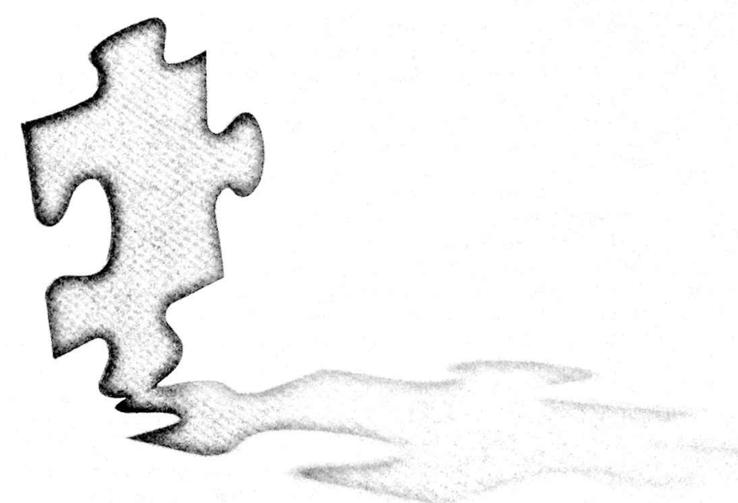
13

Teaching by Creating Cognitive Apprenticeship in Classrooms and Beyond

Chapter Outline

Throughout human history people have learned through various forms of apprenticeship in which they participated on authentic tasks under the supervision of more experienced mentors. This chapter explores the idea that academic learning can be seen as a sort of cognitive apprenticeship in which students and teachers work together to master authentic academic tasks. In particular, the chapter lays out the case for cognitive apprenticeship and then examines three ways that social features of instruction can affect student learning–collaborating, modeling, and personalizing. Concerning collaborating, I explore the conditions under which collaboration is effective, including working for a group goal based on individual performance and interacting with each other in a structured way. Concerning modeling, I explore the value of having learners and mentors demonstrate and describe how to carry out the to-be-learned task. Concerning personalization, I explore the conditions under which learners can be induced to view a tutor or author as a conversational partner, including writing or speaking in a conversational style. Within each approach, I search for how the social context of learning can promote deep understanding in learners.



Introduction

LEARNING IN AND OUT OF SCHOOL

Consider the arithmetic knowledge of M, a 12-year-old coconut vendor on the streets of Recife in northern Brazil. We visit him at his stand one day and ask him how much it will cost to buy 10 coconuts that cost 35 cents each. Let's listen in as he computes his answer:

CUSTOMER: How much is one coconut?
M: Thirty-five.
CUSTOMER: I'd like ten. How much is that?
M: [Pause] Three will be one hundred and five; with three more, that will be two hundred and ten. [Pause] I need four more. That is . . . [Pause] three hundred and fifteen . . . I think it is three hundred and fifty.

As you can see, M correctly computes that 10 times 35 is 350. However, he doesn't use the procedure taught in Brazilian schools of simply placing a zero to the right of any number that is being multiplied by 10. Instead, he converts multiplication into repeated addition by threes: 105 + 105 + 105 + 35. This is an example of an invented strategy used on an informal test of arithmetic.

M has had some schooling and currently is in the third grade. Suppose we visit him in school one day, give him a pencil and paper, and dictate some arithmetic problems and words problems to him. This is a formal test of arithmetic. For example, for the problem 35 × 4 = ——— , M writes the answer "200." He explains his answer as follows:

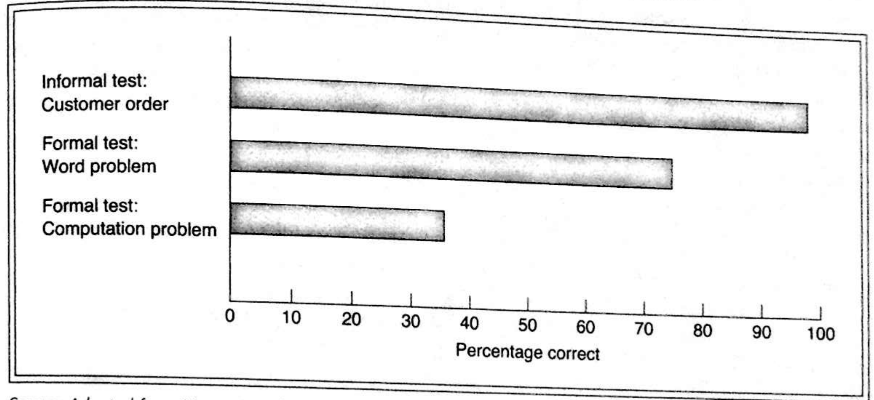
> Four times five is twenty, carry the two; two plus three is five, times four is twenty.

As you can see, M is trying to use the school-taught procedure but because it is meaningless to him, he tends to makes some errors in applying it.

This example comes from a study by Nunes, Schliemann, and Carraher (1993) in which they compare the performance of five children—all street vendors between ages 9 and 15—on formal and informal tests of arithmetic. Figure 13–1 shows the overall percentage correct on equivalent arithmetic problems that occur in verbal form in everyday life (on an informal test) and in school-like form as word problems and symbol problems (on a formal test). As you can see, the street vendors were nearly errorless in computing answers to arithmetic problems in the street but performed much more poorly when equivalent problems were presented in school-like form. In short, children who are "capable of solving a computational problem in the natural situation" often "fail to solve the same problem when it is taken out of context" (Nunes et al., 1993, p. 23).

What can we conclude from studies of Brazilian street vendors? These results demonstrate that "daily problem solving may be accomplished by routines different from those taught in schools" (Nunes et al., 1993, p. 26). In spite of the fact that the children in this study had received formal instruction in arithmetic computational procedures, they invented their own procedures to solve computational problems in the context of their roles as street vendors. Although they had difficulty in correctly applying school-taught procedures in a formal school-like context, they were highly successful in applying their own invented procedures in an informal everyday context. These findings "raise doubts about the pedagogical practice of teaching children how to solve mathematical operations simply with numbers" (p. 25) and point to the role of cultural context in learning. In short,

FIGURE 13–1 Percentage correct on informal and formal tests by young street vendors



Source: Adapted from Nunes, T., Schliemann, A. D., & Carraher, D. W. (1993). Street mathematics and school mathematics. *Cambridge, England: Cambridge University Press. Reprinted with the permission of Cambridge University Press.*

there is some support for students' claims that they do not use school-taught math outside of school.

This line of research has important implications for teaching that is intended to promote transfer. The major finding is that students often fail to transfer what they learned in school to problems outside of the school setting and often fail to transfer what they learned outside of school to solving problems in school. Thus, these findings indicate a need to teach in ways that promote transfer—that is, ways that help students be able to use what they learned in school when they are confronted with problems outside of school.

This example helps distinguish two views of the generality of learning. According to the *classic view* of learning, students abstract a general procedure from instruction and apply it across a wide variety of problems. Such a view would predict that people would use a school-taught procedure to solve the coconut problem. In contrast, the *situated view* of learning is that students acquire a specific procedure based on the context in which it was encountered and are able to use it mainly within that context. The coconut example supports a theory of *situated learning*—the idea that learning is shaped by and depends on the situation in which it takes place, including the social and cultural context of learning. An important challenge for educators is to create the kinds of social contexts that foster meaningful learning—that is, being able to use what is learned to solve new problems in new situations.

THE CASE FOR COGNITIVE APPRENTICESHIP

An interest in the social context of learning has encouraged many educators to examine the classic work of the Russian psychologist Lev Vygotsky (1978; Wertsch, 1985), who developed one of the first theories of learning in social context. For example, consider a situation in which an elementary school class is discussing the story "Freddie Finds a Frog"

(Tharp & Gallimore, 1988). In the story, Freddie shows his newly found frog to Mr. Mays. Mr. Mays suggests that he might like to take Freddie's frog fishing. This grisly proposal upsets Freddie. The teacher notices that none of the children understand the double meaning of Mr. Mays's proposal to take the frog fishing or why it upset Freddie. In the dialogue that follows, the teacher assists the children in making sense out of Mr. Mays's joke (Tharp & Gallimore, 1988, p. 19):

TEACHER: What did Mr. Mays say he would do with the frog?
LON: He would take . . .
MELE: . . . water, um fishing.
TEACHER: Do frogs like to go fishing? [The children give several opinions—Frogs don't like water, don't like flies, don't like fish.]
BILL: They use for da bait.
TEACHER: If you use it for bait, what do you have to do to the frog? [The children give several opinions, including one explanation of disgust.]
ALICE: Put it on a hook.

This instructional episode demonstrates two important aspects of Vygotsky's theory—that learning occurs in a social context and that learning occurs within a child's zone of proximal development. Vygotsky's (1978) theory emphasizes the role of social collaboration in the development of new skills: "Human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them" (p. 88). Vygotsky proclaims the essential role of social collaboration in learning: "Learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers" (p. 90).

The social context of learning is reflected in the way that the students and teacher jointly try to make sense of the story; by discussing the story under the guidance of the teacher, the students participate in a sort of collective sense making. In the process, they are learning reading comprehension strategies that will serve them in the future. Vygotsky (1978) refers to this process as *internalization*—"internal reconstruction of an external operation" (p. 56). In this case, each student learns strategies for how to make sense of text passages based on working on this task with a more skilled reader. The *zone of proximal development (ZPD)* refers to the difference between the child's current level of performance and the level of performance that the child could attain with expert guidance. Vygotsky defines the ZPD as "the distance between the actual developmental level as determined by individual problem solving and the level of potential development as determined through problem solving under adult guidance in collaboration with more capable peers" (p. 86).

For example, the children reading "Freddie Finds a Frog" do not perform well in understanding the double meaning of Mr. Mays's joke, but with assistance from the teacher, they are able to do so. Thus, comprehension of the double meaning of a joke is within the children's zone of proximal development. According to Vygotsky (quoted in Wertsch & Stone, 1985), instruction is effective "when it proceeds ahead of development" so that it "awakens and rouses to life those functions which are in a stage of maturing, which lie in the zone of proximal development." In this example, the teacher focuses on helping children move from their current level to their potential level of reading comprehension performance.

