# 11

# Teaching by Fostering Learning Strategies

Part 2

## Chapter Outline

How to Turn a Passive Learning Task into an Active Learning Task
Mnemonic Strategies
Structure Strategies
Generative Strategies
Chapter Summary

## RESEARCH: DO GENERATIVE STRATEGIES WORK?

Consider the following scenario: You enter a lecture hall where the professor is giving a lecture on the formation of lightning. You sit down and glance at the notes of the student sitting on your right. She has written a series of verbatim phrases from the instructor such as "cool, moist air" on one line, "forms a cloud" on the next line, "reaches freezing level" on the next line, and so on. To her, notetaking seems to involve selecting relevant facts to write down. You look to the student on your left. He has written a sort of outline consisting of five major steps labeled 1 through 5, and under each he has listed some component processes labeled by letters such as a, b, c. To him, notetaking seems to mean organizing relevant facts into a structure. Finally, you look over the shoulder of the student in front of you. She has written a summary in her own words describing how lightning forms, and in the margin she has written some comments based on her own knowledge (such as "positive and negative charges attract"). To her, notetaking seems to mean trying to elaborate on the material and relate it to what she already knows.

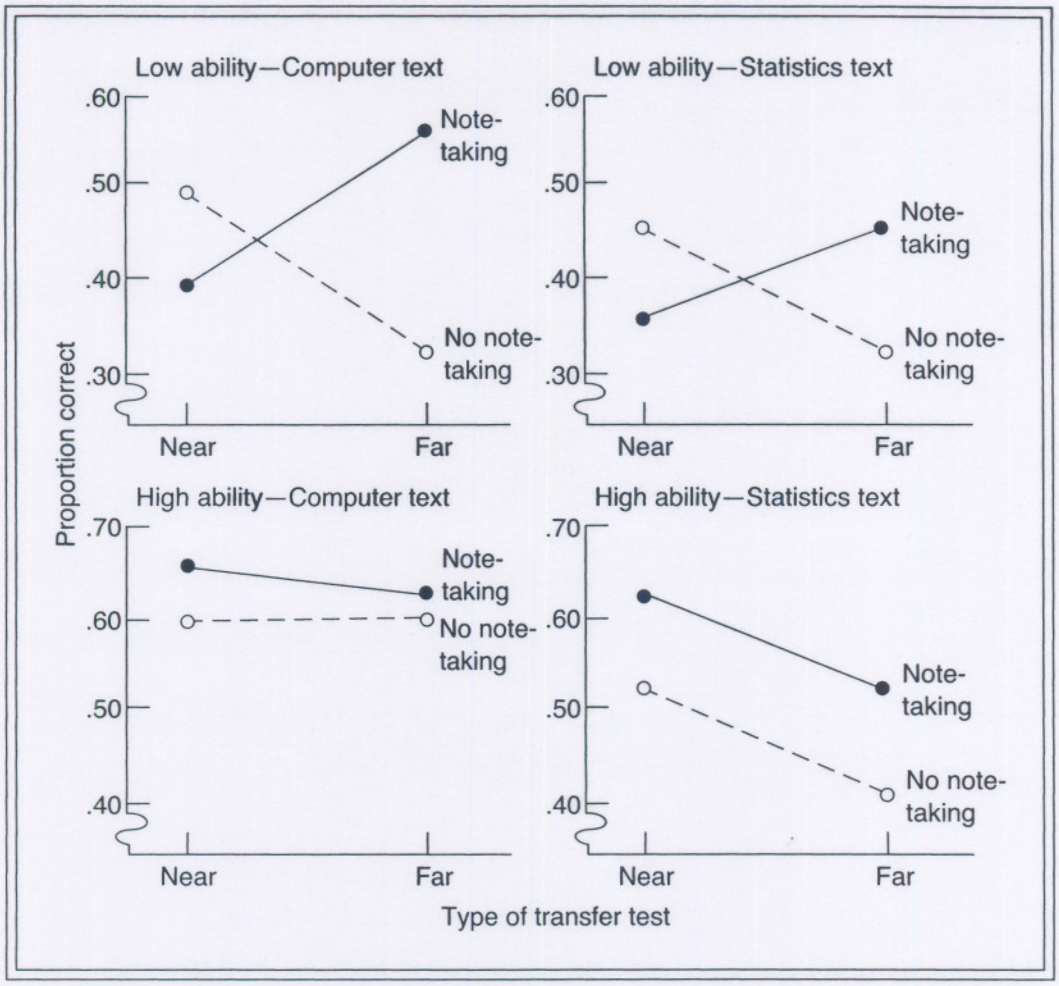
This section focuses mainly on aspects of notetaking reflected in the third student—using notetaking as a way to integrate the presented information with past experience. Generative strategies are intended to promote deep understanding by prompting the learner to put the material into his or her own words, distill its main message, and relate it with other knowledge. Two important generative strategies are summarizing and questioning.

