTRUCTIONAL METHODS
FOR PROMOTING EFFECTIVE GROUP PROCESSES

So far in this chapter, you have learned about the goals of and obstacles to effective groups and about core processes of effective groups. In this section, we will discuss practical teaching methods that can be used to foster the productive core processes and to avoid the obstacles.

The figure below summarizes the ideas presented in the chapter. Researchers have identified powerful instructional methods that promote the core processes of effective groups; these instructional methods are presented in the box on the left. By using these methods, you can promote core processes of effective groups, which in turn helps you achieve the central goals of collaborative learning. The methods you will learn in this section will also help you avoid the obstacles to effective group collaboration.

Using Rewards

An important issue in collaborative learning is how to use grades and other rewards. After reading about the debate over rewards in Chapter 8 (Motivation), you are aware that the use of extrinsic rewards in cooperative learning is controversial. Many researchers who investigate collaborative learning object to the use of rewards to motivate student performance in groups because of concerns about undermining intrinsic motivation (Cohen, 1994a; D. W. Johnson & Johnson, 1983). Other researchers argue that group rewards are essential for motivating productive group behavior (Hays, 1976; R. E. Slavin, 1996).

Reward structures. There are three methods for assigning rewards for group work (R. E. Slavin, 1984). These methods include:

Assigning a group reward for a group product. Using this type of reward structure, a group works together on a project and as a group, they earn the same reward regardless of individual contributions to the group product. For example, a group may be assigned to create a PowerPoint presentation, and every student in the group receives the same grade or reward based on the evaluation of that product.

Promoting group study and individual rewards. Under this reward structure, students study together in groups, but students earn all grades or other rewards individually. An example is a cooperative activity in which students study together for a spelling test, then each take the test individually, and the students get their own individual grades.

Offering group rewards for individual learning. With this system, all students in a group receive the same grade or reward, but the grade or reward is based on an average of group performance. For instance, a group of four students study spelling words together and then take a test. Their grade or reward is determined by taking the average score on the spelling test.

It is possible to mix methods. For instance, a teacher could have students study spelling words together in groups and then give the students a spelling test. The students' *grades* could be assigned individually based on each individual test score, but the teacher could additionally give a separate reward (a certificate, additional class privileges, etc.) to the group based on average performance. For instance, the teacher might give students additional class privileges if the average improvement over the last spelling test is 5% or higher.

STAD: An example of group rewards for individual learning. Educational psychologist Robert Slavin and his colleagues have developed a number of different approaches that employ group rewards for individual learning (DeVries & Slavin, 1978; R. E. Slavin, Leavey, & Madden, 1984). One well-known method is **Student Teams-Achievement Division (STAD***)*. Using STAD, the teacher has four to six students work together in teams that are heterogeneous with respect to ability, gender, and ethnicity. After the teacher has presented a lesson to the class, the teacher will provide students with worksheets to guide their work. For instance, a group of sixth graders studying ancient Rome might receive a worksheet with key information and questions about ancient Rome. The students quiz each other about the information covered by the worksheet, compare their answers, and work out any problems they encounter. At the end of the study period, each student takes a quiz. Each team's score is based on how much the students improved, on average, over their past scores. For instance, suppose that among the four students on a team, one student improves from an average quiz score of 72 to 80, a second improves from 78 to 95, a third improves from 84 to 90, and the fourth declines slightly from 96 to 95. This team's score would be (8 + 17 + 6 + -1) / 4 = 7.5.

On the basis of team performance, teams may receive rewards that can include certificates, recognition in class newsletters, or other tangible rewards. While some teachers may occasionally use grades as the reward, many favor assigning grades based on individual performance and, separately, providing additional rewards based on average group performance for individual learning. For example, students might earn grades based on their individual test performance, but their groups earn class points based on their average test performance. The students can then use their class points to "purchase" free time, computer time, books, or other prizes that the teacher has provided.

How reward structures promote core processes. Group rewards for individual learning is a reward structure that is tailor-made to promote positive interdependence in that students working in groups can earn rewards only if all students, on average, show sufficient improvement. Because low-performing students know that their contribution is important, they have an incentive to work hard. Similarly, high-performing students have an incentive to help low-performing students because they can receive rewards only if the low-performing students improve. Because group scores are based on improvement, even a failing student can contribute to the group just by making a modest improvement. As learners improve, their self-efficacy is likely to increase. Group norms will emerge that discourage off-task behavior because students will encourage each other to make the effort needed to secure the rewards. Thus, the group will also be more engaged.

In contrast, group rewards for a group product do not promote positive interdependence. For example, if a group of students is assigned a worksheet to turn in together for a group grade, the group can opt to let the most proficient student in the group do all of the work so that the entire group will end up receiving an A.

Problem 15.5   Evaluating teaching: Reward structures

Ms. Amborn, a fourth grade teacher, has worked out a lesson plan using group rewards. Her lesson is about forms of propaganda. She will introduce students to 12 propaganda techniques, such as jumping on the background and making overgeneralized claims. She will give groups of students 15 different advertisements from different times in history. The students will work in groups of four to determine which propaganda techniques appear in each advertisement. Ms. Amborn will determine what each student learns by having them create their own advertisement that incorporates at least 5 different propaganda techniques. Students will be allowed to help each other, but each student is responsible for his or her own work, and each advertisement will be graded individually. Then Ms. Amborn will provide rewards to the group based on the average quality of the advertisement in each group. Any group whose members correctly incorporate an average of 4 or more propaganda techniques in their ads will receive a reward. << The problem will include a small picture of a student's ad.>>

Evaluate this lesson plan from the point of view of reward structures. Is this lesson plan an instance of STAD? Is it likely to promote positive interdependence? Is it likely to promote individual student learning?

Response. The lesson plan shares many elements with STAD. Students work in groups. They are given a group reward, and the group reward is based on average student performance. However, there is also a crucial difference between this activity and STAD. In the STAD procedure described in the test, the reward was given for average individual learning on a test. There was no way for one student to help another on the test; therefore, the test assessed what each individual had learned. In Ms. Amborn's plan, the individual work is an advertisement, not a test, and students can help each other freely on it. If one student—say, Eric—does not understand the propaganda techniques, there is no need for other students to help him understand. They only have to tell Eric explicitly what to put in his ad. To make sure that Eric gets a high score on his ad, the most proficient student in the group might even do Eric's advertisement for him, leaving only the artwork for him to do. Eric can get a high score on the advertisement just by doing what his peers tell him to do, even if he does not understand the propaganda techniques at all. For this reason, Ms. Amborn's plan falls short of being STAD. It creates some interdependence, but it does not require students actually to help each other learn and understand the material.

The individual reward structure also presents obstacles to effective collaborative learning. For example, there is no incentive for proficient students to help a lower-performing peer in the group if the proficient students don't stand to benefit. Consider a case in which a teacher asks students to study spelling words together in groups. If the most skilled speller in the group knows that she can get 100% on the spelling test on her own, she may feel no desire to help another student in the course.

Research evidence on reward structures. In reviews of the literature on cooperative learning, Slavin (1983; 1984) examined experiments contrasting cooperative learning and individual (noncooperative) learning in regular classrooms. He found that cooperative learning was clearly superior to individual learning when there were group rewards for individual learning. When this reward structure was incorporated into cooperative learning, 24 of 27 studies (89%) showed positive effects of cooperative learning over individual learning. Among studies that used group study and individual rewards, 63% showed positive effects for cooperative learning. Among studies that used group rewards for group products as the reward structure, only 38% showed positive effects for cooperative learning.

Despite these positive results for group rewards for individual learning, there are three additional points to keep in mind about STAD and related reward-based methods.

Studies that support group rewards for individual products have not measured the role of intrinsic motivation as a possible outcome. Thus, it is possible that academic gains occur at a partial cost to intrinsic motivation.

For many educators, one goal of cooperative learning is to promote genuinely prosocial, caring, altruistic behavior by students. However, students are not—by definition—learning to help others altruistically when they are always rewarded for any help that they give (Batson, 1991; Noddings, 2002).

The tasks used in the studies cited in Slavin's classic review tend to employ fairly low-level cognitive learning tasks, typically involving reviewing material on worksheets provided by the teacher. As we will discuss in a later section, many collaborative learning experts urge teachers to use complex tasks at a higher cognitive level. A reward structure that is successful with lower-level cognitive tasks may be unnecessary for higher-level tasks with much greater situational interest, such as working on complex projects with topics chosen by students (Cohen, 1994b).

These three points suggest that teachers may want to consider alternatives to STAD, especially when they are engaging students in more complex projects with high situational interest.

Assigning individual grades. A thorny issue for teachers and students is whether and, if so, how to assign individual grades for group work. While some teachers may give every individual who worked on a project the same grade for that project, other teachers may assign individual grades based on how much credit each member deserves for the final project. In either case, collaborative learning expert Elizabeth Cohen (1994a) argued that teachers should not assign grades in this way:

> Never grade or evaluate students on their individual contributions to the group product. Even if it were true that a student contributed almost nothing, it is never clear that the student is at fault. Other students may have acted to exclude him or her from the process. Since the individual's lack of participation may be a consequence of a status problem, it is unfair to blame the victim for the group's low expectations of him or her. (p. 83)

Cohen (1994a) also argued that group products should not be graded because of the risks to low-status students. If a group wants to get a high grade, high-status students in the group may deliberately exclude a low-status student because of fears that that student's contribution will pull the grade down. And, as we have noted, there is a strong incentive for the most proficient student to take over the task. Cohen's recommendation is that the group's work should be put on public display but not be graded. The students' desire to create a product of which they can be proud of will provide sufficient motivation to ensure good performance. As yet, there is little research on these important questions.

Problem 15.6 Evaluating Teaching. Out-of-school collaborative assignments

Brian Hinman gives his high school students group work assignments that they must do out of school. He gives his own grade to the group product, such as a PowerPoint presentation. He also has students evaluate each group member's contribution to the group work using this form:

Your name: ________________________

Your project title: ____

On a scale from 1 to 10, evaluate your own contribution to this project, together with each of your fellow group members' contribution.

Name:	How much did this student contribute to the project?
Yourself	not at all 0 1 2 3 4 5 6 7 8 9 10 a lot
________________	not at all 0 1 2 3 4 5 6 7 8 9 10 a lot
________________	not at all 0 1 2 3 4 5 6 7 8 9 10 a lot
________________	not at all 0 1 2 3 4 5 6 7 8 9 10 a lot

Mr. Hinman is very careful to have the students fill out the form and hand it to him in a way that keeps the process private, so that no one knows how he or she has been evaluated by the other group members. Evaluate the pros and cons of this method.