The role of teacher, according to this Vygotskian view, is that of someone who provides assistance to students who are engaged in a cognitive task. Tharp and Gallimore (1988) propose a redefinition of teaching: "Teaching must be redefined as assisted performance. Teaching consists in assisting performance. Teaching occurs when performance is achieved with assistance" (p. 21). Importantly, Tharp and Gallimore (1988) note that assistance should be gauged to the student's needs: "Teaching consists in assisting performance through the zone of proximal development. Teaching can be said to occur when assistance is offered at points in the zone of proximal development at which performance requires assistance" (p. 31). Similarly, students may be seen as apprentices—learning to perform intellectually like the expert members of their societies.

Although Vygotsky's theory offers many provocative implications for education, it is wise to ask whether his claims can be substantiated. Because he worked in Russia in the years following the Russian Revolution through his death in 1934, and because he aimed to develop a Marxist theory of human intellectual functioning, Vygotsky's standards of scientific research differed from those prevailing in much of the rest of Europe and the Americas. Cole and Scribner (1978) offer the following methodological critique:

> Vygotsky's references . . . to experiments conducted in his laboratory sometimes leave readers with a sense of unease. He presents almost no raw data and summaries are quite general. Where are the statistical tests that record whether or not observations reflect real effects? . . . Those steeped in the methodology of experimental psychology as practiced in most American laboratories may . . . consider [Vygotsky's research] to be little more than interesting demonstrations or pilot studies (p. 11).

Regrettably, selected portions of classroom transcripts, such as the instructional sequence involving "Freddie Finds a Frog," also fail to yield the kind of convincing evidence that many scientists would require. Yet in spite of the scientific shortcomings of Vygotsky's theory, his ideas are simply too intriguing to ignore.

Modern research on apprenticeship in the tradition of Vygotsky offers some potential benefits and costs to educational psychology. On the positive side, broadening our conceptions of acceptable educational practices and educational research frees us from what Lave (1988) calls "the claustrophobic view of cognition from inside the laboratory and school" (p. 1). Research in which learners are observed in natural situations can provide important information that traditional experimental methods cannot. On the negative side, ethnographic studies of how people behave in natural settings may be difficult to interpret because different observers may see different things in viewing the same situation. Sternberg (1990) observed that it has "often been difficult to draw conclusions from the research. . . . One can read into the research almost whatever one wishes" (p. 16). A complete theory of learning and instruction is likely to depend on both experimental and observational data.

What is the role of apprenticeship in promoting meaningful learning? Rather than building educational practice solely on the pronouncements of experts—however interesting the ideas might be—the approach I take in this book is to search for methods of teaching for meaningful learning that are based on scientific research. Extreme views, such as the idea that all learning can take place only in a social context, are probably not testable in scientific research and ultimately are probably not very productive stances. Instead, let's focus on the intriguing idea that some educational practices can be improved by making better use of the social context of learning.

COGNITIVE APPRENTICESHIP IN EDUCATIONAL SETTINGS

Research on formal and informal learning raises important questions about the nature of schooling. Why is it that people can learn so well in the context of their everyday lives but often fail to learn within the context of schools? How can schools be changed to incorporate the positive features of natural learning outside of schools? Or as Serpell (1993) asks, "Given that education can and does take place informally in the context of everyday life, why was it felt at a certain point in history that a more explicit, deliberately instructive set of activities should be introduced in the form of schooling?" (p. 82).

Let's compare how people learn new skills, such as arithmetic, in school and outside of school. In schools, cognitive skills are taught as general and abstract procedures that are separate from everyday life; for example, because arithmetic is taught as symbol manipulation, students learn general procedures for how to carry out arithmetic operations on numerical symbols. In everyday environments, cognitive skills are learned as concrete and specific procedures that fit in the context of everyday life; for instance, in computing prices, street vendors invent repeated addition as a way of carrying out multiplication.

Advocates for incorporating apprenticeship techniques into schools base their arguments on evidence that apprenticeship is a successful method of instruction that emerged in societies around the world over the course of human history (Lave & Wenger, 1991; Rogoff, 1990). Collins, Brown, and Newman (1989) point to the proven role of apprenticeship as an instructional vehicle:

> Only in the last century, and only in industrialized nations, has formal schooling emerged as a widespread method of educating the young. Before schools appeared, apprenticeship was the most common means of learning and was used to transmit the knowledge required for expert practice in fields from painting and sculpturing to medicine and law (p. 453).

The goal of cognitive apprenticeship is to help students learn the cognitive "processes that experts use to handle complex tasks" (p. 457) through guided experience on intellectual tasks. In spite of its apparent effectiveness in informal learning situations, "apprenticeship as a form for producing knowledgeably skilled persons has been overlooked" (Lave & Wenger, 1991, p. 62) in modern schooling.

Although cognitive and traditional apprenticeship both rely on guided practice as an effective instructional method, cognitive apprenticeship differs from traditional apprenticeship in several ways. First, cognitive apprenticeship takes place within a formal instructional setting—a school, a training program, a computer simulation—whereas traditional apprenticeship occurs within the context of everyday life or work. Second, cognitive apprenticeship emphasizes learning cognitive skills, whereas traditional apprenticeship tends to emphasize physical practical skills.

Three core methods in cognitive apprenticeship are modeling, coaching, and scaffolding (Collins et al., 1989). *Modeling* occurs when a teacher describes her or his cognitive processing in the course of carrying out a task. For example, in modeling of reading comprehension strategies, a teacher might read "aloud in one voice while verbalizing her thought process (e.g., making and testing hypotheses about what the text means, . . . what she thinks will happen next, and so on) in another voice" (p. 481).

Coaching occurs when a teacher offers hints, comments, and critiques to a student who is carrying out a task. For example, in coaching for reading comprehension strategies, a teacher might "choose texts with interesting difficulties, might remind the student that a summary needs to integrate the whole text into a sentence or two, might suggest how to start constructing a summary, might evaluate the summary a student produces . . . or ask another student to evaluate it" (Collins et al., 1989, p. 482).

Scaffolding is needed when a student is working on a task but is not yet able to successfully manage each part without some kind of support. Scaffolding refers to the teacher's performing those parts of a task that a student is not able to accomplish unaided. The teacher must be able to diagnose when a student needs support and know when to gradually remove support. For example, in teaching reading comprehension strategies, a teacher may provide support to a student who fails to correctly summarize a text by modeling how she or he would summarize it.

The techniques of modeling, coaching, and scaffolding can be found in the examples of cognitive apprenticeship described in each of the following three sections of this chapter: collaboration methods, modeling methods, and personalization methods. In short, this chapter examines the idea that meaningful learning can take place in an apprenticeship context and samples the research literature testing this idea.

Collaboration Methods

The most obvious aspect of learning by apprenticeship is that it is a social activity that occurs in groups. In this section we explore three instructional methods based on collaboration within a group of learners: cooperative learning, reciprocal teaching, and computer-supported collaborative learning.

COOPERATIVE LEARNING

Consider two classrooms scenes—one based on competition and one based on cooperation. In one classroom, the teacher, Ms. Competition, writes a math problem, $3\frac{1}{4} - 1\frac{3}{4} =$ ______, on the board and calls on Sam to give an answer. Sam writes $2\frac{1}{4}$ on the board as the answer. "That's not right," the teacher says. "Who can help him?" In response, many hands shoot up. The teacher calls on Elizabeth, who calmly walks to the board, erases Sam's answer, and replaces it with the answer $1\frac{2}{4}$. "That's almost right," the teacher announces. "Who can help her finish it?" Of the many wildly waving hands, the teacher chooses Mia, who reduces Elizabeth's answer to its final form, $1\frac{1}{2}$. In Ms. Competition's class, the teacher may euphemistically refer to Elizabeth's "help" for Sam or Mia's "help" for Elizabeth, but far from feeling helped, Sam feels humiliated by Elizabeth and Elizabeth feels betrayed by Mia. The teacher concludes the episode by saying, "You will have a quiz worth 50 points on addition and subtraction of mixed fractions on Friday, so study hard." The students' individual scores will be listed on a sheet at the rear of the room. The students know that they are graded on the basis of how many points they get in the class, with the top 20% of the class getting As, and so on.

Now imagine an alternative in which Sam and Elizabeth and Mia work together as a team. The teacher, Ms. Cooperation, seats them face-to-face around the same table. She gives them sheets that explain addition and subtraction of mixed fractions, worked-out examples, and practice problems to work on. She tells them, "I will give you a quiz on Friday covering this material. I will add your scores together to get a score for your group—let's call your group the Mathbusters. Your grade in math depends on how well all of you do together as a group." The team score will be listed on a sheet at the rear of the room. In Ms. Cooperation's classroom, Sam and Elizabeth and Mia take responsibility for each other's learning and help each other master the material.

Should the atmosphere of competition that currently prevails in most classrooms be replaced with a cooperative environment? The rationale for cooperative learning environments is that working together on tasks is required in many real-world situations (Slavin, 1982):

> Cooperation is one of the most important human activities. Elephants have survived because of their size; cheetahs because of their speed; humans because of their ability to cooperate for the good of the group. In modern life, people who can organize as a group to accomplish a common end are likely to be successful . . . in virtually any endeavor (p. 5).

In spite of the central role of cooperative activities out of schools, cooperation is not generally emphasized in schools. In fact, as Slavin notes, in many classrooms, students may be punished for cheating if they help one another. In classrooms where students are in competition with one another for grades, students are unlikely to encourage each other's academic success.

This comparison of competitive and cooperative classroom environments gives rise to the most popular way in which apprenticeship principles can be applied to formal education, namely, what Slavin (1983a, 1983b, 1990; Slavin, Hurley, & Chamberlain, 2003) calls *cooperative learning*. In cooperative learning, small groups of up to six students who differ in ability work together as a group on an academic task. Rather than competing against each other, members of the group work together and are evaluated as a team. For example, instead of each student trying to outscore his or her peers on a test, in cooperative learning the goal is to improve the combined scores of all members of the group. Thus, if the average score of a group shows improvement on a test, the entire group receives a reward. In summary, in cooperative learning, "students spend much of their class time working in small, heterogeneous groups, in which they are expected to help one another learn" (Slavin, 1983a, p. 431). There is no doubt that cooperative learning methods are popular among classroom teachers. When Antil, Jenkins, Wayne, and Vadasy (1998) surveyed teachers they found that 93% of the responding teachers reported using cooperative learning and 81% reported daily use.