**Summarizing Strategies** Under some conditions, notetaking may help the learner build external connections (i.e., to relate the information presented to existing knowledge). The learner may be encouraged to explain an idea in his or her own words or to relate information to a familiar concrete model. For example, Mayer (1980) asked college students to read a manual on computer programming with one programming command described on each page. For some students, after each page they were asked to explain the command in their own words and relate it to a concrete familiar situation (elaboration group). Other students read each page without elaborating (nonelaboration group). Students in the elaboration group tended to recall more conceptual information from the booklet and to perform better on problem-solving tests that involved applying commands to new tasks than did the nonelaboration group. However, the nonelaboration group performed just as well as the elaboration group on recall of details from the manual and on solving problems like those given in the manual. Apparently, elaborative notetaking encouraged readers to relate the presented information to what they already knew, resulting in meaningful learning.

In a similar series of studies, Peper and Mayer (1978) asked college and high school students to view a 15-minute videotaped lecture on computer programming or statistics. Some students were asked to take notes during the lecture; while others were not allowed to take notes. Following the lesson, students were given problem-solving tests that included problems like those given during the lecture (near transfer) and problems that required creative use of the information in new situations (far transfer).

Figure 11–18 shows that for low-ability subjects, the notetaking group excelled on far transfer, whereas the non-notetaking group excelled on near transfer. For high-ability subjects, notetaking increased performance by a modest amount on both types of questions. If

**FIGURE 11–18**
Effects of notetaking on creative problem solving




*Source: Adapted from Peper, R., & Mayer, R. E. (1978). Notetaking as a generative activity.* Journal of Educational Psychology, 70, *514–522.*

notetaking served mainly to focus the learner's attention, we would expect superior performance on problems like those given in the lesson; if notetaking served mainly to elicit integrative processing (i.e., building external connections), we would expect better performance on tests of creative transfer. Thus, the increase in far transfer performance is most consistent with the idea that notetaking in this study resulted in building external connections.

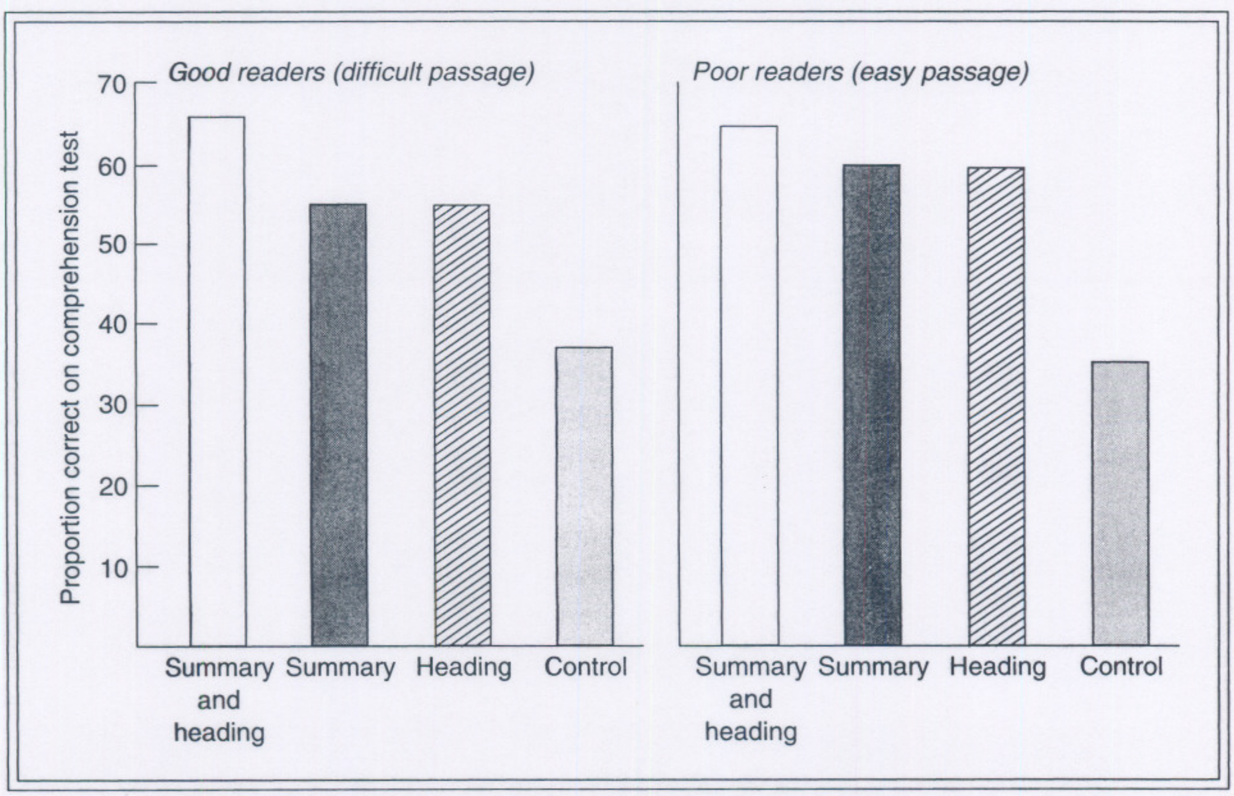
In addition, subsequent recall tests revealed that notetakers excelled mainly on recall of conceptual information but not on recall of specific details and that notetakers produced more "intrusions" about information that was not in the booklet. If notetaking served mainly to focus attention on the main facts in the lesson, we would expect better recall of specific facts. If notetaking helped the learner construct coherent external connections, we would expect better recall of the basic conceptual principles in the passage. These results are consistent with the idea that when appropriate dependent measures—such as far transfer or recall of concepts—are used, evidence for integrative processing emerges.