Response: There are many pros and cons that you could consider. The method has some potential to deter social loafing because the students all know that their contributions will be evaluated by their peers. Providing a group grade may encourage students to put more effort *into the project than if it were not graded. On the negative side are Cohen's concerned that grading products may lead more proficient students to exclude less proficient students who they fear will bring the grade down. Moreover, if the more proficient students have excluded a less proficient students, then that student has not had a fair chance to contribute, and it is unfair for that student to receive low contribution ratings from his or her group members.*

An additional concern that arises with out-of-school collaborative group assignments is that some students may not be able to join a group meeting because of other after-school commitments. Three students may decide to meet to work on a project at one student's house on Monday evening because that is convenient for them. A fourth student may be unable to attend because her parents cannot give her a ride on Monday night, or she may be required to babysit siblings after school while her parents are working. Moreover, in out-of-school group meetings, teachers are not present to help ensure that students do not become disrespectful or even hostile, and some students may not feel comfortable or even safe in an unsupervised arena. Thus, in out-of-school group work, there can be many legitimate reasons why a student cannot join one or more group meetings.

Rewards are only one method that teachers can use to encourage effective group processes. Another kind of method involves providing students with clearly specified guidelines that encourage them to use high-level cognitive strategies in their group conversations. We will discuss these methods in the next section.

Guided Cooperation

Guided cooperation is a way of structuring collaborative learning tasks. In guided cooperation, students are given questions or instructions that specifically encourage them to use specific cognitive strategies. For example, pairs of students can be directed to take turns summarizing passages that they have read. We will examine three approaches to guided cooperation: (1) scripted cooperation, (2) Peer-Assisted Learning Strategies (PALS), and guided peer questioning.

Scripted cooperation. Scripted cooperation is a form of guided cooperation that provides students with a "script"—a set of questions to ask each other as they study together. Scripted cooperation is typically used with pairs of students. Consider the following example of how scripted cooperation might be used by two students studying a textbook together for a text (O'Donnell, 1999, p. 180):

1. The two students break the textbook up into sections divided by headings.
2. Both students read the first passage.
3. The students set the textbook aside so that they cannot refer to it. Both work from memory.
4. One student becomes the "recaller." That student's task is to recall and summarize what the passage said. The other student is the "listener." The listener's task is to "detect errors, identify omissions, and seek clarification of specific issues" (O'Donnell, 1999, p. 180).
5. Both students now talk about the text, adding elaborations to what they had said so far. They co-construct knowledge during this step.
6. If necessary, they may check what they have said against the textbook if necessary.
7. They repeat steps 2 through 6 for subsequent passages.

Studies of scripted cooperation have demonstrated strong positive benefits. Researchers have found that pairs who use scripted cooperation learned more than pairs who study together using their own methods and more than students who study individually (O'Donnell, 1999).

Peer-Assisted Learning Strategies (PALS). Another guided cooperation method is **Peer-Assisted Learning Strategies (PALS)**. PALS is designed to promote reading comprehension. As in scripted cooperation, students are provided with clear guidelines for questions to ask each other as they work in pairs. In pairs, the students retell passages, summarize what they read, and make predictions.

Special educators Douglas Fuchs, Lynn Fuchs, and their colleagues (1997) conducted a study in which they investigated the effectiveness of PALS as a collaborative learning method. They divided 22 schools into high-level, medium-level, and low-level schools, based on reading performance of the schools and the proportion of students on free or reduced lunch programs. (For instance, low-level schools were those with low reading scores and high proportions of students on free or reduced lunch.) Half of the schools at each level (high, medium, and low) were randomly assigned to the PALS condition, and half were assigned to the condition without PALS (no-PALS). Forty third-grade teachers in these schools volunteered. Each teacher elected a student with learning disabilities, a student who was a low-performing reader but did not have a learning disability, and an average-performing reader. The study focused on these three students in each class.

In the PALS condition, teachers implemented PALS 35 minutes per day, 3 times a week, for 15 weeks. Teachers paired all the students in their classes so that stronger readers were paired with weaker readers throughout the class. PALS pairs engaged in three kinds of guided cooperation activities: partner reading with retell, paragraph summery, and prediction relay.

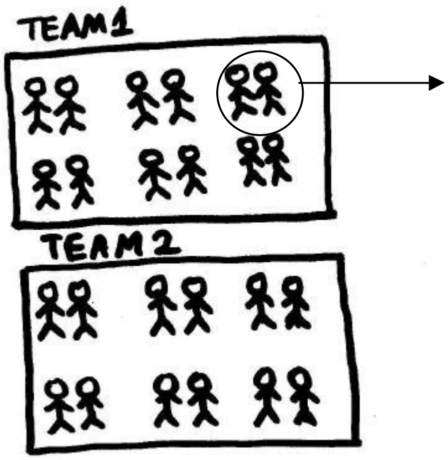
Partner reading with retell. In this group, the stronger reader read the text for 5 minutes. The weaker reader played the role of the *tutor*, checking and correcting any errors. Then the weaker reader read the same text while the stronger readier acting as the tutor. Thus, the students took turns playing the role of tutor. (Reading the same text a second time was intended to enhance the reading fluency of the weaker reader.) After each student finished reading, the partner asked the reader what he or she had learned first, next, and so on. The tutor's role was to fill in any information that the reader forgot.

Paragraph summary. This activity required students to take turns reading one paragraph at a time and then answer some questions, such as "Who or what was the paragraph about?" or "Tell the most important thing you learned in the paragraph." The students again took turns playing the role of tutor. The tutor was to follow up on incorrect responses by saying, "Try again."

Prediction relay. Beginning in the fifth week, students participated in *prediction relay*, in which readers made predictions about the contents of the next page, read aloud from the next page, checked the prediction, summarized the text that was just read, and then continued the cycle with a new prediction. After 5 minutes, the students switched roles.

All pairs in each class were also assigned to one of two class teams. Teams won points based on how successfully they achieved a number of goals, including: error-free partner reading, accurate retelling of the story, accurate presentations of summaries, reasonable predictions, and fulfilling other task requirements. Tutors and teachers were in charge of awarding the points each week. At the presentation of the award, the winning team stood and was applauded by the losing team; there were no other rewards of any kind. Thus, PALS uses a form of group rewards for individual learning. Several of the key features of the study are summarized in Figure 15.2.

Figure 15.2: The PALS procedure in the Fuchs et al. (1997) study. <This diagram provides a very rough sketch.>



Each pair within each team did the following 3 times a week:
--Partner reading with retell
--Paragraph summary
--Prediction relay
Teachers and tutors assigned points based on how well students did.

Each week, the team with the most points that week received applause from the other team.

In the no-PALS condition of this experiment, teachers were asked to teach reading in their usual way. These teachers usually had students read silently before they led whole-class discussions with their students. Thus, the teachers' goal was to improve students' reading ability, but they did not learn about or use the PALS method.

The chart below displays the percent correct on a reading comprehension test administered at the end of the 15-week program. (Percentages are low because the test was designed to be challenging.) You can see from the chart that students with learning disabilities and readers who are below-average especially benefited from PALS. In addition, on a *fluency measure* (how many words students read correctly in three minutes) and on another *comprehension measure* (of the ability to fill in blanks in a text with meaningful words), PALS students improved more than control students.

Figure 15.3: Results of the Fuchs et al. (1997) study

Figure 15.3 will be a bar chart of the results, showing percent correct

Learning-disabled students receiving PALS:	56.8%
Learning-disabled students receiving no PALS:	41.5%
Lower skilled readers receiving PALS:	53.0%
Lower skilled readers receiving no PALS:	44.5%
Average readers receiving PALS:	69.5%
Average readers receiving no PALS:	69.5%

The chart shows that lower skilled readers and students with learning disabilities benefited from the PALS method. Average readers did equally well with PALS and regular instruction.

Guided Peer Questioning. Educational psychologist Alison King (1994; 1999) has developed a method called **guided peer questioning**. The goal of guided peer questioning is to encourage students to engage in high-level comprehension strategies. To do this, students read a passage within a chapter and then question each other about that text using question stems. A question stem is a question with blanks for students to fill in as they ask each other questions. Examples are "Describe ____ in your own words" and "Explain why _____."

In King's (1994) study, the goal was to contrast the effects of two different sets of question stems. The first set of question stems consisted of "lesson-based questions." These questions focused on the information in the text. Figure 15.4 shows the lesson-based questions used in the study. The second set of question stems were "experience-based questions." These questions (also shown in Figure 15.4) focused both on the information in the text and on connections to students' own prior knowledge. In Figure 15.4, the questions that differed across the two conditions are in italics.

King studied 29 pairs of students (fourth and fifth graders) who were learning about human anatomy and divided them into three groups. In all three conditions, students studied their human anatomy textbook in pairs. One third of the students were taught to use the *lesson-based questions*. Another third of the students were trained to use *experience-based questioning.* (The two types of questions are described below.) Students in these two groups were given cue cards with question stems for the students to use when they worked in pairs to ask each other questions. The final group of students—the control group—were not trained to use any kind of questioning. They studied in pairs without using any cue cards.

To evaluate students' comprehension, the posttests included two types of questions:

Inference questions, which require students to make inferences or to integrate new information with knowledge that went beyond the information in a single lesson: i.e., "How is the cerebellum different from the medulla?" "What would happen if we had no bones?"

Literal questions, which are based on information stated in a single lesson: i.e., "Describe in your own words what a neuron is." "How many bones are in the body?"

On a posttest given immediately after the fourth lesson, both groups of students who used guided questioning did better than control students on both kinds of questions. On a delayed posttest given 7 days later, students who used the experienced-based questions did best, students who used the lesson-based questions were next best, and students in the control group performed the worst on both kinds of questions. Overall, this study strongly supports the use of guided questions in pairs. Furthermore, it illustrates the effectiveness of using questions that require students to integrate current knowledge with prior knowledge.

Figure 15.4: Lesson-based and Experience-based question stems

This figure shows the cue cards that were given to the students in the King et al. (1994) study. The card on the left shows the question stems for the lesson-based questions. The card on the right shows the question stems for the experience-based questions.

Lesson-based questions
Comprehension questions Describe _____ in your own words. What does _____ mean? Why is _____ important? Connection questions Explain why _____. Explain how _____. How are _____ and _____ similar? What is the difference between _____ and _____? *How does _____ affect _____?* *What are the strengths and weaknesses of _____?* *What causes _____?*

Experience-based questions
Comprehension questions Describe _____ in your own words. What does _____ mean? Why is _____ important? Connection questions Explain why _____. Explain how _____. How are _____ and _____ similar? What is the difference between _____ and _____? *How could ____ be used to _____?* *What would happen if _____?* *How does ____ tie in with ____ that we learned before?*

Problem 15.7. Designing instruction. Developing question stems for stories.
A student teacher in the third grade wants to develop question stems for students to use in Guided Peer Questioning when they are discussing stories that they have read. (The question stems in Figure 15.4 were designed for expository texts. The goal is to develop questions for narrative texts.) The student teacher proposes the following question stems. How could these questions be modified to be better?

What did ____ ?

Why did ____ ?

Where did ____ ?

How did ___ feel when ____ ?

Tell me more about ___ ?