Although cooperative learning can be implemented in many different ways, let's examine one of the most well-known versions developed by Slavin and his colleagues (Slavin, 1982, 1983a, 1983b, 1990)—Student Teams Achievement Divisions (STAD). In STAD, students in a classroom are arranged into groups of four to six members, with group names such as Math Monsters, Five Alive, and Fantastic Four. Each group consists of the same balance of high- and low-performing students, boys and girls, and members of racial and ethnic groups as is represented overall in the class. For each instructional lesson, the teacher introduces the material to the whole class through lecture and discussion. Then the students break into their groups to study together until all group members are able to solve problems presented on worksheets. When the team is confident that all members understand the material, each member takes a quiz on the material—but without any help from other team members.

The teacher scores the quizzes in an unusual way. Instead of simply recording the score for each student, the teacher computes the improvement score for each student and adds

them all together to get a team improvement score. The teacher determines a base score for each student by taking five less than the student's past quiz average. To compute an improvement score on a quiz, the teacher gives the student 1 point for each point that the student's quiz score exceeds his or her base score—up to a maximum of 10 points. A perfect quiz score earns 10 improvement points regardless of the student's base score, and no improvement score can be less than 0. For example, if José's base score is 21 and his quiz score is 23, his improvement score is 2; if Mary's base score is 18 and her quiz score is 30, her improvement score is 10; and if Pat's base score is 18 and her quiz score is 17, her improvement score is 0. According to Slavin (1982), the "improvement score system gives every student a good chance to contribute maximum points to the team" (p. 9).

The team improvement scores are used as the basis for rewarding students. The class publishes a weekly newsletter that lists the teams ranked in order of team improvement scores as well as the names of individual students who show large improvement or error-less performance. An example of a newsletter is shown in Figure 13–2.

Are cooperative learning methods effective in improving student achievement? To help answer this question, Slavin and Karweit (1984) conducted a yearlong study in ninth-grade mathematics classrooms from an inner-city school. The majority of students were African American, and the average achievement level in mathematics was very low. Some classrooms were selected to use cooperative learning techniques, namely, the STAD procedure described previously. Other classrooms were selected to use a mastery technique that emphasized individual learning. In these classrooms, for each lesson, the teacher instructed the whole class, asked the students to work on individual worksheets, and gave a quiz on the material. If a student scored lower than 80% on the quiz, the student received corrective instruction and then took a final quiz. If a student scored 80% or higher on the quiz, the student received enrichment activities to work on until all students had taken the final quiz.

Students took a mathematics achievement test at the beginning and the end of the academic year. Figure 13–3 shows that the students in classrooms that emphasized cooperative learning improved substantially more than students assigned to classrooms that emphasized individual learning. The amount of change is approximately twice as much for the cooperative learning group as for the individual learning group. In a review of 323 studies involving cooperative instructional methods, Johnson and Johnson (1990) determined that students averaged higher levels of achievement in cooperative learning situations than in competitive or individualistic ones. Based on these results, Johnson and Johnson concluded that "students at the 50th percentile in a cooperative learning situation will perform at the 75th percentile of students learning in a competitive situation and at the 77th percentile of students learning in an individualistic situation" (p. 24). The superiority of cooperative learning methods has been reported across many subject areas, types of learning materials, and ability levels of learners (Johnson & Johnson, 1985, 1990). The results led Slavin, Hurley, and Chamberlain (2003, p. 177) to conclude that "research on cooperative learning is one of the greatest success stories in the history of educational research."

More recently, a large scale experimental study conducted with low-achieving students in 38 elementary schools found that students who learned reading through the Success for All program—which included a heavy emphasis on cooperative learning as well as tutoring, performance-based grouping, and targeting of specific reading skills—showed greater gains on reading tests than did students taught by conventional methods (Borman, Slavin, Cheung, Chamberlain, Madden, & Chambers, 2005a, 2005b). For example, after 2 years

FIGURE 13–2 A newsletter from a cooperative learning classroom

THE MOUNTAIN CLIMBER

MOUTAIN VIEW ELEMENTARY SCHOOL

Issue No. 5
March 21, 1995

CALCULATORS OUTFIGURE CLASS

The Calculators (Charlene, Alfredo, Laura, and Carl) calculated their way into first place this week, with big 10-point scores by Charlene, Alfredo, and Carl, and a near-perfect team score of 38! Their score jumped them from sixth to third in cumulative rank. Way to go Calcs! The Fantastic Four (Frank, Otis, Ursula, and Rebecca) also did a fantastic job, with Ursula and Rebecca turning in 10-pointers, but the Tigers (Cissy, Lindsay, Arthur, and Willy) clawed their way from last place last week to a tie with the red-hot Four, who were second the first week and first last week. The Fantastic Four stayed in first place in cumulative rank. The Tigers were helped out by 10-point scores from Lindsay and Arthur. The Math Monsters (Gary, Helen, Octavia, Ulysses, and Luis) held on to fourth place this week, but thanks to their big first-place score in the first week they're still in second place in overall rank. Helen and Luis got each 10 points to help the M.M.'s. Just behind the Math Monsters were the Five Alive (Carlos, Irene, Nancy, Charles, and Oliver), with 10-point scores by Carlos and Charles, and then in order the Little Professors, Fractions, and Brains. Susan turned in 10 points for the L.P.'s, as did Linda for the Brains.

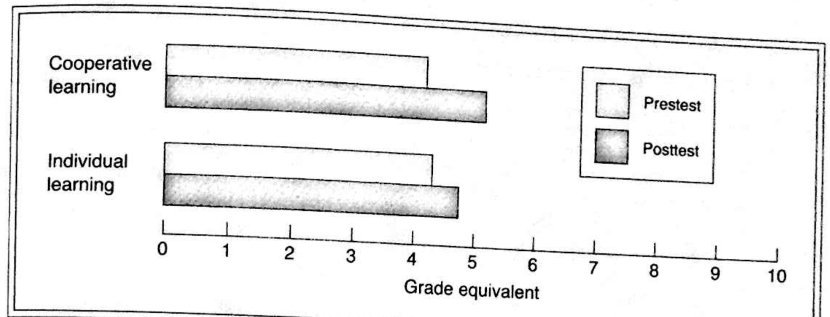
This Week's Rank	This Week's Score	Overall Score	Overall Rank
1st - Calculators	38	81	3
2nd - Fantastic Four } Tie	35	89	1
3rd - Tigers	35	73	6
4th - Math Monsters	40/32	85	2
5th - Five Alive	37/30	74	5
6th - Little Professors	26	70	8
7th - Fractions	23	78	4
8th - Brains	22	71	7

TEN-POINT SCORERS

Charlene	(Calculators)	Helen	(Math Monsters)
Alfredo	(Calculators)	Luis	(Math Monsters)
Carl	(Calculators)	Carlos	(Five Alive)
Ursula	(Fantastic Four)	Charles	(Five Alive)
Rebecca	(Fantastic Four)	Susan	(Little Professors)
Lindsay	(Tigers)	Linda	(Brains)
Arthur	(Tigers)		

Source: Modified from Slavin, R. (1982). Cooperative learning: Student teams. Washington, DC: National Education Association. Copyright 1982 National Education Association Reprinted by permission.

FIGURE 13–3 *Pretest-to-posttest gains in mathematics achievement for cooperative and individual learning classrooms*



Adapted from Slavin and Karweit (1984).

in the program, children scored 4.7 months ahead of controls in their ability to sound out words (i.e., word attack skills).

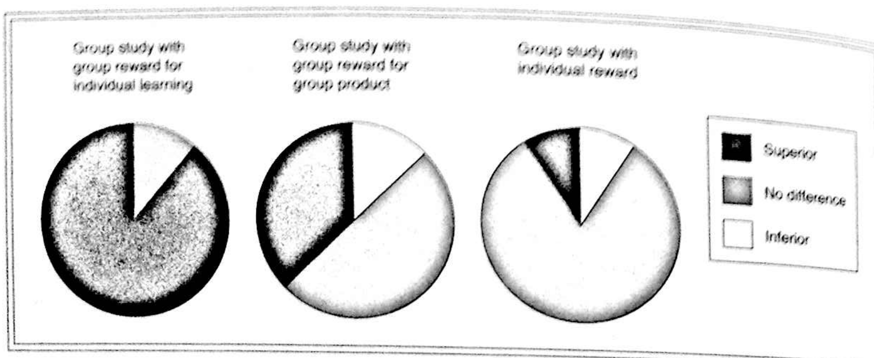
Why does cooperative learning affect student achievement? Slavin and collegaues (1983a; Slavin, Hurley, & Chamberlain, 2003) argue that cooperative learning situations consist of two important ingredients—*cooperative incentive structure* and *cooperative task structure*. Cooperative incentive structure refers to a situation in which rewards depend on group performance. A cooperative incentive structure occurs "when the students are individually assessed and the group members' scores are summed to form group scores" that are "recognized in class newsletters, or qualify the groups for certificates, grades, or other rewards" (Slavin, 1983a, p. 432). Thus, a cooperative incentive structure involves *group rewards* (i.e., rewards depend on how the group does as a whole) based on *individual accountability* (i.e., each member must make a major contribution to the group).

A cooperative task structure occurs when a heterogeneous group works together on a common task. It refers to a situation "in which two or more individuals are allowed, encouraged, or required to work together on some task, coordinating their efforts to complete the task" (Slavin, 1983a, p. 431). For example, a cooperative task structure occurs when a group of students works together to learn some material in preparation for a test. Cooperative task structure requires that the group, in addition to having a group task, be heterogeneous with respect to ability, gender, and ethnic composition. In short, an important aspect of cooperative task structure is that learning take place in a *social context* consisting of a *heterogeneous group*.

Not all group learning is equally effective. Slavin (1983a) contrasts three scenarios for group learning: group study with group reward for individual learning, group study with group reward for group product, and group study with individual reward. These forms of group learning are summarized in Figure 13–4. In the first scenario, students work in groups to improve their understanding of material and are evaluated as a group, as exemplified in the STAD technique described previously. In this case, the students engage in group study, which fulfills the requirement for a cooperative task structure, and are individually accountable for contributing to the overall success of the group, which fulfills the requirement for a cooperative incentive structure.

In a research review, Slavin (1983a) found that student achievement in classrooms involving this form of cooperative learning was superior to achievement in traditional

FIGURE 13–4 Effectiveness of three types of group learning



Source: From Robert E. Slavin, Cooperative Learning. Published by Allyn and Bacon, Boston, MA. Copyright © 1983 by Pearson Education. Adapted by permission of the publisher.

classroom environments in 89% of the studies surveyed and produced no effect in the remaining 11%. These results are illustrated in the lefthand pie chart in Figure 13–4. Slavin concluded that "cooperative learning methods that use group rewards and individual accountability consistently increase student achievement more than control methods in many academic subjects in elementary and secondary classrooms" (p. 443).