Some more restricted forms of notetaking may not elicit the building of external connections. For example, Mayer and Cook (1981) asked students to listen to a passage about how radar works. Some were asked to repeat each phrase verbatim during pauses in the presentation. Verbatim shadowing of the passage resulted in poorer recall for the conceptual principles and in poorer performance on creative problem solving than in a control group that simply listened to the passage. Thus, verbatim copying seems unlikely to lead to the building of external connections even though the learner is being forced to be behaviorally active.

Other ways of encouraging students to construct external connections (as well as internal connections) in a passage include summary notetaking. In a summary notetaking study, Doctorow, Wittrock, and Marks (1978) asked elementary school students to read a passage and then recall the passage. Some students were asked to generate a summary sentence that expressed the main idea for each paragraph (summary group); some students were given a two-word heading for each paragraph that summarized the main idea (heading group); some students received both treatments (summary and heading group); and some subjects read the passage without headings or summary notetaking.

Figure 11–19 summarizes the results on a subsequent retention test for good readers who were given a 1,125-word passage for 20 minutes and for poor readers who were given a 372-word passage for 8 minutes. As Figure 11–19 shows, for both good and poor readers, the summary group retained over 50% more information than did the control group, and this advantage was enhanced when headings were provided for each paragraph. Wittrock (1974) argued that subjects who write summaries engage in generative learning—generating connections among ideas in the passage rather than memorizing specific words.

**FIGURE 11–19** Effects of summary notetaking and headings on prose comprehension

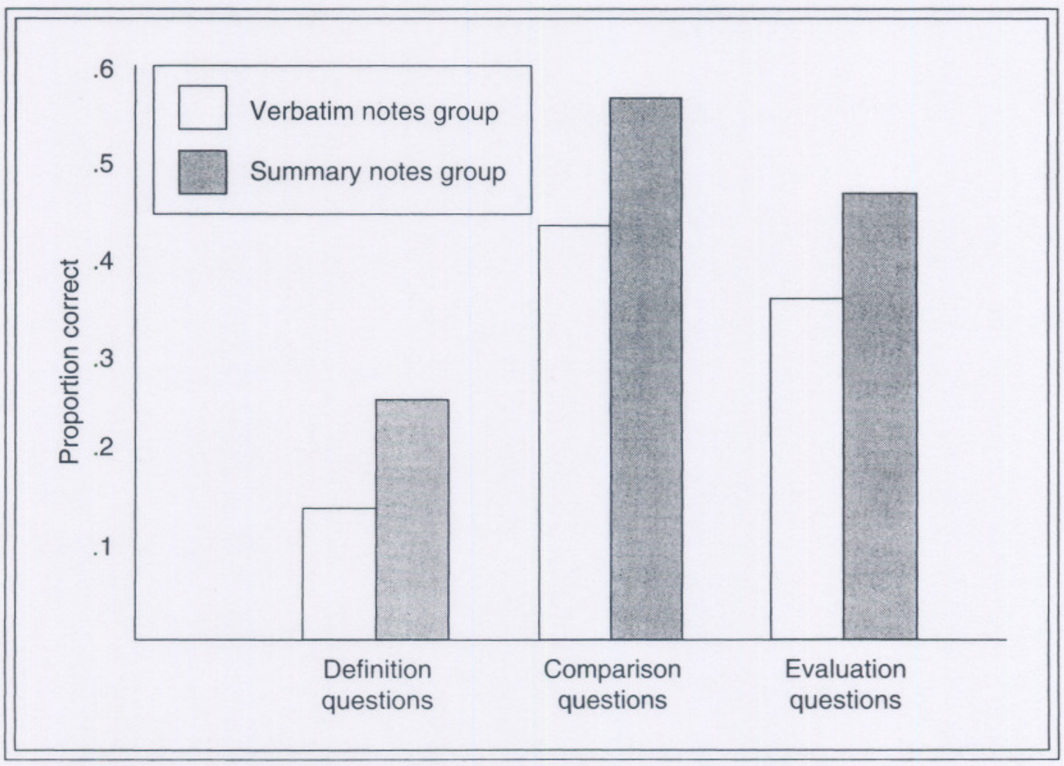



*Source: Adapted from Doctorow, M., Wittrock, M. C., & Marks, C. (1978). Generative processes in reading comprehension.* Journal of Educational Psychology, 79, *109–118.*

Suppose students are asked to take notes in any way that would help them as they read a philosophy text. As a result, some students write verbatim words and phrases (verbatim notes group), whereas other students summarize the main ideas in their own words (summary notes group). Which form of notetaking is more effective? If summary notes require deeper processing by the learner (including organizing and integrating the material), you would expect the summary notes group to outperform the verbatim notes group on being able to use the presented information to answer essay questions. This is exactly what happened in a study by Slotte and Lonka (1999). For example, Figure 11–20 shows the essay test scores on defining key concepts, comparing and contrasting several different ideas, and evaluating the author's views on a given topic. As you can see, for each type of essay question, students who opted to take summary notes outperformed students who opted to take verbatim notes. These results are consistent with the observation that all notetaking activities are not equally useful ways to promote transfer. It appears that notetaking is more likely to promote transfer when learners generate summaries in their own words rather than copy verbatim words and phrases.

