# 11.

# The Teaching of Learning Strategies

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## Introduction

In recent years increasing attention has been focused on the role of the learner as an active participant in the teaching-learning act. In particular, this view suggests that the effects of teaching depend partly on what the learner knows, such as the learner's prior knowledge, and what the learner thinks about during learning, such as the learner's active cognitive processing (Anderson, Spiro, & Montague, 1977; Cook & Mayer, 1983; Dansereau, 1985; Jones, Amiran, & Katims, 1985; Mayer, 1984; Ryan, 1981; Weinstein, 1978; Weinstein & Underwood, 1985; Wittrock, 1974, 1978).

The present paper investigates techniques that a learner can be taught to use during learning. These techniques, referred to as learning strategies, can be defined as behaviors and thoughts that a learner engages in during learning and that are intended to influence the learner's encoding process. Thus, the goal of any particular learning strategy may be to affect the learner's motivational or affective state, or the way in which the learner selects, acquires, organizes, or integrates new knowledge. For example, in preparing for a learning situation, a learner may use positive self-talk to reduce feelings of anxiety; in learning paired-associates, a learner may form a mental image to help associate the objects represented by the members of each pair; in learning from an expository passage a learner may generate summaries for each section; in learning about a scientific concept, a learner may take notes about the material. Each of these activities—coaching, imaging, summarizing, and note-taking—are examples of learning strategies.

Why should there be a chapter on "learning strategies" in a handbook of research on teaching? The rationale is that good teaching includes teaching students how to learn, how to remember, how to think, and how to motivate themselves. Norman (1980) summarizes this argument as follows:

> It is strange that we expect students to learn yet seldom teach them about learning. We expect students to solve problems yet seldom teach them about problem solving. And, similarly, we sometimes require students to remember a considerable body of material yet seldom teach them the art of memory. It is time we made up for this lack, time that we developed the applied disciplines of learning and problem solving and memory. We need to develop the general principles of how to learn, how to remember, how to solve problems, and then to develop applied courses, and then to establish the place of these methods in an academic curriculum. (p. 97)

This argument becomes even more compelling as the lifelong learning concept continues to be defined and expanded in societal self-descriptions and educational forecasting. Helping students to develop effective ways to handle the barrage of information coming from the environment, as well as their own thinking processes, is a major goal of our educational system that will only increase in importance in the future.

This change in approach has important implications for teacher training and practice. Teachers enter the classroom with two distinctly different kinds of goals: (1) *Goals concerning the products of learning*, which focus on what students should know or be able to do as a result of learning, that is, on teaching *what* to learn. For example, when teaching addition, one goal of instruction may be that the learner acquire the number facts up to 100. (2) *Goals concerning the processes of learning*, which focus on techniques and strategies students can use to accomplish learning, that is, on teaching *how* to learn. For example,

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when teaching addition, one goal of instruction may be that the learner acquire techniques for relating new problems to existing knowledge, such as identifying that $7 + 5 = \_\_$ is the same as $6 + 6 = \_\_$. Successful teaching requires sensitivity to both types of instructional goals and skill in teaching both types of instructional objectives.

## Conceptual Framework

An interest in learning strategies is the natural outgrowth of a change in orientation from behaviorist theories to cognitive theories of learning. The behaviorist (or S-R) approach to learning—as developed from the work of Hull and Spence and Skinner—focuses on how presentation of material influences behavior. As Farnham-Diggory (1977) points out, this S-R approach is based on the idea that "a stimulus goes in, a response comes out, and what happens in between is summarized by a hyphen" (p. 128).

In contrast, the cognitive approach to learning seeks to understand how incoming information is processed and structured in memory. Farnham-Diggory (1977) notes that "with the emergence of cognitive psychology in the 1960's ... now, instead of a hyphen, we have mental structures and processes" (p. 128).

The cognitive approach has changed our conception of the teaching-learning process in several ways. Instead of viewing learners as passively recording the stimuli that the teacher presents, learning is viewed as an active process that occurs within the learner and which can be influenced by the learner. Instead of viewing the outcome of learning as depending mainly on what the teacher presents, the outcome of learning is supposed to depend jointly on what information is presented and on how the learner processes that information. Hence, there are two different kinds of activities that influence the encoding process: (1) teaching strategies, such as the teacher presenting certain material at a certain time in a certain way; and (2) learning strategies, such as the learner actively organizing or elaborating or predicting about the presented material. While the traditional S-R approach has focused educators' attention on the first kind of activity, the cognitive approach requires also focusing on the second kind of activity.

**Table 11.1. Framework for Analyzing the Teaching-Learning Process**

| | |
|---|---|
| Teacher Characteristics<br>What the teacher knows | Learner Characteristics<br>What the learner knows |
| Teaching Strategy<br>What the teacher does during teaching | Learning Strategy<br>What the learner does during learning |
| Encoding Process<br>How information is processed | |
| Learning Outcome<br>What is learned | |
| Performance<br>How learning is evaluated | |

A framework for describing the teaching-learning process is presented in Table 11.1. The elements in this process include the following:

- Teacher characteristics—including the teacher's existing knowledge concerning the subject matter and how to teach, that may be required for the teaching strategy selected.
- Teaching strategies—including the teacher's performance during teaching such as what is presented, when it is presented, and how it is presented.
- Learner characteristics—including the learner's existing knowledge concerning facts, procedures, and strategies, that may be required for the learning strategy selected.
- Learning strategies—including behaviors that the learner engages in during learning that are intended to influence affective and cognitive processing during encoding.
- Encoding process—including internal cognitive processes during learning such as how the learner selects, organizes, and integrates new information.
- Learning outcome—including the newly acquired knowledge that depends on both teaching and learning strategies.
- Performance—including behavior on tests of retention and transfer.