Response. One issue to consider is whether the questions include both questions that are analogous to the connection questions in Figure 15.4 as well as questions that are analogous to the comprehension questions. These questions look mostly like comprehension questions, which address mainly the events in the story. The question stems would be most readily filled in with questions about what happened in the story, such as "How did Timmy feel when he opened the door?" or "What did Jen do after she came home?" There is a need for questions that will connect the students knowledge from one part of the text to another or from this texts to other texts that they have read. You should try to add questions that would help students make such connections.

Reciprocal teaching. Reciprocal teaching, which we discussed at length in Chapter 14 as a way of helping students improve their reading comprehension strategies, can also be used as a collaborative learning method. Unlike scripted cooperation, PALS, and guided peer questioning, reciprocal teaching is typically used with groups of three or more. When reciprocal teaching is used as a collaborative reasoning format, students work in groups of three or four. Students take turns being the leader, just as they do in the teacher-led reciprocal teaching that we discussed in Chapter 15. The students all read the same passage. Reciprocal teaching employs guided questioning in that the leader centers the discussion around four questions. The leader summarizes the passage and then asks a question based on the passage. The leader asks for or makes a prediction and invites questions of clarification. There is evidence that reciprocal teaching is effective at promoting growth in reading comprehension when used as a collaborative learning method (Rosenshine & Meister, 1994). Reciprocal teaching also illustrate that guided questioning methods can be used with groups larger than pairs.

Pedagogy 15.8. Understanding Students' Thinking: A pair discussion using guided peer questioning

Here is a pair of fifth graders using guided peer questioning. They are discussing an earth science topic, tide zones, from their science textbook. Evaluate the quality of the students' interaction.

Katie: How are the upper tide zone and the lower tide zone different?

Janelle: They have different animals in them. Animals in the upper tide zone and splash zone can handle being exposed—have to be able to use the rain and sand and wind and um—and they don't need that much water and the lower tide zone animals do.

Katie: And they can be softer 'cause they don't have to get hit on the rocks.

Janelle: Also predators. In the spray zone it's because there's predators like us people and all different kinds of stuff that can kill the animals and they won't survive, but the lower tide zone has not as many predators.

Katie: But wait! Why do the animals in the splash zone have to survive?

(From A. King, 1999, p. 97)

Response. Katie begins by asking a connection question (How are ___ and ___ different?). Janelle replies with an elaborated answer. Then Katie builds on Janelle's ideas (co-construction) by noting another characteristic of the lower tide zone animals. Janelle builds on the list of differences that she and Katie are jointly constructing. In the last line, Katie makes a implicit critique—questioning the idea implicit in Janelle's comments about the survival of the animals in the splash zone. In sum, Katie and Janelle use high-level strategies in this discussion, particularly elaboration. There is strong uptake of ideas as students discuss each others' comments using both co-construction and critiques.

How guided cooperation promotes core processes. Guided cooperation methods (including scripted cooperation, PALS, and guided peer questioning) promote many of the core processes of effective groups. First, guided cooperation is tightly focused on the goal of enhancing high-quality strategy use in classes. The scripts and the question cards explicitly direct students to use targeted strategies. Because students are expected to respond to their partners by answering questions or giving feedback, the methods encourage uptake of ideas. As students gain confidence that the strategies they are learning are enhancing their achievement, these methods should also boost students' expectations of success, which encourages engagement, as well. Students gradually master advanced cognitive strategies through repeated, engaged practice. Finally, guided cooperation promotes positive interdependence in that students must work together to perform the task. The formats require students to work together to take turns speaking and then attending carefully to what the other student is saying.

Guided cooperation versus traditional teacher and textbook questions. As you think about designing guided cooperation for your classes, keep in mind that the guided questions are a special kind of question. They are focused on useful strategies, and they are general enough to be used across many different specific tasks. This differs from more traditional questions found in textbooks, which focus on the current content rather than general strategies. For instance, consider the following questions from an earth sciences chapter in a middle school science textbook (Aldridge et al., 1998, p. 81):

1. At what point does magma turn into lava?
2. What differentiates the three types of seismic waves?
3. Describe how volcanoes and earthquakes are alike.

A guided questions approach such as King's guided peer questioning gives students the resources they need (the question stems) to develop these questions on their own (e.g., "What is the difference between _____ and _____?" or "How are _____ and _____ similar?"). By learning to develop their own questions, students learn more about how to think about the text than if they simply respond to questions that teachers or textbooks pose (A. King, 1999). Furthermore, by repeatedly using the same set of general prompts, they come to understand how the same strategies can be used in many different tasks.

In this section, we have examined methods that engage students in conversations using high-level cognitive strategies as they question each other about texts that they have read. In the next section, we will examine a very different instructional method to promote effective group processes: using complex tasks that go beyond reading and asking questions about a text passage.

Complex Tasks

Much of the research on collaborative learning during the past two decades has employed more complex, authentic tasks that require students to engage in activities such as solving realistic problems, writing skits, creating multimedia presentations, and carrying out original research. Here are some examples of complex tasks that can be used with collaborative groups:

- Fourth graders develop a skit about law enforcement in feudal Japan, working with a variety of source materials providing needed information (Lotan, 1997).
- A high-school social studies class develops a thorough plan to convert a vacant lot owned by the city into a playground. The plan includes detailed cost and use estimates.
- Middle school students research, design, and implement a plan to reduce nitrogen run-off from their school's ground (Malhotra, Chinn, & Obrupta, 2005).
- A second grade class investigated how the length of their shadows changes as the day progresses (Wainwright, 2002).
- A high school history class develops a museum exhibit that teaches museum goers about the Robber Baron Age.
- A kindergarten class transforms their room into a travel agency with posters, brochures, ticket booths, and so on.

These tasks require at least several hours to accomplish. Many require days or even weeks of work for successful completion. They also require a great deal of higher-order thinking and high-level strategy use.

These tasks differ markedly from more traditional teacher and text activities. They also differ from the scripted interactions found in guided cooperation methods. These complex tasks require more complex strategy use, and they have the potential to be highly motivating. The tasks are varied, challenging and open-ended, and relevant to students' lives. They arouse curiosity. As you learned in Chapter 11, motivation can be enhanced by using tasks that have these properties. Therefore, complex tasks have the potential to arouse intrinsic motivation.

Characteristics of complex tasks that promote core processes of effective collaborative learning. Most complex tasks have several characteristics, which are listed in Figure 15.5. A task does not have to have all of the characteristics below to be effective, but a task that has few or none of these characteristics may not be very effective in promoting learning. These characteristics are summarized in Figure 15.5.

Characteristic #1. In effective complex tasks, students must use *multiple strategies and diverse knowledge* (Cohen, 1994a). To promote positive interdependence, it is important that the task be complex enough that no one student has all the knowledge and resources to successfully complete the task. For example, when students are trying to investigate the question, "Why do I need to wear a helmet when I ride my bicycle?" (Singer, Marx, Krajcik, & Chambers, 2000), they will likely find that all students in the group have ideas that are relevant to tackling this question.

Characteristic #2. Effective tasks are also relatively *challenging and open-ended*. When tasks are simple and have a single right answer, it is far too likely that a single student will produce the answer, circumventing productive group processes (Cohen, 1994a). Challenging, open-ended tasks require students in the group to share their diverse perspectives in order to reach the best solution.

Teachers sometime undermine their collaborative tasks by providing so much detail that they turn a good open-ended task into a trivial task that requires no collaboration for completion (Cohen, 1994a). For instance, consider a teacher who poses this problem:

> "How much paint would it take to paint the walls in this room? The walls in this room cover 910 square feet. It takes 1 gallon of paint to paint 350 square feet, and you will need 2 coats to completely cover the blue."

Contrast this with a second version of the same problem:

> "How much paint would it take to paint the walls and ceiling in this room?"

If the teacher poses the first problem, he has provided so much information that the groups may have little to talk and think about. The students now know that gallons-of-paint-per-square-feet is a relevant number. If the teacher had posed the second problem, they would have had to figure this out on their own. In the first problem, the teacher has oversimplified the problem by providing the square footage of the walls, instead of having the students work it out themselves. He has also removed the need to figure out how many coats would be needed. Thus, the second question is more challenging, and it would probably evoke more productive, engaged group talk.

Figure 15.5 **Characteristics of complex tasks that promote core processes of effective collaborative learning**

1. To complete the tasks, students must use multiple strategies and diverse knowledge

2. The tasks are challenging and open-ended.

3. To solve the tasks, students must consider multiple sources of information and must conduct various types of investigations.

4. Students produce public artifacts.

Characteristic #3. Effective complex tasks invite students to consider *multiple sources of information* and to conduct *various types of investigations* (Cohen, 1994a; J. Krajcik, Blumenfeld, Marx, Bass, & Fredricks, 1998). Students investigating why a tree on the school grounds is dying will need to investigate the question using many different sources of information, such as: library books on trees and diseases, information from websites, certain chapters in textbooks, encyclopedia entries, and /or inquiries to government offices. Students might also observe the tree and compare it to similar healthy trees on the grounds to determine what about the tree is unhealthy and where the source of the problem might be. To help make that determination, the student might design some experiments to glean more information (Olson & Loucks-Horsley, 2000). Having a variety of activities, including hands-on investigations, is motivating to students and encourages them to use deeper learning strategies (Guthrie et al., 2004).

Characteristic #4. Many researchers who advocate complex tasks recommend that groups of students produce **public artifacts** (Cohen, 1994a; Herrenkohl & Guerra, 1998; Lehrer, 1993). Public artifacts are artifacts that students make public. For example, teachers might have students produce hypermedia presentations that summarize what they have learned in a project investigating clothing worn during the Civil War (Lehrer, 1993). Students present to other members of the class. Kindergarteners fill the room with posters and other information for their "travel agency" and invite parents and others in the community to come and see what they have done. High school students prepare a multimedia presentation to persuade a corporation to locate their headquarters in their town; they share their presentation with the town's chamber of commerce. Elementary school students make a scientific presentation at a "conference" in which two classes come together to present the results of their research.

Public artifacts promote engagement by giving students a real audience to present to. The artifacts help focus students' attention jointly on a product that they will produce. Because it is public, they will be more likely to hold themselves to high standards. They will be more likely to critique work that is not up to these standards. They will be motivated to engage in the high-quality cognitive strategies needed to produce a product of which they can be proud.

How complex tasks promote core processes. By recommending complex, open-ended tasks, researchers are trying to foster positive interdependence. The tasks are designed to be intrinsically motivating, which enhances engagement. To that end, all group members must work together to complete complex task because the tasks are difficult enough that multiple perspectives are needed to solve the problems. To complete complex tasks successfully, students must attend to each others' ideas, especially when peers offer new perspectives that others had not yet considered. In these cases, students are using high-level cognitive strategies to complete these tasks.

Many different collaborative learning approaches have been developed that implement most or all of these principles of developing tasks. Following are three different cooperative learning methods that employ complex tasks and that have shown positive results in empirical studies.