What can be done to help students reflect on their notes and organize them into coherent summaries? To study this issue, King (1992) presented students with a 20- to 30-minute social science lecture on a topic such as "civil liberties" and asked them to take notes. The students were involved in a remedial study skills course and had been selected because of their relatively low-verbal-ability scores. During a subsequent study period, some students (note-taking-with-review group) were told to prepare for a test by reviewing their notes, whereas other students (note-taking-with-summarizing group) were told to prepare for a test by using their notes and recollections to write a summary of the main points from the lecture. Students in the notetaking-with-summarizing group were taught

**FIGURE 11–20**
Students who take summary notes produce better answers to transfer questions than students who take verbatim notes




*Source: Adapted from Slotte, V., & Lonka, K. (1999). Review and process effects of spontaneous notetaking on text comprehension.* Contemporary Educational Psychology, 24, *1–20.*

how to write a summary by writing a sentence stating the main point and then writing sentences linking the main point of each subtopic back with the main topic. In addition, they were told to write using their own words. These activities appear designed to help students select relevant ideas (by choosing the points to be summarized), organize them into a coherent structure (by linking the subtopics to the main topic), and integrate them with prior knowledge (by writing in one's own words). Students who were taught to summarize their notes actually took more complete notes than those who were not, perhaps in anticipation of the summarization activity. Specifically, the notetaking-with-summarizing group had 29% more of the important ideas in their notes than did the notetaking-with-review group. What happened after the groups reviewed or summarized their notes? On a comprehension test for the lecture, the notetaking-with-summarizing group scored 25% higher than the notetaking-with-review group. These results show that students can learn how to be active notetakers in ways that are more likely to promote deep learning.

In a review of programs aimed at teaching students how to write summaries, Pressley and Woloshyn (1995) concluded that "summarization training is a powerful intervention" (p. 62). Furthermore, Peverly, Brobst, Graham, and Shaw (2003) provide evidence that college students need training in how to take notes for difficult material.

**Questioning Strategies** Listening to a lecture or reading a textbook chapter may appear to be a passive activity. How can we turn it into an active learning experience in which the learner tries to make sense of the material? One approach is to teach students how to generate and answer appropriate questions as they learn.

A first step is to examine what successful learners do as they read a textbook. Chi, Bassok, Lewis, Reimann, and Glaser (1989) compared how successful and less successful students read a physics lesson that included worked-out problems. Students were asked to talk aloud as they read. For example, they might say "Ummm, this would make sense because they're connected by a string that doesn't stretch" or "If the string's going to be stretched, the earth's going to be moved, and the surface of the incline is going to be depressed." In these comments, you can see that the students are trying to explain the worked-out problems to themselves, creating what Chi et al. call *self-explanations*. In creating self-explanations, students turn the seemingly passive task of reading a textbook lesson into an active task of sense making. Importantly, students who were successful in solving physics problems generated five times as many self-explanations while reading as did the less successful students. These results suggest that successful learners are more likely to know how to engage in active cognitive processing during learning—that is, they ask themselves questions and answer them.

If successful problem solvers are more likely to engage in self-explanations while learning, what would happen if we encourage inexperienced students to engage in generating self-explanations? To examine this question, Chi, De Leeuw, Chiu, and LaVancher (1994) asked eighth graders who had never taken a biology course to read a 101-sentence passage on the human circulatory system. Some students were told to explain what each sentence means after reading it (self-explanation group), whereas others were told to repeat each sentence after reading it (control group). Students in the self-explanation group showed a much greater improvement on transfer questions than did the control group. These transfer questions required making inferences that went beyond simple retention of the facts, such as "Why doesn't the pulmonary vein have a valve in it?" Subsequent interviews revealed that 57% of the self-explanation group developed an accurate mental model of how the human circulatory system works, compared to 22% for the control group.

Developing an accurate mental model is an indication of meaningful learning and is usefu for solving problem-solving transfer problems. Apparently, students learned more deeply when they were required to engage in explaining text as they read.