A seemingly related version of group learning is for students to work together on a common project, such as producing an entry for a science fair. In this case, students work as a group, but each student may not be individually accountable for contributing to the group. For example, one or two students may do all of the work while the others do not participate much in the project.

In a review, Slavin (1983a) compared cooperative learning methods consisting of group study with group reward for group product versus traditional methods. As illustrated in the middle pie chart in Figure 13–4, most of the studies (62%) failed to find any evidence that cooperative learning improved achievement more than other methods. Slavin concluded that "group study methods that provide group rewards based on the quality of a group product have not been found to improve student achievement" (p. 441). According to Slavin's analysis, an essential aspect of an effective cooperative learning method is that it fosters individual accountability; That is, each individual is essential for the success of the group. Individual accountability is likely to be lacking in cooperative learning situations involving a group product.

The third approach to group learning is for students to work in groups but to be evaluated as individuals. An example is a study group that holds group study sessions in preparation for a test in a traditional classroom. Although this situation involves cooperative task structure, it lacks cooperative incentive structure because the students may compete against each other as individuals for grades. In reviewing studies comparing this form of group learning with traditional methods, Slavin (1983a) found no evidence for its effectiveness. The right-hand pie chart in Figure 13–4 shows that 80% of the studies revealed no differences in achievement between cooperative learning and traditional classroom environments, with the remaining studies evenly split between the cooperative and traditional methods being most effective. Slavin concluded:

> The opportunity for students to study together makes little or no contribution to the effects of cooperative learning on achievement. Providing an opportunity for group study without providing further structure in the form of individual assessment and group reward has not been found . . . to increase student achievement more than having students work individually (p. 439).

In an updated review done 20 years later, Slavin, Hurley, and Chamberlain (2003) offer the same basic picture of the research results. They identified 99 research studies that compared achievement gains in cooperative learning groups and control groups, lasted at least 4 weeks, and involved students in Grades K–12. Of the 64 studies they found in which cooperative learning was implemented with group rewards based on the individual performance of each group member, the median effect size favoring cooperative learning was 0.32 (which is considered in the small-to-medium range); in contrast, of the remaining studies in which group rewards were based on a single group product or in which there was no group reward, the median effect size favoring cooperative learning was 0.07 (which is considered inconsequential). Slavin, et al. conclude: "cooperative learning is most consistently effective when groups are recognized or rewarded based on individual learning of their members" (p. 185). In another review of 81 published studies comparing some form of collaborative learning (e.g., cooperative learning, peer teaching, peer tutoring, and small group learning) against a control group, the median effect size was $d = 0.59$, which is a medium-sized effect (Rohrbech, Ginsburg-Block, Fantuzzo, & Miller, 2003). The effect was much stronger in studies involving younger students (i.e., in Grades 1–3) rather than older students (i.e., in Grades 4–6), predominately minority students rather than nonminority students, lower income students rather than higher income students, and urban schools rather than suburban and rural schools.

It would be incorrect to conclude from our review of research on cooperative learning that learning in small groups is more effective than learning individually. Slavin (1983a) correctly warns that "there is no evidence as of yet that group study per se makes any difference in student achievement" (pp. 440–441). Similarly, Gillies (2004) notes: "While the benefits that accrue to students from cooperative learning are unequivocal, it is also clear that just placing students in groups and expecting them to work together will not promote cooperative learning" (p. 198). Based on their review of the research literature on cooperative learning, Johnson and Johnson (1990) issue a similar warning: "Simply placing students in groups and telling them to work together does not in itself promote higher achievement" (p. 34). Instead, cooperative learning methods have been found to be effective when students are rewarded based on group performance (i.e., cooperative incentive structure) and when each student must participate fully within a group on an academic task (i.e., cooperative task structure).

Table 13–1 lists five theoretical perspectives and their implications for improving cooperative learning. According to a motivational perspective, rewarding groups based on members' individual performance motivates all students to make sure everyone in the group learns well, and these features have been shown to be instrumental in fostering achievement gains. Are there any other features that contribute to the effectiveness of cooperative learning? According to a cognitive load perspective, students may engage in

TABLE 13–1
Searching for effective features of cooperative learning

Theoretical Perspective	Feature	Example	Effectiveness
Motivational	Group incentive based on individual performance	STAD	High
Cognitive load	Structuring of interactions	Think sheets	High
Social cohesion	Team building	Jigsaw	Low
Cognitive development	Peer interaction	Peer tutoring	Insufficient evidence
Cognitive elaboration	Mental elaboration	Reciprocal teaching	High

unproductive discussions that distract them from focusing on the main instructional content; thus, it may be useful to provide some structure for student interactions and some training in how to participate in cooperative groups. In a review of research, Slavin and colleagues (2003) conclude that "there is some evidence that carefully structuring interactions among students in cooperative groups can be effective even in the absence of group rewards" (p. 185). For example, Meeloth and Deering (1992, 1994) provided group members with "think sheets" to remind them of the key content of the group exercises.

However, other features do not fare as well. According to social cohesion theory, group members will work better together if they receive some sort of team-building activity. One way to foster team building is the jigsaw method in which each member of the group gathers information about one aspect of the task, so when the group meets each member is an expert on at least one part of the project. However, Slavin and colleagues (2003) conclude that "research on the original form of the jigsaw method has not generally found positive results" (p. 181). According to cognitive developmental theory, children learn through peer interaction, but Slavin et al. report that "there is almost no research explicitly linking this conceptual work with classroom practice" (p. 183). Finally, they note that cognitive elaboration theory proposes that group learning causes students to mentally elaborate on the material, particularly when one student must explain something to another student. For example, Webb's (1989, 1992) observations of student groups revealed that students who gained the most were those who provided explanations to others. Reciprocal teaching explicitly requires students to take the role of teachers, and is described in the next section.

RECIPROCAL TEACHING

Another way of learning as an apprentice within a group of learners is through *reciprocal teaching*—an instructional technique in which students and teacher take turns leading a dialogue about strategies for how to study some material (Brown & Palincsar, 1989; Palincsar & Brown, 1984). Reciprocal teaching takes place in learning groups consisting of a teacher and one or more students. The goal of each instructional episode is for the group to study a text passage using a variety of reading comprehension strategies. Teacher and students take turns as discussion leaders, although the teacher provides comments, feedback, and hints as needed. As you can see, this version of collaboration tends to prime mental elaboration in group members, as they are called upon to explain material to others.

Suppose, for example, that the goal of a unit in a seventh-grade English course is to help students improve their reading comprehension skills. In particular, suppose that we want students to learn to use four widely acclaimed reading comprehension strategies—*questioning*, in which a student generates an appropriate question for a passage; *clarifying*, in which a student detects and corrects any potential comprehension difficulties, such as definitions of unfamiliar words; *summarizing*, in which a student produces a concise summary for a passage; and *predicting*, in which a student suggests what will occur in subsequent text. In typical classroom practice, the teacher may model each of these strategies for students (i.e., modeling method) or may describe each strategy and ask students to apply them in workbook exercises (i.e., direct instruction method). In contrast, in reciprocal teaching, the students get a chance to teach these strategies to the group. In short, the teacher and student reciprocate: The one who was instructed takes the role of teacher, and the one who instructed takes the role of student.

In reciprocal teaching, we begin with a teacher and a group of students who jointly are trying to make sense out of a paragraph, such as the text about crows in Figure 13–5. The participants engage in a structured discussion in which the discussion leader models the cognitive strategies of questioning, clarifying, summarizing, and predicting. At first, the teacher

FIGURE 13–5
An example of reciprocal teaching

Text from which students are working:

Crows have another gift. They are great mimics. They can learn to talk and imitate animal sounds. Some have been known to learn 100 words, and even whole phrases. They can imitate the squawk of a chicken, the whine of a dog, or the meow of a cat.

Games have a certain fascination to crows. In a game of hide-and-seek, a crow hides in the hollow of a tree and then sounds a distress caw. The others rush to the spot, look around, then flap away. This may be done over and over, after which the young crow pops out of its hiding place and caws gleefully. Far from being annoyed at this, the flock bursts into loud cawing themselves. They seem to like the trick that has been played on them.

T: Chantel, you're our teacher, right? Why don't you summarize first? Remember, just tell me the most important parts.
S1: Crows have a hundred words they can learn by imitation. They can imitate chickens, the whine of a dog, and cats.
T: Okay. We can shorten that summary a bit.
S2: You could say they can imitate other animals.
T: Oh! Good one! There's a list there, Chantel, did you notice that? It says they can imitate the squawk of a chicken, the whine of a dog or the meow of a cat; and you could call that "animal sounds." Can you ask us a question?
S1: Ain't no questions in here.
S3: The words that need to be clarified are "mimics."
S4: That means imitate, right?

(continued)

FIGURE 13–5

(continued)

T: Right. How did you figure that out, Shirley?
S4: The paragraph.
T: Show us how somebody could figure out what "mimic" means.
S5: They are great mimics. They can learn to talk and imitate animal sounds.
T: Yes, so the next sentence tells you what it means. Very good, anything else need to be clarified?
All: No.
T: What about that question we need to ask? (pause) What is the second paragraph about, Chantel?
S1: The games they play.
S3: They do things like people do.
S4: What kinds of games do crows play?
S3: Hide and seek. Over and over again.
T: You know what, Larry? That was a real good comparison. One excellent question could be, "How are crows like people?"
S4: They play hide and seek.
T: Good. Any other questions there?
S2: How come the crows don't get annoyed?
S5: What does annoyed mean?
T: Irritated, bothered.
S5: Because they like it, they have fun. If I had a crow, I'd tell him he was it and see what he'd do.
T: Let's summarize now and have some predictions.
S1: This was about how they play around in games.
T: Good for you. That's it. Predications anyone?
S2: Maybe more tricks they play.
S4: Other games.
T: Maybe. So far, they have told us several ways that crows are very smart; they can communicate with one another, they can imitate many sounds, and they play games. Maybe we will read about another way in which they are smart. Who will be the next teacher?