Pedagogy 15.9. Designing Instruction. Alvin's Masterpiece.

Fourth-grade students are to discuss a story called "Alvin's Masterpiece." In the story, a boy named Alvin is trying to create a painting on canvass for an art contest at a local art museum. After many failures, Alvin sees that he is largely covered in paint as a result of all of his efforts and decides that he himself is a masterpiece. He takes a large frame and stands in the museum behind the frame. He wins a prize in the contest.

Rank order these four tasks for use with groups of five. The particular goals of the task are to arouse engagement, stimulate high-level strategy use, encourage a good understanding of the story, and promote a good understanding of the issues raised by the story.

#1	#2	#3	#4
Discuss these questions: 1. What did Alvin want to do? 2. Why did he want to do it? 3. What did Alvin's masterpiece turn out to be? 4. What did he decide at the end of the story?	Did Alvin *really* create a masterpiece? There is a table of resources at the back of the room that you can use you help you decide. Be ready to report all your group's best arguments to the class.	Create a storyboard showing 5 important occurrences in this story. You should have five images in your storyboard.	Students are given a folder with pictures of works of four works of art and short descriptions of how each of the four artists created this work. The pieces of art are: Jackson Pollock, *Shimmering Substance* Paul Klee, *Red and White Domes* Abramovic & Ulay, *Rest Energy* (performance art) Elena Madden, *Unexpected Discoveries of Nature.* All of these works are viewed as masterpieces by at least some art experts. What do they have in common? If these are masterpieces, did Alvin create a masterpiece?

Response. #1 is not a complex task. There is no need for multiple sources of information or various kinds of investigations. The students merely answer comprehension questions about the story. #3 is also not complex. Although the students may enjoy drawing pictures, most students probably already understand most of the central events in the story, so the task of generating 5 important occurrences is probably not cognitively challenging for most students.

#2 qualifies as a complex task. This question engages students in high-level thinking about some of the fundamental questions of philosophy—what makes art beautiful? If the resources include information about how different people define art, then students will be exploring different sources of information and asking exploring different subquestions as they explore the available materials. Although the students do not construct a public artifact , they do prepare a public presentation.

#4 is an interesting task that raises the same philosophical issues as in #2 and thus encourages some of the same high-level thinking. Although it is not as complex an activity as #2, because fewer resources are provided for students' consideration, it does provide students with a rich base of information to use as they think about what a masterpiece is. #4 lacks a public artifact or presentation of any kind, but that could easily be added to the activity.

Group Investigation. In **Group Investigation** (Y. Sharan & Sharan, 1992), teachers provide the class with a broad topic, and student groups select their own subtopics for investigation and decide how to investigate these subtopics. Figure 15.6 shows the stages of implementation of a typical Group Investigation.

Figure 15.6: Stages of Group Investigation. These are the stages that students in a group follow when they engage in a Group Investigation.

Stage I: Class determines subtopics and organizes into research groups. Students scan sources, propose questions, and sort them into categories. The categories become subtopics. Students join the group studying the subtopic of their choice.
Stage II: Groups plan their investigations. Group members plan their investigation cooperatively; they decide what they will investigate, how they will go about it and how they will divide the work among themselves.
Stage III: Groups carry out their investigations. Group members gather, organize, and analyze information from several sources. They pool their findings and form conclusions. Group members discuss their work in progress in order to exchange ideas and information, and to expand, clarify, and integrate them.
Stage IV: Groups plan their presentations. Group members determine the main idea of their investigation. They plan how to present their findings. Group representatives meet as a steering committee to coordinate plans for final presentation to class.
Stage V: Groups make their presentations. Presentations are made to the class in a variety of forms. The audience evaluates the clarity and appeal of each presentation.
Stage VI: Teacher and students evaluate their projects. Students share feedback about their investigations and about their affective experiences. Teachers and students collaborate to evaluate individual, group, and classwide learning. Evaluation includes assessment of higher level thinking skills. (Table from Y. Sharan & Sharan, 1992, p. 72)

Researchers have found that students learning in classrooms with Group Investigation outperform control groups of students learning in classrooms that did not use participate in Group Investigation (Lazarowitz & Karsenty, 1990; Shachar & Fischer, 2004; Shachar & Sharan, 1994; Y. Sharan & Sharan, 1989/1990, December). The studies conducted span a variety of ages and subject matters.

Here is an example of a Group Investigation from a class of eighth graders (adapted from Y. Sharan & Sharan, 1992). The teacher has offered the following the recommendations using group investigation procedures. First, the teacher posed the general topic (Arizona Native Americans) as a question, "In what ways do the Native Americans in Arizona differ from Native Americans in other states?" The class generated a list of possible subtopics. Five students were interested in one of these subtopics, "How did Native American tribes adapt their dwellings to the environment?" and so they formed a group to investigate this question. Following is the transcript in which the students begin planning how to investigate their subtopic:

Elliot:	Should we read about every … tribe?	The students are focused well on laying out a plan of investigation.
Nancy:	Each one of us could take a different tribe . . .	
Bob:	But there are so many, and they live in such different places.	
Jean:	We don't have to read about every tribe. Let's take those who live in totally different surroundings.	Jean makes an interesting point that that the most interesting analyses would contrast tribes that were most different.
Shel:	I'd like to know why the ancient [Native Americans] lived the way they did.	Shel identifies a particular learning goal.
Elliot:	Well, should we stick to the tribes of today or study the ancient tribes, too?	
Jean:	We have a lot of material on the Navajo… (adapted from Y. Sharan & Sharan, 1992, p. 77)	Jean notes a useful practical consideration.

The groups then complete a group planning form that lays out their plan (see Figure 15.7). Note that the students have assigned themselves roles. We will discuss roles in more detail later in this chapter; for now, the key point is that students with different roles have different tasks that they are to especially focus on. For instance, in the group who wrote the plan in Figure 15.7, Jean and Nancy have taken the role of resource persons. This means that they are responsible for identifying good resources and collecting them for the group. In taking the role of coordinator, Bob is responsible for monitoring that everyone does their work in a way that it will fit together well in the end. The students spend multiple classes locating their information and preparing a presentation for the class.

Group Investigation has been used successfully in grades ranging from early elementary through high school. In all cases, this method gives students a great deal of control over their learning. Because the tasks are open-ended and complex, students must learn and use an impressive range of self-regulatory strategies in order to manage their group tasks.

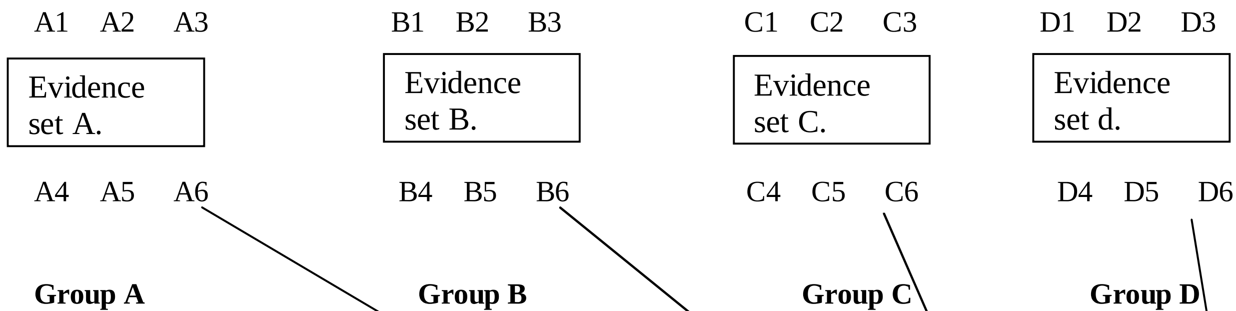
Figure 15.7: Group Planning Form, Group Investigation. [This is filled out in handwriting.]
This form has been filled out by a group students as they have planned a Group Investigation focused on how Native American tribes adapt their dwellings to their environment.

OUR RESEARCH TOPIC:	*How did Native American tribes adapt their dwellings to their environment?*
GROUP MEMBERS:	*Bob, Elliot, Jean, Shel, and Nancy*
ROLES:	*Bob—coordinator; Jean and Nancy—resource persons; Elliot—steering committee; Shel—recorder.*
WHAT DO WE WANT TO FIND OUT?	*Bob and Nancy—How did the nomadic Apaches design their shelters?* *Elliot and Jean—In what way did the hogans suit the Navajo way of life?* *Shel—What kind of dwellings did the ancient Native Americans live in?*
WHAT ARE OUR RESOURCES?	*Under this heading the recorder will list the books to be read, the people to be interviewed, and the sites (such as museums) to be visited. Perhaps all five members of this group will visit the same site, but each one will prepare different questions to ask. Students might also opt to build models or other activities.* (adapted from Y. Sharan & Sharan, 1992, p. 78)

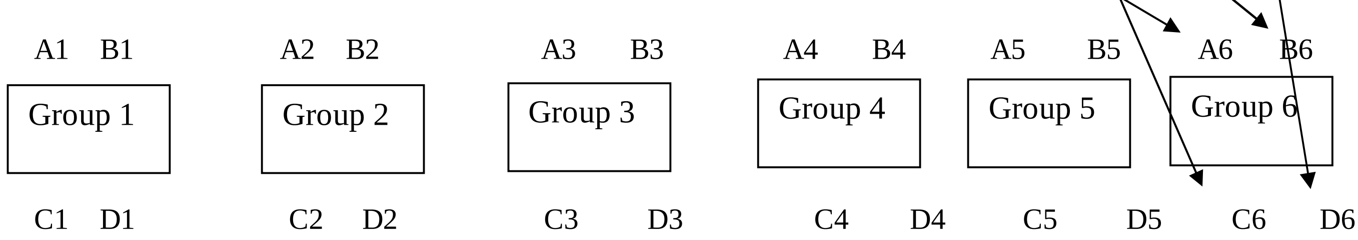
Jigsaw. As discussed earlier in the chapter, jigsaw (Aronson, 1978) is a format for collaborative learning that focuses on ensuring positive interdependence. Recall our example from earlier in the chapter when students were creating a classroom aquarium. In another example, a high school English literature class is investigating evidence bearing on whether William Shakespeare really wrote the plays that are credited to him. The teacher divides the class of 24 students into four groups of 6 (Groups A, B, C, and D), and each group reads about and discusses some evidence bearing on this issue. The evidence read by each group is different. The groups discuss their evidence, making sure that each person understands it, and then discuss how convincing the evidence is. When each group is finished, six new groups of four are formed. Each group of four contains one member from Group A, one from Group B, one from Group C, and one from Group D. Thus, each new group now is fully equipped to evaluate all of the evidence and to reach a decision. Each member of the new group must be able to explain her or his evidence clearly so that the whole group can reach a sound decision that takes account of all of the evidence (see Figure 15.8).

Figure 15.8: Jigsaw. This diagram shows how jigsaw works.