The self-explanation results encourage the idea that low-achieving students might benefit from training in how to generate and answer appropriate questions as they read a textbook or listen to a lecture. In an exemplary study, King (1992) taught self-questioning skills to college students who had been diagnosed as having learning difficulties. First, the students were given a list of 13 general questions, as listed in Figure 11–21. King (1992) designed the questions to "guide students in processing the lecture content by . . . analyzing

**FIGURE 11–21**
A Questioning Strategy

| *QUESTIONS* | *COGNITIVE PROCESSES THE QUESTIONS ARE INTENDED TO INDUCE IN LEARNERS* |
|---|---|
| Explain why _____ | analysis of processes and concepts—explicit or implicit in the lecture |
| Explain how _____ | translating terms into different vocabulary |
| What is the main idea of _____ ? | identification of central idea explicit or implicit in the lecture |
| How would you use _____ to _____ ? | application of information in another context—perhaps relating to prior knowledge or experience |
| What is a new example of _____ ? | generation of novel examples of a concept or procedure—perhaps involving relating to prior knowledge or experience |
| What do you think would happen if _____ ? | retrieval of background knowledge and integration with lecture material to make predictions |
| What is the difference between _____ and_____ ? | analysis of two concepts—comparison and contrast of concepts |
| How are _____ and _____ similar? | analysis of two concepts—comparison and contrast of concepts |
| What conclusions can you draw about _____ ? | drawing conclusions based on the content presented |
| How does_____ affect_____ ? | analysis of relationships among ideas |
| What are the strengths and weaknesses of _____ ? | analysis and integration of concepts |
| What is the best _____ and why? | evaluation of ideas based upon criteria and evidence |
| How is _____ related to _____ that we studied earlier? | activation of prior knowledge and integration with new information |

*Source: From King, A. (1992). Comparison of self-questioning, summarizing, and notetaking-review as strategies for learning from lectures.* American Educational Research Journal, 29, *303–323.*

the ideas and concepts in the lecture, determining how those ideas relate to each other, and relating new information to their own prior knowledge or experience" (p. 309). The instructor modeled (a) how to use the general questions to generate specific questions relevant to a specific lecture and (b) how to answer the specific questions based on the lecture content. Next, the students worked individually to generate questions and answers. The students shared their questions and answers with the class and received constructive feedback. Finally, they practiced by taking notes on a short lecture and then generating questions and answers based on their notes.

Does training in self-questioning affect learning from a lecture? To test this question, King (1992) asked students to take notes on a 20- to 30-minute lecture on a social science topic such as "civil liberties" and then review the notes (notetaking with review) or engage in self-questioning (notetaking with questioning). The lecture notes of the notetaking-with-questioning group contained 33% more of the important ideas than did the lecture notes of the notetaking-with-review group, suggesting that the questioning training helped students focus on the important material. In addition, the notetaking-with-questioning group generated 13% more correct answers on a comprehension test (involving transfer) than did the notetaking-with-review group, suggesting that questioning helped students learn more deeply.

If your goal is teaching for transfer, the process of generating and answering thought-provoking questions can help learners reflect on the presented material. For example, King, Staffieri, and Adelgais (1998) taught middle school students how to ask a series of thought-provoking questions based on science lessons. The questioning pattern begins with a knowledge-review question such as "How does the muscular system work, Kyle?" and follows up with probing questions such as "Can you tell me more?" and hint questions such as "Why are muscles important?" Students worked in pairs taking turns as question asker and question answerer. Figure 11–22 gives a portion of a transcript involving Kyle (who serves as the question asker) and Jon (who serves as the question answerer).

Students who participated in generating and answering questions about science lessons (questioning group) performed about as well as other students (no-questioning group) on remembering the factual material—the scores were 66% correct versus 63% correct, respectively. However, on tests of problem-solving transfer in which students had to make inferences, the questioning group scored 68% higher than the no-questioning group—the scores were 57% versus 34%, respectively. Overall, this research shows how questioning strategies can be used to promote deep understanding that leads to transfer. In this case, questions prime more than simply selecting relevant information; it appears that skillfully used questions can guide the process of organizing and integrating knowledge.

This research shows that an effective strategy for promoting generative processing is to teach students to engage in self-explanations—producing oral explanations of textbook material they are reading. Although some students spontaneously generate self-explanations when they are asked to "think aloud" as they read a textbook lesson, some students do not. Importantly, students who spontaneously produce high-quality self-explanations perform better on tests on the material, including tests involving deep understanding (Chi, 2000; Roy & Chi, 2005). For example, suppose you are reading a 19-page lesson on geometry proofs, including the segment shown in Figure 11–23. You are asked to think aloud—that is, to talk about what you are thinking as you the read the materials, and if you remain quiet for more than 5 seconds you are reminded to think aloud. If you engage in generative processing we would expect your thinking-aloud protocol to contain high-quality self-explanations such as management statements, in which you identify a text element as new, monitor your