Source: From Metacognitive strategy instruction by A. S. Palincsar, Exceptional Children, *53, 118–124.*
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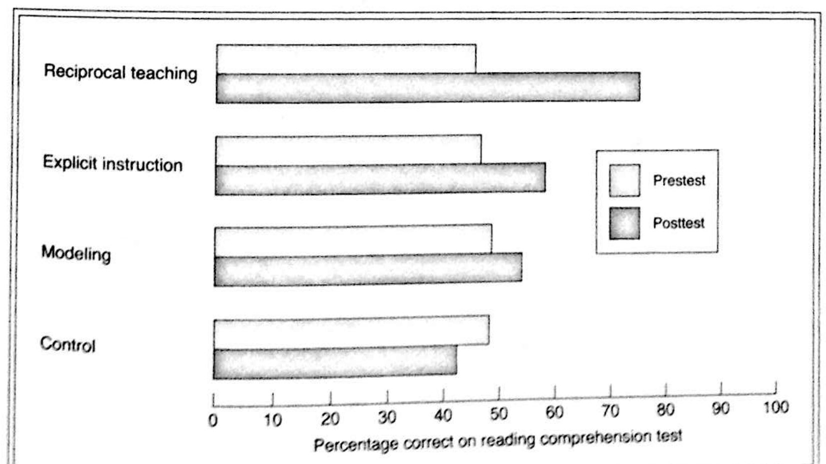
leads the discussion by generating a question about the text, summarizing the gist of the text, clarifying any comprehension problems, and making predictions about subsequent text. When disagreements arise, all participants reread the text and discuss options until consensus is reached. So far, this procedure is much like the strategy training programs discussed in Chapters 11 and 12. However, in reciprocal teaching, the teacher eventually turns over the job of discussion leader to the students, such as Chantel (identified as S1) in Figure 13–5. When a student leads the discussion, the teacher periodically provides guidance on exercising cognitive strategies, such as how to ask appropriate questions or how to generate good summaries. The teacher prompts the student discussion leader, offers critiques, and generally provides support that enables the student to proceed. As the students become more proficient, the teacher reduces the amount of direction and feedback. The teaching dialogue in Figure 13–5 provides an example of reciprocal teaching in action.

Does reciprocal teaching work? To answer this question, Brown and Palincsar (1989) compared four groups of junior high school students who had reading problems. Students in the reciprocal teaching group took turns with the teacher in leading discussions about applying the four reading comprehension strategies; students in the modeling group observed the teacher as she modeled how to apply each of the four comprehension strategies to example paragraphs; students in the explicit teaching group listened to the teacher's description of each strategy and completed paper-and-pencil exercises; and students in the control group received no information about the four strategies. All students received 12 sessions of group instruction along with regular tests of reading comprehension. Figure 13–6 shows the average scores of each group on a pretest and posttest of reading comprehension. As you can see, all groups begin at a level between 40% and 50% correct; however, the reciprocal teaching group shows the largest gain. In a similar study, the reciprocal teaching students showed a 20-month pretest-to-posttest gain on a standardized test of reading comprehension, whereas the control group showed a 1-month gain (Palincsar & Brown, 1984). In addition, Brown and Palincsar (1989) report that the improvements of the reciprocal teaching group are still strong when students are tested 2 or 6 months later.

Why does reciprocal teaching work? The procedure combines several powerful techniques involving the what, where, and who of learning. First, what is learned are cognitive strategies for reading comprehension rather than specific facts and procedures. That is, the

FIGURE 13–6 Pretest-to-posttest gains in reading comprehension for four groups



Source: Adapted from Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and monitoring strategies. Cognition and Instruction, 1, 117–175.

instruction focuses on how to learn rather than what to learn. Second, learning of the cognitive strategies occurs within real reading comprehension tasks rather than having each strategy taught in isolation. The goal is not to learn isolated strategies per se but to learn them in order to understand the passages. Third, students learn as apprentices within a cooperative group that is working together on a task. The teacher serves as a critic and helper who provides feedback and basic information as needed. In short, the teacher provides *expert scaffolding* within a group that is jointly working on a task. The most distinguishing aspect of reciprocal teaching is that the student assumes the role of the teacher and thereby learns by teaching. In short, the student learns to assume an important role within a social context.

Recent research has shown that reciprocal teaching must sometimes be adapted to fit the needs of particular learning situations. Consider an eighth-grade math class in which the topic for the next 10 days will be linear graphs, including how to interpret line graphs. Each 45-minute lesson begins with about 10 minutes of the teacher introducing a task to the whole class and modeling how to carry out the strategies for completing the task, followed by 30 minutes of students working collaboratively in small groups based loosely on Brown and Palincsar's principles for reciprocal teaching, and ending with 5 minutes of whole-class instruction in which the teacher reviews what has been learned. Is there anything we can do to improve on this use of collaborative learning? Kramarski (2004) developed supplemental instruction that helped provide structure to the conversations in small groups. Students were given a booklet containing four kinds of questions to be used during small-group discussions about graphs:

Comprehension questions, such as "What does the *x*-axis represent? What does the *y*-axis represent? What is the trend of the graph?"

Strategic questions, such as "What principle can be used to solve the problem? Why is this principle most appropriate for solving the problem?"

Connection questions, such as "Can you think of a similar problem?"

Reflection questions, such as "Is the result reasonable?"

These questions provide a metacognitive aid to students because they help students think about their own learning. Students who learned in collaborative groups without the metacognitive aids showed a pretest-to-posttest gain in graph comprehension performance (up 14 percentage points from 39% correct to 53%), but students who learned in collaborative groups with metacognitive aids showed a much larger gain (up 25 percentage points from 43% to 68%). On a graph construction task, students who learned in collaborative groups without metacognitive aids showed a small pretest-to-posttest gain (up 8 points from 62% to 70% correct), but students who learned in collaborative groups with metacognitive aids showed a much larger gain (up 23 points from 57% to 80% correct). Kramarski concludes that students need guidance in how to structure useful discussions while in small groups.

What happens when teachers implement reciprocal teaching in their classrooms? To answer this question, Hacker and Tenent (2002) observed 17 elementary school teachers during a 3-year period as they implemented and modified reciprocal teaching in their classrooms. Teachers found that students (a) tended to focus on two of the strategies (clarifying and predicting), (b) tended not to use the strategies correctly, (c) had trouble engaging in high-quality dialogues, and (d) required substantial amounts of direct instruction from the teacher. Teachers modified the program by adding more direct instruction on strategy use, incorporating parts of the program into whole-class instruction, and requiring written summaries of the passages being read. Hacker and Tenent (2002) conclude: "researchers and educators who advocate new programs must be aware of the ways in which programs change with each teacher" (p. 713). Hacker and Tenent's observation of the important role of the teacher providing instruction in how to use the strategies is consistent with research reviews. In a review of 16 early research studies on reciprocal teaching, Rosenshine and Meister (1994) reported a weak but positive effect size favoring reciprocal teaching ($d = 0.14$), although the effect was much stronger for studies in which students received direct instruction in how to use the four strategies (Shuell, 1996).

Finally, let's consider a more recent application of Palinscar and Brown's reciprocal teaching technique. Josh is an elementary school student who can read words accurately (i.e., he is an adequate decoder) but has difficulty in being able to comprehend what he has read (i.e., he is a poor comprehender). Let's take a group of students like Josh—adequate decoders but poor comprehenders—and see if reciprocal teaching techniques can help them. Over the course of 10 weeks, they work in groups of approximately 4 students and 1 instructor, in which they learn to use the reading comprehension strategies of summarization, clarification, and prediction, and question generation, similar to the description of the Palincsar and Brown (1984) experiment. When Johnson-Glenberg (2000) carried out this study she found that students in the reciprocal teaching group showed a large pretest-to-posttest gain in answering open-ended questions about what they had read (54% to 67%), whereas a control group showed a slight decline (58% to 52%). These results are consistent with the idea that reciprocal teaching can improve students' reading comprehension skill. However, you might wonder if other methods are equally effective. Johnson-Glenberg reported that students who received 10 weeks of small-group training in which they learned to visualize summaries of the text passages also showed pretest-to-posttest gains greater than those of the control group (55% to 62%). Thus, although reciprocal teaching can be effective, it is not clear that social collaboration is the major feature that promotes learning of comprehension skills.

In summary, two adjustments to reciprocal teaching that may be worthwhile are to provide guidance to students for how to structure small-group discussions and to provide direct instruction in the to-be-learned strategies as part of the instructional program. In addition, it is not clear whether collaboration is the major cause of learning, or whether the same benefits can be achieved with other instructional methods such as modeling of strategies. This approach is examined in the section titled "Modeling Methods."

COMPUTER-SUPPORTED COLLABORATIVE LEARNING

In collaborative learning, students work together on academic tasks. Advances in computer technology and communication technology have enabled instructors to incorporate a new form of collaboration—*computer-supported collaborative learning (CSCL)*—in which students work together online (Hiltz & Goldman, 2005). Does computer-supported collaborative learning work?

To help answer this question, consider the following scenarios. At one school, groups of two or more students sit at a computer screen and work together on a task, whereas at another school, students work individually at a computer screen. Alternatively, in one online course two or more students work on assignments as a group—communicating with each other online—whereas in another online course each student works individually. When you are learning with a computer, is it better to learn in a group or individually? Lou, Abrami, and d'Apollonia (2001) examined the results of 178 experiments aimed at answering this question and found a small but positive effect favoring group learning. On average, students who learned in groups scored higher than students who learned individually on achievement tests covering the course material—but the effect size, which was $d = 0.16$, is considered to be below the small range. In addition, students who learned in groups may have spent more time learning, so the treatments were not always equivalent in terms of time on task. Overall, there is a need for high-quality research that specifically focuses on the effects of various collaborative methods.

Which features of computer-supported collaborative learning are most effective? Regrettably, we just do not yet know much about the pedagogical impact of computer-supported collaborative learning. In a recent review, Jonassen, Lee, Yang, and Laffey (2005) concluded: "The majority of CSCL research has focused on the nature of discourse and collaboration in a variety of collaborative environments without relating those results to learning outcomes. From a research perspective . . . without examining the effects of . . . communication or collaboration on learning outcomes, the implications for computer-supported collaborative learning may never be established" (p. 262). In reviewing the research on CSCL, Swan (2003) comes to the same conclusion: "Further research, more rigorous research, and more creative research are definitely needed" (p. 37). In summary, there is not strong research evidence to support the widespread use of online collaboration.