Step 1. Initial groups are formed. Each group becomes expert on a different set of evidence bearing on whether William Shakespeare really wrote the plays that are credited to him. There are six groups. (Each student is represented by a letter. Student A1 is the first student in Group A, Student A2 is the second student in Group A, and so on.) The students in each group become experts on their evidence set as they study and discuss their evidence set.



Step 2. Now new groups are formed. Each group has one expert from Group A, one expert from Group B, one expert from Group C, and one expert from Group D. (The arrows show where the members of one group—Group 6—came from. Other groups are formed in the same way.) Collectively, then, each group has information from all four evidence sets available to reach a judgment about whether Shakespeare really wrote Shakespeare's plays.



The example above shows how a jigsaw format is used to solve a problem. There are other applications of jigsaw, however. Research has demonstrated how jigsaw is used to help students learn one topic in groups and then teach that material to others. For instance, in one project,

> Students are assigned curriculum themes (e.g., changing populations), each divided into approximately five subtopics (e.g., extinct, endangered, artificial, assisted, and urbanized populations). Students form separate research groups, each assigned responsibility for one of the five or so subtopics. These research groups prepare teaching materials using commercially available, stable computer technology …. Then, the students regroup into … seminars in which each student is expert in one subtopic, holding one-fifth of the information. Each fifth needs to be combined with the remaining fifths to make a whole unit, hence "jigsaw." All children in a learning group are expert on one part of the material, teach it to others, and prepare questions for the test that all will taken on the complete unit. …All children are responsible for mastery of the entire theme, not just their fifth of the material. So the burden of teaching others from expertise is a real one…." (A. L. Brown & Campione, 1994, pp. 233-234)

In this example, each student's newly acquired expertise is necessary so that each student in the group will be fully prepared for exams and other class activities that use the information. Positive interdependence is explicitly structured into the task. Research on jigsaw has found positive effects (Aronson, 1978; Lazarowitz, Hertz-Lazarowitz, & Baird, 1994), although in some studies positive effects were found only if jigsaw was combined with group rewards for individual learning (R. E. Slavin, 1984).

Problem 15.9. Designing Instruction. Jigsaw

Choose a future class and topic that you expect to teach someday in the future. Outline a jigsaw activity that you could use to promote learning.

Response: As you create your activity, be sure that the task in Step 2 really requires students to pool the information that from Step 1 to solve a problem or reach a decision.

Constructive controversy. As you learned in Chapter 12 (discussions and questioning) *productive argumentation* promotes learning by building on and challenging ideas. Johnson and Johnson (D. Johnson & Johnson, 1992; D. W. Johnson & Johnson, 1995, 2000) have developed a method called **constructive controversy**, based on productive argumentation. Constructive controversy encourages students to present reasons and evidence for positions, but in a way that is open-minded. Constructive controversy is unlike debate where opponents are at opposite sides of an argument; students participating in constructive controversy build knowledge together, present reasons and evidence for their positions, and are fully willing to change ideas.

To promote constructive controversy, teachers select a topic for discussion. They assign students to heterogeneous groups of four, and each group is further divided into two pairs. Each pair is assigned to a position on a particular topic for which they are to become expert and develop persuasive arguments for use when the entire group of four gets back together. For example, in one experiment (K. Smith et al., 1981) students considered the issue of the advisability of strip mining for coal. One pair of students read texts providing arguments for strip mining, and the other read material against strip mining. Students work together to learn their assigned positions and the evidence for those positions. When the pairs reconvene, they then present their position and arguments to the other pair. The group of four then discusses the issue, both arguing for their position and listening carefully to the other side. As one pair presents their position, the other pair is instructed to take careful notes so that they understand it well. Students are then asked to reverse positions and present the opposing position as if it were their own. Finally, the students each discuss their own points of view, and the group is directed to reach consensus on the position that is best supported by the evidence. The students then write a group reporting stating their position and the arguments that led them to support it. Students also take a posttest on both positions.

Johnson and Johnson (1995) summarized the results of 25 experiments investigating the use of controversy-based collaborative groups. Participants ranged in age from early elementary through college and adult. These experiments demonstrated clear positive effects of constructive controversy on mastery of content, reasoning ability, ability to understand more than one perspective on an issue, motivation, feelings of liking of group mates, social support of group mates, and self-esteem. Constructive controversy was found to provide superior results on all these measures in comparison to students working individually and to students instructed to seek consensus (rather than to argue constructively). Constructive controversy is also superior on all these measures to debate formats, in which students only try to persuade each other to change positions (D. W. Johnson & Johnson, 1995).

Scaffolding Complex Tasks

Many students are not ready to undertake complex tasks on their own without assistance. Therefore, teachers must provide scaffolding to enable students to complete complex tasks successfully. Students learn through a process of guided participation, in which teachers provide scaffolding that so that students can perform a task that they could not learn on their own. Scaffolding refers to assistance that is provided to help students do a task that many students would be unable to do on their own without these this assistance (Puntambekar & Hübscher, 2005; Quintana, 2004; Sherin et al., 2004). We have discussed scaffolding in a number of chapters. In this chapter, we will focus on several scaffolding methods that teachers can use with their collaborative groups, which will enable these groups to succeed at complex tasks. Figure 15.9 provides an overview of the forms of scaffolding we will discuss.

Figure 15.9 Methods of scaffolding complex tasks during collaborative group work

1. Preteaching needed knowledge and strategies

2. Task decomposition–breaking a task into steps

3. Cognitive prompts--posing questions that direct students to use particular cognitive strategies.

4. Social and cognitive roles--assigning students to take the lead on particular tasks such as being group leader, recording the group's ideas, or ensuring that the group provides explanations.

5. Providing hints–responding to students difficulty by giving some information that can help them through the difficulty

6. Self-evaluation–Having groups of students evaluate the quality of their own group processes using criteria that they help design.

7. Fading scaffolding–over time reducing the level of scaffolding provided so that students can do more and more of the task on their own.

Preteaching needed knowledge and strategies. One option is to teach students essential background knowledge and strategies before they begin group work. For example, a teacher might introduce students to argumentation strategies before having students carry out a constructive controversy.

Task decomposition. A second scaffolding method is to decompose the task into smaller segments. For instance, Group Investigation accomplishes this by breaking the investigation tasks into the six stages presented in Figure 15.6.

Cognitive prompts. Cognitive prompts are questions or cues that remind students to think about certain issues or to use particular strategies. The question stems in guided peer questioning (see Figure 15.4) are examples of cognitive prompts. In guided cooperation methods, following the cognitive prompts is the very purpose of the task. In contrast, when cognitive prompts are used as scaffolds for complex tasks, the purpose of the task is not to follow the prompts but to solve a larger problem (such as finding out how different Native American tribes differ). The cognitive prompts are used to support students as they try to pursue this larger task.

Barbara White and John Frederiksen (1998) successfully used a variety of cognitive prompts in science lessons with sixth graders. One set of prompts that they used focused on how to design, carry out, and interpret experiments with moving objects and forces (see Figure 15.10). The overall goal of the students' work was to develop explanatory models of forces and motion. The researchers specifically prompted students to focus on experimentation processes that they knew to be difficult for students.

Figure 15.10: Cognitive Prompts for Conducting Experiments

For each experiment, you need to do the following:

1. Create a plan with:
   A sketch showing how you will set up the experiment.
   A description of what you will do and how you will measure the velocity of the ball.

2. Do your experiment.
   Record your data in a clear and organized way.
   Record any problems you had in doing your experiment.

3. Analyze your data and present your conclusions.
   State any laws you discovered that predict and describe what happens
   Give an explanation for why this happens.
   Explain how your results agree or disagree with what you predicted would happen when you stated your hypotheses. (White & Frederiksen, 1998)

These cognitive prompts direct students to engage in key cognitive processes needed to design, execute, and interpret experiments.

King (1991) taught fifth graders to solve a variety of prompts problems using the cognitive prompts, as illustrated in Figure 15.11. Collectively, these questions were designed to promote self-regulated problem solving by encouraging effective goal setting, monitoring, and self-evaluation. Students who solved problems using these strategies outperformed control students in two conditions, one condition in which students were encouraged to asked questions of each other while solving the problems and another condition in which students were not directed to ask each other questions (A. King, 1991).

Figure 15.11. Cognitive prompts for developing plans to solve a problem.

PLANNING	MONITORING
1. What is the problem? What are we trying to do here? 2. What do we know about the problem so far? What information is given to us? How can this help us? 3. What is out plan? 4. Is there another way to do this? What would happen if…? 5. What should we do next?	1. Are we using our plan or strategy? Do we need a new plan? Do we need a different strategy? 2. Has our goal changed? What is our goal now? 3. Are we on the right track? Are we getting closer to our goal? EVALUATING 1. What worked? 2. What didn't work? 3. What would we do differently next time?

These cognitive prompts direct students to engage in key cognitive processes needed to develop plans to solve problems. They are designed to be generally useful on a wide range of problems.

Ann Britt and Cindy Aglinskas (2002) developed cognitive prompts to help students address one of the common reasoning problems you learned about in Chapter 7—students' failure to consider source information when evaluating historical evidence. These researchers devised a task in which students evaluated source documents that chronicled the events in Panama in 1903 that made it possible for the United States to build the Panama Canal. For each document read, students filled out a card that directed them to think explicitly about who the source was, what the sources motives might have been, how the source knew what was claimed to be known, and so on. Figure 15.12 shows the information contained in one of these cards.

Figure 15.12: Cognitive Prompts for Evaluating Sources of Historical Documents

Document:
Who:
Position:
How know:
Author motives:
When:
Type:
Docs mentioned:
Main point:
Comments:

These prompts were written on cards in a study by Britt and Aglinskas (2002). Students completed cards for each historical document they read.

Cognitive prompts can presented not just as lists of questions but in the form of graphs or charts that students fill out. We discussed this form of scaffolding in Chapter 14.

As you think about designing cognitive prompts for your classes, keep in mind that cognitive prompts should be general enough that the same set of prompts can be used across different tasks. For example, the prompts used by White and Frederiksen (White & Frederiksen, 1998) to guide students' experimentation could be used with any of the experiments that the students conducted over many weeks.

Problem 15.10. Evaluating Teaching: Cognitive Prompts in a history class

A seventh grade teacher has assigned groups of three students to be the "editorial board" for a local newspaper in the year 1832. Their job is to evaluate what they've learned about Andrew Jackson's first term and decide whether to support or oppose Jackson's reelection bid. The teacher wants students to learn how to write persuasive essays of this sort, so she gives them cards with these cognitive prompts.

1. Decide whether you think that Andrew Jackson should be reelected.
2. Support your ideas with evidence from Jackson's first term (such as his positions on patronage, the Bank of the U.S., and infrastructure)
3. Think about what arguments on the other side would be, and think about how to argue against those arguments.

Evaluate this cognitive prompt card. Should it be changed? If so, how?