**FIGURE 11–22**
Using questions to guide learning

| | *PORTION OF TRANSCRIPT* | *TYPE OF QUESTION OR COMMENT* |
|---|---|---|
| Jon: | How does the muscular system work, Kyle? | knowledge-review question |
| Kyle: | Well . . . it retracts and contracts when you move. | comprehension statement |
| Jon: | Can you tell me more? | probing question |
| Kyle: | Um . . . well . . . | |
| Jon: | Um, why are muscles important, Kyle? | hint question |
| Kyle: | They are important because if we didn't have them we couldn't move around. | comprehension statement |
| Jon: | But . . . how do muscles work? Explain it more. | probing question |
| | Can you give an example? | probing question |
| Kyle: | Um, muscles have tendons. Some muscles are called skeletal muscles. They are in the muscles that—like—in your arms—that have tendons that hold your muscles to your bones—to make them move and go back and forth. So you can walk and stuff. | comprehension statement |
| Jon: | Good. Alright! | feedback (accuracy and praise) |
| | How are the skeletal muscles and the cardiac muscles the same? | thinking question |
| Kyle: | Uhh—the cardiac and the smooth muscles? | |
| Jon: | The cardiac and the skeletal. | |
| Kyle: | Well, they're both a muscle. And they're both pretty strong. And they hold things. I don't really think they have much in common. | knowledge construction (integration, similarities) |
| Jon: | Okay. Why don't you think they have much in common? | probing question |
| Kyle: | Because the smooth muscle is—I mean the skeletal muscle is voluntary and—the cardiac muscle is involuntary. Okay, I'll ask now. | knowledge construction (integration, differences) |

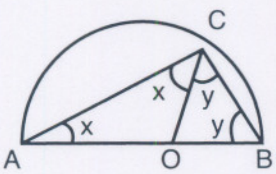
*Source: From King, A., Staffieri, A., & Adelgais, A. (1998). Mutual peer tutoring: Effects of structuring tutorial interaction to scaffold peer learning.* Journal of Educational Psychology, 90, 134–152.

**FIGURE 11–23**
Portion of geometry lesson

**Angle in a semicircle theorem**

The angle in a semicircle is a right angle

**Proof**




Let C be any point on a semicircle (other than at A or B) where AB is its diameter.

Let <CAB be x and <CBA be y. Join OC.

In OAC,

OA = OC (equal radii)

∴ OAC is isosceles

∴ <ACO = <CAO = x (equal base angles)

Likewise, BOCV is isosceles and ∴<BCO = y.

In ΔABC,

$x + (x + y) + y = 180°$[sum of angles of triangle]

∴ $2x + 2y = 180°$

∴ $x + y = 90°$

Hence angle ACB is a right-angle,

*Source: Reprinted from* Learning and Instruction, 12, *R. M. F. Wong, M. J. Lawson, & J. Keeves, The effects of self-explanation training on students' problem solving in high-school mathematics, pp. 233–262, Copyright © 2002, with permission from Elsevier.*

comprehension, or evaluate a step in the solution; access statements, in which you remember relevant prior knowledge that was not mentioned in the lesson; and generation statements, in which you create new connections or relations. When Wong, Lawson, and Keeves (2002) asked high school students in Australia to think aloud as they read the lesson, they tended to produce few high-quality self-explanations and they performed poorly on a posttest in which they solved geometry problems. Apparently, students did not engage in much generative processing and they did not learn much from the lesson.

What can we do to encourage students to study the material more deeply. Wong, Lawson, and Keeves (2002) taught some students how to produce high-quality self-explanations. For each section of the lesson, students were told to answer three questions:

1. What parts of this page are new to me?
2. What does the statement mean?
3. Is there anything I still don't understand?

To make sure they understood how to generate answers to these questions, they listened to a student successfully answer the self-explanation questions in a demonstration involving different material. Figure 11–24 shows that students in the trained group generated approximately twice as many self-explanation statements during learning from the lesson than did students in the control group. Importantly, the trained group also scored higher than the control group on a posttest involving solving geometry problems. This

**FIGURE 11–24**
Students who are trained in generating self-explanations produce more high-quality self-explanations during learning and show greater gains in problem-solving performance

| | Trained group | Control group |
|---|---|---|
| **Self-explanation statements during learning** | | |
| Management statements | 58 | 21 |
| Access statements | 35 | 20 |
| Generation statements | 42 | 22 |
| **Problem-solving test** | | |
| Percentage correct on pretest | 61% | 61% |
| Percentage correct on posttest | 75% | 61% |

*Source: Reprinted from* Learning and Instruction, 12, *R. M. F. Wong, M. J. Lawson, & J. Keeves, The effects of self-explanation training on students' problem solving in high-school mathematics, pp. 233–262, Copyright © 2002, with permission from Elsevier.*

experiment encourages the idea that self-explanation activities can be taught to students who don't spontaneously use them, and that the training can result in deeper learning.

**Self-Regulated Learning Strategies** Overall, teaching of summarization strategies and teaching of questioning strategies are attempts to help students develop into *self-regulated learners*—learners who take responsibility for managing their learning activities (Azevedo & Cromley, 2004; Winne, 2001). Self-regulated learners are particularly needed in the information age, where students are exposed to many sources of information in many different forms. For example, suppose you are seated at a computer that is running a multimedia encyclopedia, and I ask you to learn all you can about the human circulatory system in 45 minutes. Here are your main instructions:

> You are being presented with a hypermedia encyclopedia, which contains textual information, static diagrams, and digitized video clip of the circulatory system. Your task is to learn all you can about the circulatory system in 45 minutes. We ask you to think aloud continuously while you use the hypermedia environment to learn about the circulatory system. (Azevedo & Cromley, 2004, p. 526)

To get you started, I show you the three most relevant articles—on blood, the heart, and the circulatory system—which together contain 16,900 words, 107 hyperlinks, and 35 illustrations (including diagrams, photos, and animation).