Modeling Methods

Another way of incorporating apprenticeship into classrooms is *participatory modeling*—in which an expert and a novice each participate in modeling the process for accomplishing some cognitive task. For example, Chapter 12 included a description of Bloom and Broder's (1950) techniques for teaching thinking strategies to college students. In Bloom and Broder's study, an expert described out loud what was going on in his mind as he solved an exam problem; a novice did the same thing and compared his thinking process to that of the expert.

Let's consider two examples of how students accomplish a writing assignment. Suppose that a teacher asks the students in her class to write an essay on an interesting job or occupation. As soon as Mark is given the topic, he begins writing. "An interesting job is being a police officer," he writes. Then he remembers the following information that he adds to his essay: "Police officers ride in fast cars with sirens and catch speeders on the freeway. Once my dad was stopped for speeding." Then, it occurs to him that the job can be dangerous, so he adds: "Sometimes criminals attack police officers so they always have to be ready for action. I saw a wounded officer on TV." Finally, he runs out of ideas, so he concludes by writing: "I would really like to be a police officer one day."

Mark displays the characteristics of a novice writer. When given a topic to write about, novices write the first idea that occurs to them, then the next idea, and so on until they cannot think of any more ideas—a strategy that Bereiter and Scardamalia (1987) call *knowledge telling*.

In contrast, Sheening writes an outline before he begins and revises the outline during the writing process. His outline begins as "1. Introduction—vets love animals. 2. What vets do. 3. How vets help animals. 4. How vets help people. 5. How vets help society." He collects his thoughts and organizes them about each of these topics, and he establishes a theme for his paper: Being a veterinarian is one way of expressing your love of animals.

Sheening's writing process reflects many of the characteristics of expert writing. When expert writers are given a topic to write on, they use what Bereiter and Scardamalia (1987) call a *knowledge transforming* strategy, in which they plan what they are going to write and revise what they have written. The processes used for good writers are described in more detail in Hayes and Flower's (1980; Hayes, 1996) analysis of the cognitive processes in writing, discussed in Chapter 4.

How can teachers help students change from the linear writing processes of novices to the reflective writing processes of experts? To accomplish this goal, Scardamalia, Bereiter, and Steinbach (1984) developed an instructional procedure based on modeling of reflective processes in writing. Sixth-grade students participated in a 15-week unit on reflective writing (experimental group) or were given typical classroom instruction (control group).

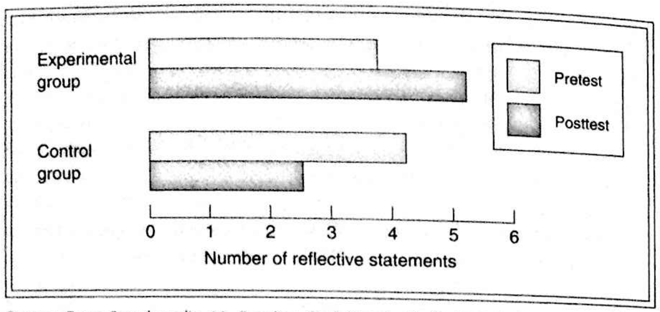
In the experimental group, the instructor frequently modeled her thinking processes for the group, and the students also frequently modeled their thinking processes for each other. For example, when faced with a writing assignment, the teacher stood in front of the group and produced a thinking-aloud description of how she thought of ideas and organized them, how she decided on the goal of the essay, how she figured out ways to elaborate and improve on what she had, and so on. Later, students were asked to do the same while standing in front of the group.

Whenever the writer got stuck, he or she selected a card from a deck. Each card contained a hint about how to generate a new idea (e.g., "An important distinction is . . ." or "The history of this is . . ."); how to improve ideas (e.g., "To put it more simply . . ." or "I could give the reader a clear picture by . . ."); how to elaborate (e.g., "An example of this is . . ." or "My own experience with this is . . ."); how to set goals (e.g., "My purpose is . . ." or "A goal I think I could write to . . ."); or how to organize ideas (e.g., "If I want to start off with my strongest idea . . ." or "I can tie this together by . . ."). Students learned to determine which category of cue card they needed, select a card from that category, respond to it, and continue their thinking-aloud monologue. The teacher led group discussions following thinking-aloud monologues in which students could critique the processes that had been modeled. In addition, the teacher provided direct instruction on how to write reflectively, using the strategies of expert writers. After experience with these "public demonstrations of planning" (Scardamalia et al., 1984, p. 179), students worked individually on planning essays at their seats. They used the deck of cue cards but gave their thinking-aloud monologue silently to themselves.

As you can see, this procedure is like reciprocal teaching in that teachers and students take turns in modeling a set of cognitive strategies. At first, the teacher models how to plan an essay using prompts from a deck of cue cards, and later students take their turns at planning essays using the cue cards. In addition, as in reciprocal teaching, the students and teachers both provide criticisms and comments on each other's modeling performances.

Does experience in observing, producing, and critiquing thinking-aloud descriptions of expert writing processes have an effect on students' writing processes and products? To provide some information about writing processes, selected students in both groups were tape-recorded as they engaged in thinking-aloud monologues before and after the 15-week

FIGURE 13–7
Pretest-to-posttest changes in the number of reflective statements made while preparing to write an essay



Source: From Scardamalia, M., Bereiter, C., & Steinbach, R. (1984). Teachability of reflective processes in written composition. Cognitive Science, 8, *173–190. © Cognitive Science Society, Inc.*

instructional unit. Raters tallied the number of reflective statements—that is, statements involving planning and organizing ideas—in each monologue, without knowing whether the monologue occurred before or after instruction or whether the monologue was produced by an experimental or a control student. Figure 13–7 shows that the average number of reflective comments increased from pretest to posttest for experimental students and decreased for control students. This finding indicates that the training was effective in helping students think more like experts as they planned an essay.

To provide some preliminary data on writing products, students in both groups were asked to write essays before (pretest) and after (posttest) the 15-week instructional unit. Figure 13–8 shows essays written on the pretest and posttest by a student in the experimental group. Raters were given the pretest and posttest essay of each student without any indication of which essay had been written first and which group the writer had been in. For each of several important rating dimensions, the rater's job was to rate how much better one essay was than the other. The average ratings on several key dimensions for the groups are shown in Figure 13–9. If the rater preferred the posttest essay, the difference score is shown as positive in Figure 13–9; if the rater preferred the pretest essay, the difference score is shown as negative in Figure 13–9. Overall, the experimental group showed a greater pretest-to-posttest gain than the control group. This finding is consistent with the idea that the modeling procedures used during instruction had a positive effect in helping students produce more expertlike essays.

As in the teaching of expert writing strategies, Collins and Smith (1982) have proposed three stages for cognitive modeling of expert reading comprehension strategies: stage 1, in which the teacher models the strategy; stage 2, in which the student learns to model the strategy with ongoing support from the teacher; and stage 3, in which the student learns to apply the strategy without ongoing teacher support. For example, in the case of learning reading comprehension strategies, the stages are as follows:

> The first stage will consist of the teacher modeling comprehension, and commenting on his or her monitoring and hypotheses, while reading aloud to a student. The next stage will consist of encouraging students to practice these techniques themselves while reading aloud. The third and final stage will be to have students use these skills while reading silently (Collins & Smith, 1982, p. 182).

FIGURE 13–8
Examples of essays written before and after reciprocal modeling of writing strategies

(Pretest)
Jobs or Occupation

An interesting job or occupation is being an airline stewardess. I think airline stewardesses have an interesting job because they get to travel all over the world and meet new people. I know because my friend is an airline stewardess and travels a lot. I would like to be an airline stewardess when I grow up.

(Posttest)
An Interesting Kind of Animal

All animals are interesting, but sometimes you may find a person that may like an animal better than you. That proves that all people are different. I think an interesting animal is a tiger because of its fierce and gentle sides makes it exquisite. Most people think it is only fierce and only hurts people but that isn't so. The tiger has so much grace in his walk it almost looks as if he puts a lot of thought into it, and his fur coat is so unique I think it's one of a kind, and nothing could be better or more beautiful than that striped coat to me. That is why I think the tiger is the most interesting animal.

Source: From Scardamalia, M., Bereiter, C., & Steinbach, R. (1984). Teachability of reflective processes in written composition. Cognitive Science, 8, *173–190. © Cognitive Science Society, Inc.*

FIGURE 13–9
Major pretest-to-posttest changes in ratings of essay quality to experimental and control groups

Rating Dimension	Experimental	Control
1. Questioning, speculating, or raising uncertainties	+.67	−.02
2. Suggesting personal involvement or interest in topic	+.59	−.36
3. Attempting to communicate why topic is interesting	+.54	−.36
4. Writing in essay rather than encyclopedia style	+.52	−.34
5. Using content to convey point of essay	+.43	−.11
6. Using attention-getting expressions in opening or closing	+.41	+.12
7. Stating theme or purpose	+.26	−.37

Source: Adapted from Scardamalia, M., Bereiter, C., & Steinbach, R. (1984). Teachability of reflective processes in written composition. Cognitive Science, 8, *173–190. © Cognitive Science Society, Inc.*

The three stages represent a gradual shifting of responsibility from the teacher to the student.

Not all forms of cognitive modeling may be equally effective. For example, in observational modeling (or teacher-only modeling), the teacher models the desired strategy but the students do not. In participatory modeling (or reciprocal modeling), the teacher and student each get opportunities to model and critique the strategy. Scardamalia, Bereiter, and Steinbach's (1984) method for teaching reflective writing strategies is based on participatory rather than observational modeling, as is Bloom and Broder's (1950) successful training of problem-solving strategies described in Chapter 12.

In a review of research on cognitive strategy instruction, Pressley and Woloshyn (1995) argue that modeling is most effective when both teacher and student participate and interact. They advocate an instructional sequence in which "teachers describe and model strategies initially, and then allow a great deal of student practice in order for students to master those strategies" (p. 10). In contrast, they argue against using a procedure in which the teacher explains a strategy and then assigns unsupervised practice. Although research continues in pursuit of effective ways to use modeling in classrooms, many scholars favor participatory over observational modeling (Collins et al., 1989; Pressley & Woloshyn, 1995).

Personalization Methods

Learning by apprenticeship is based on the idea that learning is an inherently social activity. Can we take this idea one step further and consider how to build social cues into lectures and books? In this section, we explore instructional methods aimed at creating a feeling of social partnership within the learner.