Response: One problem with these prompts is that the first two are completely specific to this task. To promote generalization, cognitive prompts are typically worded more generally, such simply "Generate reasons and evidence in support of your idea." Another issue that arises with this set of prompts is whether there are enough prompts to get students to think about the full range of writing strategies (recall these from Chapter 7). There are no questions that encourage organization, major revision, minor revision, or audience consideration. In the problems at the end of the chapter, you will see other set of cognitive prompts for a writing task that you can compare with this set.

Social and cognitive roles. Another form of scaffolding that may improve group collaboration is to assign *roles* to each student. **Social roles** focus on social and procedural processes that the groups perform. For instance, one possible social role is discussion leader. The discussion leader is responsible for making sure that the discussion runs smoothly and that everyone is contributing. Another social role is cleaning up. The student responsible for cleaning up carries out a crucial procedure that the group must perform. **Cognitive roles** focus on the use of particular cognitive strategies the group must use to solve a problem (cf. Herrenkohl & Guerra, 1998). For example, a possible cognitive role is *explainer*. The explainer would be responsible for ensuring that the group engaged in good explanations.

As an example of social roles, Elizabeth Cohen (1994a) developed roles for a project involving collaborative learning with second grade students. These roles were predominantly social roles because they focused on social and procedural processes that the groups were to perform. Figure 15.14 provides example of these roles. Teachers first assign each child a role and then had the children switch roles periodically. Teachers decided which roles to use for a given task, although groups always had a facilitator. Another example of predominantly social roles comes from the Group Investigation example that you saw earlier (Y. Sharan & Sharan, 1992). The group of students whose plan is shown in Figure 15.7 selected for themselves the roles of coordinator, resources persons, steering committee, and recorder. These roles focus mainly on managing the group's procedures as they carry out the process (e.g., locating resources, recording findings, and so on).

Cohen (1994b) urged teachers to avoid role divisions such as "thinker" and "typist"; which leads some students to be intellectually involved and others to be passive and uninvolved. It is important the roles be comparable in responsibility and that some roles do not imply a low level of participation.

Other roles that teachers can assign are more cognitive than social. Johnson and Johnson (1991) suggested the following roles:

- *Summarizer:* Restates the group's major conclusions or answers.
- *Checker:* Ensures that all group members can explicitly explain how to arrive at an answer or conclusion.
- *Accuracy coach:* Corrects any mistakes in another member's explanations or summaries
- *Relater/Elaboration seeker:* Asks members to relate current concepts and strategies to materials studied previously.
- *Recorder:* Writes down the group's decisions and edits the group's report.
- *Observer:* Keeps track of how well the group is collaborating (D. W. Johnson & Johnson, 1991, pp. 67-78).

The first four roles are distinctly cognitive, in that each one focuses on the use of a cognitive strategy that the students in the group must use to solve a problem. For instance, the accuracy coach is responsible for monitoring the performance of other students. The relater/elaboration seeker encourages the use of the strategy of elaboration.

Figure 15.14: Examples of Social Roles

Facilitator: Sees to it that everyone gets the help he or she needs to do the task; is responsible for seeking answers to questions within the group; teacher is only queried if no one in the group can help.

Checker: Makes sure that everyone has finished his or her worksheet, and has answered all of the questions.

Set-Up: Is responsible for setting up all the materials at the learning center. Materials are stored in such a way that a child can easily gain access to what he or she needs it. The student responsible for set-up is provided with pictures that show what materials are needed and where to put he materials.

Clean-up: Is responsible for putting away materials properly and wiping off the table.

Safety Officer: Is responsible for supervising tasks involving heat or sharp edges and for notifying adult of potentially dangerous situations.

Reporter: Is responsible for telling the class what the group discovered during the wrap-up.

These social roles were used in a study with second graders described by Cohen (1994a) .

To ensure that the assigned students understand their roles, teachers must make the responsibilities of the role clear. Cohen (1994a) recommended using activity cards for each role. For example, a teacher could give each group facilitator in an elementary class a card that specifies the duties of the facilitator. The card could state “Give everyone a fair turn; give reasons for ideas; offer different ideas.” (Cohen, 1994a, p. 99). Figure 15.15 presents a role card for the role of recorder.

Figure 15.15. A role card for elementary school students taking the role of recorder.

Recorder

Your job:

Write down your group’s main conclusions

Example questions to ask group:

What are the ideas we should write down?

Which of these ideas is more important

from Cohen (1994a)

Each student in a group receives a role card specific to their role. The card includes example questions that the student can ask to fulfill the responsibilities of the role. In a class discussion about the various roles, the teacher can ask students to help generate what questions would be appropriate for each role.

Cohen (1994a, p. 99) presented this example of how an elementary school teacher could help students learn the leader role. The teacher would present this explanation to the whole class as she discusses the roles with them:

> "But if things are not okay, then the good leader knows how to help his group. When wouldn't things be going okay? (Children may suggest, and if not, trainer mentions the silent group, the non-participator, the monopolizer.) If someone in the group never gives anyone else a chance to talk—or if one person doesn't talk—a good leader can help by asking questions—or reminding the big talker that someone else needs a chance. We'll talk about how to do this without making others angry. But remember—the good leader uses these ideas only when they're needed. Most of the time the good leader is just like everyone else in the group listening and taking turns talking."

After this discussion, students practiced the leader role by taking turns playing the role of leader in group discussions.

In a project in which sixth graders are conducting science investigations, Learning scientists Leslie Herrenkohl and Marion Guerra (1998) developed three cognitive roles for students to use when working in groups and when responding to group presentations made to the whole class after each investigation. The three roles were: (1) making a prediction and building a theory, (2) summarizing results of investigations, and (3) relating the results to the prediction and theory. In class discussions, the teacher worked with the class to develop questions that would be associated with each of these roles.

Here is an excerpt from one discussion in which the teacher was helping the sixth graders understand how the cognitive roles work:

Tammy:	[My card] says relating predictions and theorizing to findings.	
Teacher:	OK.	
Tammy:	What does that mean?	
Teacher:	OK, so . . . an example of that might be um, say Leslie's up here and I'm in your place, and I listen to Leslie and she does give me her theory and then she does tell me what happens.	← Notice that the teacher contextualizes her answer in a specific situation to make it clearer to Tammy.
Tammy:	OK.	
Teacher:	But I don't hear her say well, I thought this was gonna happen but really what happened was this and why. So how would I say that to her, I might say like "Leslie, I don't think I understood" or "I don't even think I heard you telling us about your predictions and results and how they are related," OK?	
Tammy:	OK, but do we go up right there? [Meaning to the front of the room.]	← Notice here that Tammy still has a very basic question—how you even go about asking these questions. As a teacher, you can't assume students know even basic procedures.
Teacher:	No, you just put your hand up and ask the question.	

As the class developed questions for each role, the questions were posted on a chart visible throughout the classroom. These questions are shown in Table 15.3.

Table 15.3
Cognitive Roles in Herrenkohl & Guerra (1998)

Cognitive role	Questions developed by students
Making a prediction and building a theory	What is your prediction? What is your theory? What do you think is going to happen?
Summarizing results of investigations	What did you find out? What were your results?
Relating the results to the prediction and theory	Did what you think was going to happen really happen? Where did you find your theory in your findings? Did your results support your theory?

The students subsequently used the questions they developed when they listened to group presentations of their science investigations. When groups make presentations in class, students in the audience often become bored and disinterested. (You have probably experienced this yourself!) Herrenkohl and Guerra (1998) wondered if student engagement during presentations could be increased if students were assigned to the three roles in Table 15.3 while the groups were making their presentations. Students were assigned to roles (one role per student). After hearing each presentation, students in the audience were supposed to ask questions relevant to their role (such as the questions in Table 15.3). Herrenkohl and Guerra found that when students were assigned cognitive roles during the presentations, student participation in discussions about the presentations quadrupled, in comparison with a class that had not used the roles during group presentations.

Although research has shown that cognitive roles can be used effectively, one concern is that they students may limit their discussions to what their activity cards direct them to say. However, the success of methods that use roles suggest that students may use the roles as a springboard for expansive discussions rather than as a constraint.

Problem 15.11. Evaluating Teaching. Constructing role cards.

Ruth Rodriguez is a high school teacher of English as a second language. Her students are all recent immigrants to the U.S. from Caribbean, Central American, or South American countries. She is having groups carry out research on their home countries. Their tasks is to prepare a tourist brochure to attract Americans to their country. She is having students work in groups of four. She has created the following roles for this activity:
1. Discussion leader, who leads discussions that the group undertakes.
2. Notetaker, who takes notes of their ideas as they prepare for the brochure
3. Audience checker, who encourages the group to think about their intended audience when making the cards.
4. Artist, who creates the art for the final brochure.
Before introducing the project to the class, Ms. Rodriguez creates role cards. Here's the card for the audience checker.

Audience checker
Your role is to make sure that your group is thinking about your audience—Americans—as you plan your brochure.

Evaluate Ms. Rodriguez's plan, and propose any changes that you think are needed.

Response. One immediate problem with the roles is that the roles appear likely to foster unequal participation. The artist, for instance, might think that his role is do nothing until the end, when the rest of the group will hand him their plans, and he will create the final artwork. In addition, with older students, it may be more appropriate to develop cognitive roles that focus more on the cognitive strategies that Ms. Rodriguez would like to promote. The audience checker role is the only role that is clearly a cognitive role; it is a cognitive role because it directs group members to use the strategy of considering the audience. Other possible cognitive roles that Ms. Rodriguez might consider are a "brainstormer" (who would encourage the group to think of as many ideas as possible before deciding which ones are the best) or an "organizer" (who encourages the group to think about how best to organize their ideas in the brochure). You should be able to think of other roles focused on cognitive strategies needed to compose a travel brochure.

A problem with the role card is that it defines the role but lacks model questions that the student might ask. These questions help students understand the targeted strategies better, and it reminds students that the audience checker is not the only one who is supposed to take the audience into consideration. The audience checker is supposed to make sure that the whole group is taking the audience into consideration. In addition, the teacher should consider having the class help her generate good questions for each role, rather than writing the questions herself.

Hints. Hints are scaffolds that are provided when a student is having some difficulty. Hints can be provided by a teacher or by a computer. For example, there are computer-based learning environments can provide these hints on demand when students click on a "hint" button (Linn, Davis, & Bell, 2004b). Teachers can provide hints to students in groups. When students are working on challenging, complex tasks, they will sometimes need hints from the teacher to get through difficulties they are having.

As we discussed in Chapter 14, it is important that when teachers given hints, they should give no more information than students need to proceed on their own. Consider an example in which a teacher has asked second graders to collaborate in pairs to write a travel brochure to entice tourists to a desert habitat. Students first brainstorm, generating a lit of reasons to visit the desert. Then they compose their brochure and add the appropriate art work. As the teacher is walking around the room, she notices that one pair of students has generated a list of several reasons to visit the desert, but they are having difficulty deciding which reason to put first on their brochure. The students ask her for help. How should the teacher respond? Consider these possible options for responses by the teacher:

Response Option 1. Well, I would say that your strongest reason to attract tourists is the idea that the desert is beautiful. So why don't you put that first?	← This is terminal help. The teacher provides the answer. This is unlikely to help the students as much as other alternatives below.
Response Option 2. It might be a good idea to put your strongest reason first. Which do you think is your strongest reason?	← Here, the teacher has provided a criterion for how to pick what to put first ("your strongest reason") but leaves the rest of the work for the students. The teacher has helped students move forward but has not entirely done the task for them. Still, it seems likely that she could have tried letting students do a little more of the thinking than she allowed them to do here.