Learning in a hypermedia environment can be a daunting task, so students may not learn effectively. Is there anything we can do to help students learn more effectively? Azevedo and Cromley (2004) developed a 30-minute pretraining lesson that pinpointed some generative learning strategies, such as how to set learning goals, activate prior knowledge, ask questions about the material, elaborate on the material, assess the adequacy of the information, assess how well you are learning, summarize the material, and seek relevant new information (as shown in Figure 11–25).

Did the learning strategy training help college students learn from the multimedia encyclopedia? First, let's examine whether there were differences in strategy use during the 45-minute learning session in which students used the online encyclopedia to learn about the circulatory system. Based on observations of students' behavior and students' thinking-aloud comments during learning, Azevedo and Cromley (2004) found that the

**FIGURE 11–25**
Some learning strategies performed by students using a multimedia encyclopedia

| Learning strategy | Example |
|---|---|
| Asking questions | Learner spends time reading text and then says: "What do I know from this?" and reviews same content. |
| Summarizing | Learner says: "This says that white blood cells are involved in destroying foreign bodies." |
| Drawing | Learner draws diagram after saying: "I'm trying to imitate the diagram as best as possible." |
| Taking notes | Learner copies text from encyclopedia and says: "I'm going to write that under 'heart'." |
| Reading notes | Learner refers to notes and says: "Carry blood away. Arteries—away." |
| Making inferences | Learner sees diagram of heart and says: "So the blood . . . through the . . . then goes from the atrium to the ventricle . . . and then . . . " |
| Planning | Learner says: "First, I'll look around to see the structure of the environment and then I'll go to specific sections of the circulatory system." |
| Assessing learning | Learner says: "Let me read this again since I'm starting to get it . . . " |
| Activating prior knowledge | Learner says: "I vaguely remember learning about the role of blood in high school." |
| Managing time | Learner says: "I'm skipping over that section since 45 minutes is too short to get into the details." |

*Adapted from Azevedo and Cromley (2004).*

strategy-trained learners were more likely than the nontrained learners to engage in generative learning strategies such as asking themselves questions, summarizing, drawing, taking notes, reading notes, and making inferences. Second, let's examine what happens to students' conceptions of how the circulatory system works based on asking them both before and after learning to "write down everything you can about the circulatory system" and to draw the path of blood flow throughout the body. Azevedo and Cromley scored each student's answers as reflecting one of 12 progressively more developed conceptions (or mental models) of how the circulatory system. On the pretest, both groups started at the same low level—a version of the single-loop model in which blood circulates through the body with the heart as a pump (level 6). On the posttest, the strategy-trained group showed a much better improvement than did the control group: On average, at the end of learning, the control group still had a version of the single-loop model albeit a slightly more sophisticated version (level 8), whereas the strategy-trained group had a version of the double-loop model (level 10) in which both the heart and the lungs are involved. Thus, on average, the strategy-trained students were more likely to build the double-loop model (which is largely correct), whereas the nontrained students were more likely to build a version of the single-loop model (which is seriously flawed). Third, let's see if the groups differed in their learning of the basic facts, such as being able to label the names of 20 elements on a color picture of the circulatory system. Students in the strategy-trained group showed a much greater prestest-to-posttest improvement (from 5% to 38% correct) than did the control group (from 4% to 23% correct). Overall, the strategy-trained students used more useful generative strategies during learning, performed better on transfer tests (measuring understanding), and performed better on retention tests (measuring memory for main facts).

These results show that it is possible to teach students to become self-regulated learners—that is, learners who take responsibility for controlling their own learning strategies. When learners engage in self-regulated learning they set goals for their learning and then attempt to monitor, regulate, and control their cognitive processing during learning (Azevedo & Cromley, 2004; Winne, 2001). Self-regulated learning is particularly important for learning in hypermedia environments, because learners have so many choices. As you can see, self-regulated learning involves having useful learning strategies (including generative strategies) and being able to manage them. Azevedo and Cromley's study encourages the idea that we can provide direct instruction in learning strategies that promote self-regulated learning.

Each academic discipline may require its own set of generative learning strategies. For example, Wineburg (1991) has shown that expert historians engage in three strategies while reading historical documents: *sourcing heuristic*, in which historians use the source of the document to interpret the content of the document; *corroboration heuristic*, in which historians compare content across documents to identify discrepancies; and *contextualization heuristic*,in which historians place the content within the its spatial-temporal context. However, high school students do not spontaneously use these three strategies (Wineburg, 1991) and even college students can benefit from training in how to use them (Britt & Aglinskas, 2002; Rouet, Britt, Mason, & Perfetti, 1996).