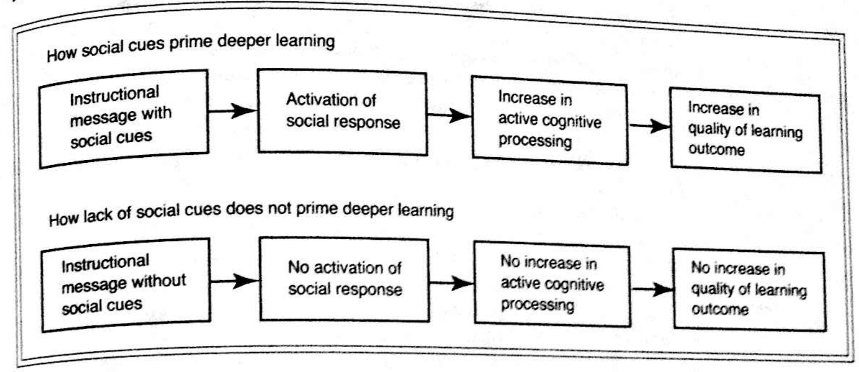
Consider a learning situation in which you are sitting on a sofa reading a textbook or sitting at your desk working on an online lesson. How can these situations be included in a chapter on social factors in learning? There is no other person with you—it is just you and the textbook or you and the computer. Yet, in this section, we explore the idea that learning can be a social activity, even when the learner is reading a book or viewing an online lesson. Reading a book can be a social activity when the learner develops a sense of social partnership with the author; similarly, listening to an online narration can be a social activity when the learner develops a sense of social partnership with the speaker. Thus, effective instruction contains social cues (such as conversational style) that can prime the learner's sense of social partnership. For example, when you feel that the author or speaker is a person who is trying to communicate with you, you are more likely to try harder to understand the instructional message.

The top portion of Figure 13–10 presents a framework for how social cues can prime deeper learning (Mayer, 2005d). Instructional messages with social cues (such as conversational style) can activate a feeling of social presence in the learner in which the learner accepts the author or speaker as a conversational partner. When you feel that you are in a conversation with someone, you have an implied commitment to work harder to try to make sense of what they are saying. When the learner exerts more effort to understand the incoming material (i.e., through an increase in active cognitive processing in the learner), the result is an increase in the quality of the learning outcome that is better able to support test performance.

In contrast, the bottom portion of Figure 13–10 presents a framework in which instructional messages that lack social cues lead to a lack of social response in the learner. When you see the instruction message simply as words rather than as part of a conversation, you are not committed to exerting effort to make sense of the material; hence, the resulting learning outcome is not improved.

First, what is the rationale for the arrow from the first box to the second box, in which cues activate the learner's sense of conversational partnership? Reeves and Naas (1996) and Naas and Brave (2005) have shown how people are easily induced to accept computers as

FIGURE 13–10 How social cues in instructional messages can affect learning



social partners. Instructional features such as the speaker's conversational style or the speaker's voice carry important social cues that can encourage the learner to respond socially to the instructional message.

Second, what is the rationale for the arrow from the second box to the third box, in which the learner's sense of conversational partnership leads to deeper cognitive processing during learning? Grice (1975) has shown that pragmatic rules come into play when people engage in human-to-human communication. When in a conversation, we assume that the speaker is trying to make sense by presenting information that is informative, accurate, relevant, and concise. According to what Grice calls the *cooperation principle*, for example, learners work hard to understand the author's message because they have an implicit social agreement to do so.

Third, what is the rationale for the arrow from the third box to the fourth box, in which deeper cognitive processing during learning leads to better learning outcomes? This idea is at the heart of the constructivist theory of learning presented in previous chapters, in which meaningful learning outcomes are built when learners engage in appropriate cognitive processing such as selecting relevant information, organizing the information into a coherent structure, and integrating that material with existing knowledge (Mayer, 2001b, 2005a; Wittrock, 1989).

I use the term *personalization* to refer to the incorporation of social cues in instructional messages. In this section, we explore two instructional situations involving personalization—visible authors in books and conversational agents in online lessons. Our goal is to determine how to infuse effective social cues in instructional messages, that is, how to personalize instruction in a way that promotes learning.

VISIBLE AUTHORS IN BOOKS

Suppose I asked you to read 6 historical documents concerning the murder of Julius Caesar (including a letter written by one of the murderers, a letter from a senator present on the day of the murder, a historical account written by ancient Romans, and an excerpt from rather than observational modeling, as is Bloom and Broder's (1950) successful training of problem-solving strategies described in Chapter 12.

In a review of research on cognitive strategy instruction, Pressley and Woloshyn (1995) argue that modeling is most effective when both teacher and student participate and interact. They advocate an instructional sequence in which "teachers describe and model strategies initially, and then allow a great deal of student practice in order for students to master those strategies" (p. 10). In contrast, they argue against using a procedure in which the teacher explains a strategy and then assigns unsupervised practice. Although research continues in pursuit of effective ways to use modeling in classrooms, many scholars favor participatory over observational modeling (Collins et al., 1989; Pressley & Woloshyn, 1995).

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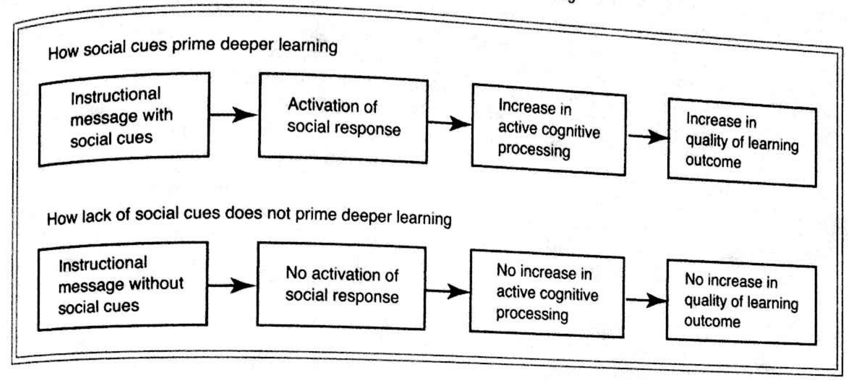
FIGURE 13–10 How social cues in instructional messages can affect learning



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What can be done to encourage young readers to get more involved in this task? Perhaps students might get more involved if the author of the introduction was more personable, so that the students could interpret this task as a form of cooperative communication on a more personal level. To explore this idea, Paxton (2002) gave half the students an introductory text written in the anonymous-author style and the other half received an introductory text containing the same content but written in a visible-author style. The anonymous-author text was written in the third person and succinctly covered the relevant historical events in chronological order. For example, one sentence was: "Caesar's rivals, afraid of losing their influence, stabbed him to death in 44 B.C." In contrast, the visible-author text used first person (i.e., "I," "me," "we," and "us") and second person (e.g., "you"), made self-disclosing comments, and spoke directly to the reader about his opinions and the larger community of historians involved in studying Roman history. For example, one sentence was: "You don't have to trust me on this: Caesar's own point of view is spelled out in his book *The Gallic Wars*, one of the best known works of Latin literature."

While thinking aloud as they read the six documents (which were identical for all students), students who had read the visible-author introduction generated more than twice as many words as did students who had read the anonymous-author introduction, indicating that the visible author helped students feel more involved in the learning process. Importantly, the students in the visible-author group also wrote better documented essays than those in the anonymous-author group, as reflected in their referring to more of the six reference documents. Complementary results were obtained by Paxton (1997) with high school students reading history texts, and by Nolan (1995) with college women reading statistics texts.

Overall, these studies offer encouraging preliminary evidence that authors can activate a sense of social partnership by using a conversational style that includes (a) first and second person constructions, and (b) some self-disclosing information. The goal of these tactics is to make the author more visible to the learner—that is, to help the learner accept the author as conversational partner. However, more research is needed to determine the appropriate level of these tactics for various kinds of learners and instructional goals. (I must admit that I fear that too much self-disclosing information from an author—such as this sentence—may distract the learner from the core instructional material, so I have minimized them in this book.)

CONVERSATIONAL STYLE IN TUTORIAL LESSONS

Suppose you are working on your laptop computer, and you need to find out how the human lungs work. You go to an online encyclopedia and click on "lungs." You find a movie icon, and when you click on it, you receive a 45-second narrated animation explaining how

TABLE 13–2 Narration script for the lungs lesson

There are three phases in respiration: inhaling, exchanging, and exhaling. During inhaling, the [your] diaphragm moves down creating more space for the [your] lungs, air enters through the [your] nose or mouth, moves down through the [your] throat and bronchial tubes to tiny air sacs in the [your] lungs. During exchange, oxygen moves from the [your] air sacs to the bloodstream running nearby, and carbon dioxide moves from the bloodstream to the [your] air sacs. During exhaling, the [your] diaphragm moves up, creating less room for the [your] lungs, air travels through the [your] bronchial tubes and throat to the [your] nose and mouth, where it leaves the [your] body.

Note: The nonpersonalized version did not contain bracketed words; the personalized version contained "your" instead of "the" in the 12 places indicated with brackets.

Adapted from Mayer, Fennell, Farmer, & Campbell (2004).

the lungs work. The narration script is shown in Table 13–2. When Mayer, Fennell, Farmer, and Campbell (2004) tested college students on this narrated animation (which can be called the nonpersonalized version), they found students performed well on remembering the material (i.e., they recalled about half of the main events), but not so well on applying what they learned in solving problems (such as listing all the ways they could think of for improving the human respiratory system).

Can we encourage students to process the material more deeply by inserting social cues? In an attempt to prime a social response in learners, Mayer et al. (2004) substituted the word "your" for "the" in 12 places in the narration script (as shown in the brackets in Table 13–2). Inserting "your" is an attempt to use conversational style in a way that encourages learners to be more personally involved, that is, to help them feel as if the speaker is addressing them personally. This narration can be called the personalized version. Across three different experiments involving college students, changing the narrated animation from nonpersonalized form to personalized form did not result in large consistent changes in recall test performance, perhaps because students in the nonpersonalized group already performed well on remembering some of the events described in the narration. However, if personalization leads to deeper processing, we would expect the personalized group to excel on the problem-solving transfer test in which students must apply what they have learned to answer novel questions. In each of three experiments, the personalized group wrote more solutions to novel problems than did the nonpersonalized group, with moderate-to-large effect sizes of 0.52, 1.00, and 0.79, respectively. These results are particularly encouraging because a seemingly modest manipulation (i.e., changing "the" to "your" in 12 places) had a strong, positive effect on measures of learner understanding.