Response Option 3. Well, let's think about that. Would it be best to put your strongest reason first, or your weakest reason, or something in the middle?	← Here, the teacher wants students to think about and generate their own explanations for whether strong or weak reasons should go first. This seems more effective than the one above, because the students have to do more of the work.
Response Option 4. Well, let's think about that. What kind of reason would you want people to read first if you really want them to come to the desert?	← In this example, the teacher gives still less help; she asks the students to articulate for themselves what kinds of reasons should go first. Note that if students have trouble answering this question, she could still shift to Response 3. Thus, this response is an excellent one because it gives the least help but still gives the teacher the option to give more help if needed.

As we have discussed, teachers should give the least possible help, leaving students to do as much of the task on their own as they can. If Response Option 4 is sufficient to help students proceed, then there is no need to give more specific kinds of help. And when teachers give low levels of help, and that proves to be inadequate, they can always shift to a hint that provides more help.

Self-evaluation. Having groups evaluate their own performance along specified criteria is a powerful instructional technique (Y. Sharan & Sharan, 1992; Webb & Farivar, 1994). Self-evaluations help students learn the standards by which their performance can be judged. Once aware of these standards, they can detect when their group processes or group products do not meet these standards and can take steps to improve things. We discussed this technique in Chapter 14.

Problem 15.12 Evaluating Teaching. Self-evaluations by groups.

Here is a general group evaluation form recommended by a educational website (http://www.saskschools.ca/). Imagine a class and a topic that you are likely to teach in the future. Based on what you have learned in this chapter, what changes would you recommend for this evaluation form?

1. How did you feel about your project?
   ____we did NOT accomplish any of our plans
   ____a little was accomplished
   ____most of our plans were accomplished
   ____we accomplished all of our plans
2. Did everyone contribute to the project? If not, why not
3. If you were to do this project again, what would you do differently?
4. What would you do the same?
5. What were some of the problems?
6. How did you and your group deal with the problems?
7. What things did you and your group do well in this project?
8. What did you learn from doing this project?

Response: There are very good questions here that ask students to address problems that they had and to think of ways of dealing with those problems in the future.

However, there are no questions that address any particular cognitive strategies or social strategies that you may want students to master. For instance, if you are planning to be a history teacher working with evaluating evidence, you would probably want to have questions that dealt with the cognitive strategies of evaluating evidence that you want your students to master. You might want to replace some of these questions with questions focusing more particularly on the strategies that you will want to teach.

Fading scaffolding. As we've discussed throughout this section, the goal of scaffolding is to help students complete a task successfully that they could not complete without assistance. But as students become better able to carry out tasks on their own, they should reach a point where they do not need the scaffolding any longer. Thus, teachers can gradually reduce or "fade" scaffolding as students gain greater skill (A. Collins et al., 1989). Then, as students master one task, teachers can challenge them with a more difficult task, for which scaffolding will be again needed for a period of time until students master that more difficult task.

How scaffolding of complex tasks promotes core processes. When teachers use complex tasks with collaborative groups, they may be concerned over whether the task will be too difficult. If students flounder on tasks that are too difficult, their expectations of success and hence their motivation will decrease. Through the use of the methods of scaffolding discussed in this section, teachers can increase students' expectations of success by giving them the cognitive tools needed to succeed at the task. Most forms of scaffolding directly support the use of high-quality cognitive strategies and encourage uptake of fellow group members' ideas.

Cognitive roles encourage students to work well in groups and to respect each other. Roles such as clean-up and set-up specialists further encourage students to share in the management of the classroom; this is consistent with ideas about self-regulated classroom management that you learned about in Chapter 11.

Preparing Students for Group Work

There is much that teachers must do to prepare students for effective group work. These include team-building activities, introducing students to norms for effective group work, and providing instruction in social and cognitive strategies that students need when working in groups. These include:

Team-building exercises which focus on the core process of promoting mutual respect and caring among students. Some activities are also designed to show students that collaborative solutions are usually superior to individual solutions (see Cohen, 1994a).

Group norms are often posted in classrooms as reminders for students. We have discussed group norms and how to promote them in Chapter 4 (Social Development). Teachers can work to foster group norms that make collaborative learning more effective. For example, Figure 15.17 shows following posting in a sixth grade class fosters constructive controversies (K. Smith et al., 1981). The norms are designed to promote the kind of interactions that make constructive controversies effective in promoting learning. The norms encourage students to consider multiple perspectives, to respect each other, and to engage in balanced interactions. These are all core processes of effective groups.

Here is an example of a different set of norms. In a study of norms being promoted in a seventh-grade class, researchers Noreen Webb and Farivar (1994) noted the following norms: (1) listen attentively, (2) no put-downs, (3) 12-inch voices (meaning no yelling), and (4) equal participation by everyone. Like the norms in Figure 15.17, these norms encourage balanced participation and respect for others. These norms focus less on desired cognitive strategies than the norms in Figure 15.18. A norm related to the cognitive strategy of explanation could be added to the list: (5) explain your ideas.

Figure 15.17 Norms for constructive controversies

1. I am critical of ideas, not people.
2. I remember that we are all in this together.
3. I encourage everyone to participate.
4. I listen to everyone's ideas, even if I do not agree with them.
5. I restate what someone has said if it is not clear.
6. I try to understand both sides of the issue.
7. I first bring out all the ideas, then I put them together.

This is an example of norms for participating in constructive controversies (K. Smith et al., 1981). These norms are posted in the classroom.

Reducing Status Differences

As noted at the beginning of the chapter, a potential problem with cooperative groups is that groups may exacerbate status differences. Students in classes can often agree on who the high- and low-status students in the class are. Those who are believed to be high status students participate more in collaborative groups than those who are thought to be low-status (Webb & Kenderski, 1984). As we discussed in Chapter 4 (Social Development), high-status students tend to be more popular (Rosenholtz & Wilson, 1980). In addition, gender and racial prejudices factor into students' status among their peers (S. Sharan & Shachar, 1988).

Because high-status students dominate collaborative interactions (Dembo & McAuliffe, 1987), it is imperative for teachers to take actions to reduce status effects. Two options have been validated by research.

The multiple-ability treatment (Cohen, 1994b). With this treatment, teachers persuade students that there are many cognitive abilities that are needed to complete the task, such as hypothesizing, considering different points of view, creativity, problem solving, planning, writing, public speaking, and so on. Then, the key to this treatment is the teacher's clear and strong statement that "*None of us has all of these abilities; Each one of us has some of these abilities;*" the teacher goes on to explain why this is likely to be true (Cohen, 1994a, p. 128, italics in original). This idea can also be prominently posted on a bulletin board in the class. Teachers should avoid the implication that some students have cognitive abilities whereas others have noncognitive abilities (artistic ability, motor skills) because students typically view skill with hands as a lower-status skill than being good with their "heads" (Cohen, 1994a). Research has showed that a multiple-ability treatment reduces status differences within groups although it does not eliminate them (Cohen, Lotan, & Catanzarite, 1988; Rosenholtz, 1985).

Assigning competence to low-status students (Cohen, 1994b). Using this second method of assigning competence to low-status students in order to reduce status differences, teachers observe groups, and when they notice a lower-status student making a good contribution, they publicly acknowledge the contribution, describing specifically what the student has done well. (see Chapter

11, Teaching for Motivation for more on this strategy.) Following is an except from a teacher who tried this method with a student with a poor school record and few friends in the class:

> We were doing an activity that involved decimal points and I was going around and noticed he was the only one out of his group that had all the right answers. I was able to say, "Juan! You have figured out all of this worksheet correctly. You understand how decimals work… Can you explain it to your group? I'll be back in a minute to see how you did." And I left. I couldn't believe it; he was actually explaining it to all the others. I didn't have faith it was going to work, but in fact he explained it so well that all of the others understood it and were applying it to their worksheets. They were excited about it. So then I made it public among the whole class, and from then on they began calling him "the smart one." (Graves & Graves, 1991, p. 14)

Another approach to assigning competence is to thoroughly train lower-status students to be experts in a task so that they can teach higher-status students how to do the task (Cohen, Lockheed, & Lohman, 1976). However, it is essential for the training to be effective; if the leaders do not succeed, it will only confirm their lower status.

Note that reducing status differences using these two methods requires that teachers use higher-level, open-ended, complex tasks that afford the use of multiple cognitive abilities. Otherwise, students will not find it plausible that multiple cognitive abilities are needed for the assigned task.

Complex Instruction. Complex Instruction is a collaborative learning format that emphasizes complex tasks, roles, and reducing status differences (Cohen & Lotan, 1997). Complex instruction lessons are arranged around stations, as described by Lotan (1997, pp. 16-17):

> At seven swarming learning stations, four or five students are working together, each group on a different task. At the station by the door, students consult an ancient map of a castle town, carefully checking the key to the map. They find out that housing patterns in Tokugawa, Japan, closely replicated the social standing of the inhabitants. "Yeah," says LaToya, one of the students, "that's like Beverly Hills, 90210, and East LA, right here in California.
>
> At the next station, students read and carefully interpret excerpts from the legal codes of feudal Japan. "That's not fair!" Jimmy exclaims. "They can't have different laws for different people!" "Obviously, they did," countered Eddie. "That's like in feudal Europe, remember? Last quarter, remember?"
>
> …At each of the stations, students explore the different aspects of social stratification and social barriers in the context of Tokugawa, Japan. In the process, they read, write, build a three-dimensional map of a castle town, prepare a skit about law enforcement in feudal Japan, ... or analyze a graph showing the frequency of peasant uprisings. (Lotan, 1997, pp. 16-17)

Each lesson begins with a brief introduction, in which the teacher may briefly explain concepts related to some of the more challenging stations. Students work at the stations for about 30-35 minutes. The last 30-35 minutes is devoted to group presentations and class discussions. Teachers assign cognitive roles prior to the students' work in stations, and they regularly use the two methods for reducing status differences that you have just read about.

Researchers have evaluated complex instruction with elementary and middle school students (Cohen et al., 1997). They found that students who learn using complex instruction outperformed students in control classes on a variety of measures, including some measures of standardized tests of reading and mathematics. Both elementary and middle school students benefited from participating in complex instruction.

Problem 15.13. Evaluating Teaching. Complex Instruction.
1. A teacher provides an inflatable model of a stegosaurus to a group of third graders. Their task is written on a card for the group to read. The card says:

> On the dinosaur, you can see a red line. That line shows you where the waist of the dinosaur is. Measure the size of the dinosaur's waist by wrapping the string around the widest part of the waist. Then measure the string.