For example, suppose you were given access to a set of six or seven documents about the United States building a canal in Panama in 1903, including historical commentary, participant reports, and excerpts from a novel. Each document is on a separate page and information about the source (e.g., a U.S. president, a novelist, a historian, etc.) is printed at the bottom of each page. You are asked to comprehend the material so you could answer questions such as "What happened during the planning of the Panama revolution?" and "To what extent did the U.S. government influence planning of the revolution?" If you are like most college students who engaged in this task, you probably would not pay much attention to sourcing information such as "Which document was written earliest?" or "Which document is least trustworthy?" In Britt and Aglinskas's (2002) study college students were able to correctly answer an average of 16% of questions about sourcing and high school students correctly answered 12%.

Given the students' low sensitivity to source information, Britt and Aglinkas (2002) developed a computer-based training program called *Sourcer's Apprentice*. The Sourcer's Apprentice program explicitly taught students to identify and use source information when reading documents. When reading documents, for example, students are prompted to take notes on the author (including the author's position and motives), document (including the date), and content (including links to other documents). On the posttest, students examined a different set of materials than those used during training, and were asked sourcing questions. Students who had received the Sourcer's Apprentice training generated twice as many correct answers on the posttest than those who did not receive the training. When asked to write an essay about the materials they read for the posttest, students who had received the Sourcer's Apprentice training generated more than four times as many references to the documents and more than five times as many causal statements. These results show that it is possible to help students improve their skills at identifying and using source information when reading documents. In light of the explosion in information that is available to students through electronic searches, Rouet (2006) has argued that the concept of literacy should be expanded to include skills of document use such as being able to evaluate the credibility and motives of the author and to compare documents.

## IMPLICATIONS OF GENERATIVE STRATEGIES

Suppose that a class is listening to a lecture on American history. Does listening mean that learning must be a passive process in which the students simply take the teacher's words and put them into their memories? This section showed that learning—even learning from lecture—can be an active process. The student can control the learning process by using generative techniques such as summarizing, questioning, and self-regulating.

When the goal of instruction is verbatim retention of specific facts, verbatim copying (or underlining in textbooks) guides the learner's attention. When the goal of instruction is retention of important material and transfer, students need to engage generative activities aimed at building connections among ideas.

The active cognitive processing elicited by generative activities such as summarizing, questioning, and self-regulating presumably can be taught. Some students spontaneously take a generative stance and do not need training in generative strategies. Other students engage in generative activities only when told to do so. These students need practice in generative activities such as summarizing, questioning, and self-regulating and in seeing that these activities can improve their test performance. Finally, some students do not know what it means to be an active learner. These students may benefit from direct instruction and practice in generative activities and in comparing their summaries or questions to those of the teacher or other students.

In summary, an activity such as notetaking is not necessarily a mindless chore with little benefit to the learner. On the contrary, in learning to productively take notes, a student can learn how to control his or her cognitive processes, including guiding attention, organizing in what is presented, and relating what is presented to what he or she already knows.

# Chapter Summary

This chapter explored three types of learning strategies—mnemonic strategies aimed at increasing the amount of information learned, structure strategies aimed at helping students build internal connections, and generative strategies aimed at helping students build external connections. The building of internal and external connections allows for meaningful learning that enables the student to transfer what was learned to new situations.

Several mnemonic strategies repeatedly have been shown to be successful, including the keyword method, which we explored in this chapter. However, developmental differences are evident in students' ability to learn and spontaneously use mnemonic strategies.

Structure strategies such as mapping and outlining can also successfully help students mentally organize presented material. This kind of training seems to have its strongest effects on transfer performance. Chapter 10 provides some additional examples of research on the role of text adjuncts designed to help learners see the organization of the material.

Generative strategies, including summarizing, questioning, and self-regulating, are aimed at building external connections and show their strongest effects on tests of transfer. Chapter 10 provides some additional examples of research on the role of text adjuncts designed to help learners integrate new material with their prior knowledge.

The theme of this chapter is that teaching of learning strategies is an appropriate instructional activity, although in practice little time is devoted to teaching students how to learn (Weinstein & Mayer, 1985). Teaching students how to remember information, how to determine what is important, or how to figure out the theme of a passage may be just as important for the student's academic success as teaching specific facts and concepts. This chapter showed how learning strategies can be taught effectively within regular subject matter contexts (i.e., using textbook material that is part of the regular program). In the course of teaching science or history, for example, the teacher can also help the student learn how to effectively read, process, and remember the material in a textbook.

The appropriateness of learning strategy training also depends on the teacher's goals. When the goal is to help students memorize paired associates as in foreign language vocabulary, mnemonic strategies are warranted. When the goal is to teach students how to figure out what is important and what is not important in a passage, structure strategies are called for. When the goal is to determine the theme of the passage, generative strategies can be taught. The appropriateness of any strategy training also depends partly on the learner (e.g., whether the learner would normally use the strategy). Before strategy training is carried out, each student should be tested to determine whether he or she knows how to use a particular strategy. If a student is already proficient in using a strategy, training is not needed for that student.

## SUGGESTED READINGS

Pressley, M., & Woloshyn, V. (1995). *Cognitive strategy instruction* (2nd ed). Cambridge, MA: Brookline Books. (Reviews research on teaching of learning strategies.)

Rouet, J.-F. (2006). *The skills of document use*. Mahwah, NJ: Erlbaum. (Explores research on teaching of information-gathering strategies.)