Similar results were obtained using a 140-second narrated animation on lightning formation, in which personalization involved use of first- and second-person constructions such as changing "the cloud" to "your cloud" and adding sentences that directly address the learner such as "Let me tell you what happens when lightning forms." On transfer tests involving listing as many solutions as possible to novel problems, such as how to reduce the intensity of a lightning storm, students who received the personalized version outperformed students who received the nonpersonalized version. Across two experiments the effect sizes in favor of personalization were 1.05 and 1.61, which are considered large effects.

Personalization can also be incorporated into onscreen conversational agents in educational games and simulations. For example, consider an environmental science game in which you travel to a distant planet that has specific environmental conditions—such as heavy winds, little rain, and strong sunlight. Your job is to design a plant that will survive by selecting appropriate roots, stem, and leaves. An onscreen agent, named Herman-the-Bug, helps you along the way, and explains why your plant flourished or withered. In the nonpersonalized version, Herman-the-Bug speaks in a formal style using third-person constructions that do not address the learner. In the personalized version, Herman-the-Bug speaks in an informal conversational style using first- and second-person constructions and directly addressing the learner. Table 13–3 shows excerpts from the nonpersonalized and personalized versions of the game.

Does Herman-the-Bug's conversational style have an effect on student learning? To test this idea, Moreno and Mayer (2000, 2004) asked college students to play the nonpersonalized or personalized version of the game. After playing the game learners took a transfer test, in which they were asked to design plants for environments they had not seen before and to specify ideal environments for plants they had not seen before. Overall, across five experiments, personalization improved transfer performance, creating very large effect sizes of 1.92, 1.49, 1.11, 1.58, and 1.93, respectively. The same pattern of results was obtained when the words were spoken or printed on the screen, and when the game was played on a desktop computer or in an immersive virtual reality environment. These findings encourage the idea that, just like human tutors, online agents can be more effective when they develop a personal relation with the learner.

TABLE 13–3 Excerpts of nonpersonalized and personalized versions of the script for the onscreen agent in an educational game

Nonpersonalized Version of Game Introduction

This program is about what type of plant survives on different planets. For each planet, a plant will be designed. The goal is to learn what type of roots, stem, and leaves allow plants to survive in each environment. Some hints are provided throughout the program.

Personalized Version of Game Introduction

You are about to start on a journey where you will be visiting different planets. For each planet, you will need to design a plant. Your mission is to learn what type of roots, stem, and leaves will allow your plant to survive in each environment. I will be guiding you through by giving out some hints.

Nonpersonalized Explanation Concerning Rainy Environments

In very rainy environments, plant leaves have to be flexible so they are not damaged by rainfall. What really matters for the rain is the choice between thick and thin leaves.

Personalized Explanation Concerning Rainy Environments

This is a very rainy environment and the leaves of your plant have to be flexible so they're not damaged by rainfall. What really matters for the rain is your choice between thick leaves and thin leaves.

From Moreno and Mayer, 2000.

Finally, let's consider the role of politeness in learning with an onscreen tutor. For example, suppose you are learning to solve math problems with an online program in which an onscreen tutor offers suggestions to help you. Suppose the tutor needs to suggest that you use the quadratic formula. Look at the eight ways of making this suggestion listed below, and in the space to the left rate the degree to which the onscreen agent respects your freedom to decide what to do. Use a 7-point scale with 1 indicating that the tutor "strongly disallows my freedom to make my own decisions" and 7 indicating that the tutor "strongly allows my freedom to make my own decisions."

_____ Now use the quadratic formula to solve this problem.
_____ The machine wants you to use the quadratic formula to solve this equation.
_____ We should use the quadratic formula to solve this equation.
_____ I would use the quadratic formula to solve this equation.
_____ I suggest that you use the quadratic formula to solve this equation.
_____ Did you use the quadratic formula to solve this equation?
_____ What about using the quadratic formula to solve this equation?
_____ You could use the quadratic formula to solve this equation.

According to Brown and Levinson's (1987) politeness theory, you are rating the level of *negative politeness*—that is, the degree to which the request was a *face threatening act (FTA)* by virtue of impeding your freedom of action. If you are like most students in a study conducted by Mayer, Johnson, Shaw, and Sandhu (2006), you gave lower ratings to the first two statements and higher ratings to the last two statements (although the ordering of presentation was mixed in the actual study). For example, the respective ratings for the eight statements were: 1.8, 2.7, 3.3, 3.3, 3.8, 4.1, 4.7, and 4.8. As you can see, the first two statements are quite direct, whereas the other statements use various techniques to soften the threat to your negative face. The bottom two statements appear to be most successful in making the request in a polite way, based on negative politeness.

Next, let me ask you to rate the following eight statements on the degree to which the statement makes you feel that the tutor wants to work with you and appreciates you. Use a 7-point scale with 1 indicating that the tutor "strongly is not working with me" and 7 indicates that the tutor "strongly is working with me."

_____ The machine wants you to use the quadratic formula to solve this equation.
_____ Now use the quadratic formula to solve this problem.
_____ I would use the quadratic formula to solve this equation.
_____ Did you use the quadratic formula to solve this equation?
_____ I suggest that you use the quadratic formula to solve this equation.
_____ What about using the quadratic formula to solve this equation?
_____ You could use the quadratic formula to solve this equation.
_____ We should use the quadratic formula to solve this equation.

According to Brown and Levinson's (1987) politeness theory, you are rating the level of *positive politeness*—the degree to which the suggestion was a face threatening act by virtue of violating your desire to be appreciated and respected by others. In the Mayer et al. (2006) study (in which the ordering of the statements was random), the first two statements were rated lowest and the last two statements were rated highest. The mean ratings of the eight statements were 3.1, 3.1, 4.0, 4.4, 4.8, 4.9, 4.9, and 5.3, respectively. As you can see, the first two statements are quite direct, whereas the last two are most successful in softening the threat to the learner's positive face.

These results are intriguing because they indicate that learners are sensitive to the politeness level of a tutor's suggestions. The next step is to determine whether students learn better from an onscreen tutor that provides suggestions in a polite way (i.e., saving the learner's positive and negative face) or in a direct way (i.e., threatening the learner's positive and negative face). To examine this question, Wang et al. (in press) asked college students to learn how to solve industrial engineering problems by using an online simulation game called Virtual Factory in which an onscreen agent offered suggestions in either a direct or polite style. Students who received the polite tutor performed better on a subsequent transfer test than did students who received the direct tutor, yielding a medium-to-large effect size of 0.71. Consistent with the predictions of politeness theory, the effects of politeness were strongest for students with low computing experience, presumably because politeness is most important when you have to work with someone you are not familiar with. Although Wang's study focused on computer-based tutors, there is reason to suspect that similar results would occur with human instructors.

In summary, even when you are reading a book or studying an online lesson, social factors can come into play that affect your quality of learning. Although the research literature is preliminary, there is encouraging evidence that the instructor's conversational style can have a powerful effect on learning. Based on this work, the most consistently effective social cues involve the use of first- and second-person constructions, directly addressing the learner, and couching suggestions in ways that avoid threats to the learner's positive and negative face.

Chapter Summary

"Let's break into small groups and discuss this." These words can be a call to engage in "real learning" or an invitation to waste precious school time. Not all forms of group learning are equally effective, and there is no evidence that learning in groups is necessarily better than learning individually. This chapter explored the rationale for the cognitive apprenticeship approach, and examined the effectiveness of several ways of implementing it.

Research shows that students often fail to use school-taught procedures outside of school. For example, young street vendors were able to solve arithmetic problems within the context of their everyday tasks using procedures they invented themselves but were often unable to solve equivalent problems presented as a school-like test.

The Russian psychologist Lev Vygotsky argued that learning always occurs within a social context. Teacher and peer assistance are needed to help students move through their zones of proximal development—that is, from their current level of development to their potential level of development under the guidance of more capable peers and teachers. Although aspects of Vygotsky's theory are not based on scientific evidence, the implications for cognitive apprenticeship in the classroom warrant closer examination.

Cognitive apprenticeship involves applying apprenticeship techniques to formal schooling. Three features of cognitive apprenticeship programs are modeling (such as when a teacher describes her cognitive processes in carrying out an academic task), coaching (such as when a teacher offers suggestions or criticisms to a student who is carrying out

an academic task), and scaffolding (such as when a teacher supports a student on parts of a task that the student is not yet able to accomplish unaided).

Collaboration methods (such as cooperative learning, reciprocal teaching, and computer-supported collaborative learning), modeling methods, and personalization methods (such as visible authors and conversational agents) are techniques inspired by a cognitive apprenticeship approach.

In cooperative learning, small groups of students study together and are rewarded as a group for each person's performance on the studied task. Slavin (1990) found that students who learn mathematics as part of a cooperative team show larger gains in academic performance than students who learn individually—but only when the cooperation consists of group rewards based on individual achievement. More recent work has shown that students in cooperative groups learn more effectively when the discussions are structured and students have specific instruction on the to-be-learned strategies.

In reciprocal teaching, the teacher and students take turns teaching how to perform an academic task, such as how to apply effective reading comprehension strategies. Brown and Palincsar (1989) found that students who learn reading strategies by reciprocal teaching show larger gains in reading comprehension performance than students who learn by more traditional methods. More recent research has shown that reciprocal teaching works best when the students are taught how to structure their discussions and when the instruction focuses on specific to-be-learned strategies.

In computer-supported collaborative learning, collaboration is extended to an online environment, but there is little available evidence showing that CSCL has large positive effects on achievement.

In participatory modeling, experts and novices each participate in modeling the cognitive processes required to perform the same academic task, such as how to write an informative essay. Bereiter and Scardamalia (1987) found that students who engaged in this form of modeling learned to write better essays than students who learned by more conventional methods.

In visible-author methods, text material is written in ways that highlight the author as a person, through using first- and second-person constructions, directly addressing the reader, and disclosing personal views. Paxton (2002) offers promising preliminary evidence that making authors more visible can improve student learning.

In conversational agent methods, onscreen speakers use conversational style, such as using first- and second-person constructions, directly addressing the learner, and using polite wording for suggestions. There is promising evidence that these techniques can improve student understanding from narrated animations and educational games.

SUGGESTED READINGS

Mayer, R. E. (2005d). Principles of multimedia learning based on social cues: Personalization, voice, and image principles. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 201–212). New York: Cambridge University Press. (Shows how the instructor's conversational style can affect student learning.)

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