Should this task be changed? If so, why, and how? If not, why not?

Response: This example is inspired by a Group Investigation task described by Cohen (1994a). The actual Group Investigation task involves giving the children the dinosaur, a string, and a rule. The task card says only: "Measure the waist of the dinosaur." The students have much more to discuss because they have to figure out where the waist is as well as how to measure it. The task card above provides so much information that it leaves little if anything for the students to discuss.

How treating status differences promotes core processes. Status differences must be addressed when working with student groups. By reducing this perceived difference, mutual respect among students increases as does engagement among lower-status students, who feel a greater sense of self-efficacy. As lower-status students come to believe that they have relevant abilities, they become more confident about participating, and as higher-status students also come to believe that the lower-status students have much to contribute, they encourage them to participate.

What Teachers Should Do As Students Collaborate

As you have seen, teachers have a lot of preparatory work to do to make groups effective. But once all this preparation is done, what should teachers in class do as the students are working together?

Most advocates of collaborative learning recommend that teachers observe and listen to groups carefully. In this way, the teachers can evaluate the quality of the interactions and whether training in certain social or cognitive strategies is needed. Researchers have found that teachers often spend too little time listening to groups. In one study, teachers moved from group to group every 5 seconds, which leaves no real chance to observe what children are saying (Meloth & Deering, 1999). Johnson and Johnson (1991; 1995) recommend that teachers work with formal observation sheets and check off student behaviors that they observe. This information serves as a formative assessment that can guide teachers as they guide and enhance group activities.

There is a fine line between when teachers should observe and when they should intervene. Many researchers agree that the teachers should minimize their active participation with groups, leaving the groups to work on their own unless intervention is essential (e.g. Cohen, Lotan, & Leechor, 1989; McMahon & Goatley, 1995). Others recommend that teachers interact with groups more frequently to provide needed assistance (e.g., D. W. Johnson & Johnson, 1995; Y. Sharan & Sharan, 1992). The evidence on this issue is conflicting. Several studies have found that when teachers intervene and speak with groups, the quality of the group conversation decreases (Almasi, 1995; Cohen et al., 1989; Hogan, Nastasi, & Pressley, 1999). For instance, educational psychologist Kathleen Hogan et al. (1999) found that when eighth graders worked on chemistry topics without the teacher, 62% of student turns were at a high reasoning level. In contrast, when the teacher joined the groups, only 32% of the student turns were at a high reasoning level. On the other hand, students did make some gains in the understanding of chemistry content when the teachers met with them (see also Meloth, 1991). Moreover, Meloth and Deering (1999) found no evidence that teacher interventions with groups lowered the quality of group talk.

Given the mixed evidence, a compromise between the two perspectives may be the best bet. When student groups are working, teachers should offer guidance only if and when the group needs help, but such intervention should be offered in moderation. Researchers recommend that teachers do the following:

Allow groups to try to work through conceptual difficulties if they can; if they flounder too long, provide help.

Be sure to listen to student groups long enough to identify what the problems are before intervening. Teachers sometimes intervene before they have listened sufficiently to understand what the issues are and in such cases, their help is unlikely to be useful (Meloth & Deering, 1999).

If you help, you should get to the point quickly and efficiently and then allow the group to continue working on their own. (Meloth & Deering, 1999)

In this section, we have examined how teachers should respond to groups as they are engaged in collaborative learning tasks. In the next section, we address another important issue in forming effective collaborative groups: the appropriate group size and composition.

Problem 15.14. Evaluating Teaching. Teacher participation.

A. This is a dialogue from a Group Investigation by tenth graders investigating "What makes a poem a poem?"

Aviva: Here's the room where he sat…he had a special room for writing…and look at those beautiful hills…it says that he loved to go on long walks…

Anat: Can you understand his poems? They're so long!

Aviva: Well, I guess I really don't understand them, and I didn't really read them, but there's one poem that I read and could make out, about the daffodils he sees on his walks. You want to hear it? [She reads the poem aloud.]

John: So, can we say that poets write about what they see around them?

Mike: At least we know that Wordsworth did. What about Langston Hughes? Doesn't seem like he was influenced by nature.

Anat: But he wrote about the kind of *people* he saw around him.

Teacher: Well, you see, each of those poets lived in such a different environment, and it seems to me that their poems tell you a lot about how they lived.

John: Then any society can have a poet.

Teacher: That's right! And all societies do have poets…. (Adapted from Y. Sharan & Sharan, 1992, p. 119)

Assume that the teacher listened to the same segment of discussion that you just read. Should the teacher have intervened when she did? Given that she did intervene, did she provide scaffolding at an appropriate level?

Response: On one hand, the students seem to come very close to articulating the generalization that the teacher makes in her first turn. They are considering different examples of what poets write about, and if the teacher had left them alone, they might well have come up with the idea that poets write about their own environments. If the teacher felt she needed to provide some scaffolding, she might have given a much lower level of hint, such as asking, "What do examples like these tell you about what poets write about?" Then the students could have generated the idea on their own on the basis *of this hint.*

On the other hand, the teacher's comment prompts John to a new insight of his own: "Then any society can have a poet." The teacher's comment may have pushed John's thinking forward. Looked at from this perspective, the teacher's comment proved to be productive.

Group Size and Composition

A final issue teachers need to consider when setting up effective groups is determining group size and composition. Teachers often assume that an ideal group has four or five students and that it should be heterogeneous in gender, ability, and ethnic group (O'Donnell, 2006); however, consensus on group size is that there is no single best group size. Group size should be determined based on the task.

Groups ranging from two to six students can be effective, though for the different group sizes, different types of instruction work best. For example, guided cooperation works very well with groups of two, while for groups with four to six students, complex instruction, group investigation, and STAD are effective.

The issue of heterogeneity of groups is more difficult to resolve. **Heterogeneous groups** have diversity among the group members (different proficiency levels, different ethnic backgrounds, different genders, and so on). **Homogeneous groups** are composed of students who are similar to each other (e.g., four European-American boys of middle proficiency). Table 15.4 summarizes an influential line of research by Noreen Webb (1982; Webb, 1985), who focused on the frequency of explanation in middle school groups working on math problems. Her work examined the effects of homogeneous and heterogeneous groups on the frequency of explanations in groups. She focused on explanations because of her finding (which we discussed earlier in this chapter) that explanations promoted learning in these groups.

Table 15.4
Group Composition and Learning

Group composition	Frequency of explaining among students	Why?
homogeneous groups composed of high-ability students	low	Students feel as if they already know the material and so do not explain to each other
homogenous groups composed of medium-ability students	high	Students feel comfortable giving explanations to each other.
homogeneous groups composed of low-ability students	low	Students do not have enough knowledge to provide explanations.
heterogeneous groups composed of students of mixed abilities	high	More able students provide explanations to less able students. However, in groups with high-, medium-, and low-ability students, the medium-ability students tend to get left out.

Webb found that there is no ideal solution to grouping. When homogeneous groups are used, high-ability students and low-ability students give few explanations. When heterogeneous groups are used, there is a high rate of explanations overall, but if the group includes high-, medium-, and low-ability students, the medium-ability students tend to get left out.

Webb (1984) also found gender effects among seventh and eighth graders studying math. Girls achieved less than boys both in majority-girl and majority-boy groups. Other research on gender effects has been mixed, and much of the research is old (O'Donnell, 2006). An older body of research, well over a decade old, also provides evidence that white students participate more than minority students in mixed-ethnicity groups (Cohen, 1994b; O'Donnell, 2006). Other studies revealed that Group Investigation has been a successful strategy for increasing the relative participation of minority students (Shachar & Sharan, 1994), and complex instruction has produced benefits as strong for girls as for boys (Cohen et al., 1997).

When I talk with teachers, they often suggest that groups of four or larger should be set up so that there are mixed abilities and equal numbers of boys and girls, and so that groups are ethnically diverse. However, there is a potential problem with this approach. When groups are consistently set up with an equal number of girls and boys and clearly defined ethnic distributions, then gender and race may become very salient to students (Cohen, 1994b). In a class with 25 percent African American students, it would certainly be obvious to them that each is always assigned to a separate group based on race. An alternative is to have flexible groups with students joining different groups depending on the day. On one day, students interested in a particular topic could form a group. On another day, a teacher might form groups by grouping students who need to work on a particular strategy together. On yet another day, groups might be assigned randomly.

SUMMARY

Introduction. Well-designed collaborative learning promotes greater student achievement than students learning alone. Students have more opportunities to engage actively in articulating ideas when working in small groups than in whole-class discussions. In well designed groups, they will be motivated to listen to and learn from their group mates.

Goals of collaborative learning. Collaborative learning can be effective at promoting student learning of content and cognitive strategies, social skills, positive attitudes toward diverse classmates, prosocial behavior, and reduction in social stratification in the classroom.

Obstacles to effective groups. There are, however, a number of obstacles to effective group work, including off-task behavior, social loafing, unbalanced interactions, negative interactions, the absence of interactions, low-quality interactions, and the exacerbation of status differences.

These obstacles can be avoided by employing groups with six **processes of effective groups**: engagement, positive interdependence, mutual respect, equal participation, high-quality strategy use, and uptake of peers' ideas. High quality strategy use includes the use of both effective social and cognitive strategies. Useful cognitive strategies include all those you learned about in Chapter 7 (Self-Regulated Learning), with the addition of providing alternative perspectives.

Instructional methods. Effective instructional methods can support processes of effective groups, while avoiding the obstacles. *Group rewards for individual learning* are one method that can be used to promote positive interdependence. Although there is debate about the extent to which collaborative methods should be based on rewards, research has shown that with methods such as STAD, group rewards for individual learning can promote learning in collaborative groups.

Guided cooperation methods script students' cooperation. Usually working in pairs, students are explicitly directed to use productive cognitive strategies. Guided cooperation methods include scripted cooperation, peer-assisted learning strategies, and guided peer questioning. They promote high-quality strategy use by directly cuing strategy use.

Many successful methods—including Group Investigation, Complex Instruction, jigsaw, and constructive controversy—employ *complex, open-ended tasks* so that students must pool their knowledge and abilities to complete the task successfully.

Complex tasks often require effective *scaffolding* for students to accomplish. Common scaffolding methods include preteaching needed knowledge and strategies, decomposing tasks into manageable chunks, providing cognitive prompts and hints, assigning social and cognitive roles, setting of mechanisms for self-evaluation. Scaffolding provides students with tools that enable them to succeed at a task that they could not have completed without experience.

Preparing students for group work includes leading team-building exercises, teaching norms, and teaching social and cognitive skills.

Teachers can ameliorate status differences by convincing students that multiple abilities are needed for complex tasks and that no one student has all these abilities. Teachers can also assign competence to low-status students.

No single group size is ideal for group work. There are different perspectives on the appropriate group composition.

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