As can be seen, instruction in learning strategies (i.e., training in how to learn) can affect learner characteristics by making specific strategies and methods available to the learner. The use of particular learning strategies during learning can affect the encoding process, which in turn affects the learning outcome and performance.

Table 11.2 lists some of the major categories of learning strategies. Each category includes methods designed to influence certain aspects of the encoding process to facilitate one or more types of learning outcome and performance. The categories listed in the table are:

- Rehearsal strategies for basic learning tasks—such as repeating the names of items in an ordered list. Common school tasks in this category include remembering the order of the planets from the sun and the order in which Shakespeare introduces the characters in the play *Hamlet*.
- Rehearsal strategies for complex learning tasks—such as copying, underlining or shadowing the material presented in class. Common school tasks in this category include underlining the main events in a story or copying portions of a lesson about the causes of World War I.

**Table 11.2. Eight Categories of Learning Strategies**

1. Basic Rehearsal Strategies
2. Complex Rehearsal Strategies
3. Basic Elaboration Strategies
4. Complex Elaboration Strategies
5. Basic Organizational Strategies
6. Complex Organizational Strategies
7. Comprehension Monitoring Strategies
8. Affective and Motivational Strategies

- Elaboration strategies for basic learning tasks—such as forming a mental image or sentence relating the items in each pair for a paired-associate list of words. Common school tasks in this category include forming a phrase or sentence relating the name of a state or its major agricultural product, or forming a mental image of a scene described by a poem.
- Elaboration strategies for complex tasks—such as paraphrasing, summarizing, or describing how new information relates to existing knowledge. Common school tasks in this category include creating an analogy between the operation of a post office and the operation of a computer, or relating the information presented about the structure of complex molecules to the information presented about the structure of simple molecules.
- Organizational strategies for basic learning tasks—such as grouping or ordering to-be-learned items from a list or a section of prose. Common school tasks in this category include organizing foreign vocabulary words into the categories for parts of speech, or creating a chronological listing of the events that led up to the Declaration of Independence.
- Organizational strategies for complex tasks—such as outlining a passage or creating a hierarchy. Common school tasks in this category include outlining assigned chapters in the textbook, or creating a diagram to show the relationship among the stress forces in a structural design.
- Comprehension monitoring strategies—such as checking for comprehension failures. Common school tasks in this category include using self-questioning to check understanding of the material presented in class and using the questions at the beginning of a section to guide one's reading behavior while studying a textbook.
- Affective strategies—such as being alert and relaxed, to help overcome test anxiety. Common school tasks in this category include reducing external distractions by studying in a quiet place, or using thought stopping to prevent thoughts of doing poorly from directing attention away from the test and toward fears of failure.

The encoding process, another element in the teaching-learning process, can be analyzed into four main components (Cook & Mayer, 1983):

- Selection—The learner actively pays attention to some of the information that is impinging on the sense receptors, and transfers this information into working memory (or "active consciousness").
- Acquisition—The learner actively transfers the information from working memory into long-term memory for permanent storage.
- Construction—The learner actively builds connections between ideas in the information that have reached working memory. This building of internal connections (Mayer, 1982, 1984) involves the development of a coherent outline organization or schema (Bransford, 1979) that holds the information together.
- Integration—The learner actively searches for prior knowledge in long-term memory and transfers this knowledge to working memory. The learner may then build external connections (Mayer, 1982, 1984) between the incoming information and prior knowledge.

As you can see, selection and acquisition are cognitive processes that determine *how much* is learned whereas construction and integration are cognitive processes that determine the organizational coherence of *what* is learned and how it is organized.

Each of the eight learning strategies listed in Table 11.2 may be used to achieve certain goals for influencing the cognitive processes in encoding. For example, rehearsal behaviors seem to be aimed primarily at acquisition and selection of information whereas organizational and elaboration behaviors seem to be aimed primarily at construction and integration, respectively. The comprehension monitoring techniques seem related to all four processes, depending on the characteristics of the task, and affective strategies could also impact all four strategies, but may be most effective for selection and acquisition. The relationship between each learning strategy and the encoding process will be discussed in subsequent sections.

## Rehearsal Strategies for Basic Learning Tasks

If you were asked to remember the names of the B vitamins, a common learning strategy you could use would be to rehearse the list of names. Rehearsing refers to the learner's actively reciting or naming the presented items during learning. The goal of this activity may be selection and acquisition of units to be transferred to working memory.

In a study by Flavell, Friedrichs, and Hoyt (1970), students' spontaneous use of rehearsal strategies during learning was found to increase with age. For example, in one experiment, subjects were given a row of windows with a button below each one. If the subject pressed a button, a light would come on for the picture in the window above the button. The light would stay on for as long as the subject kept the button pressed; as soon as the subject stopped pressing the button, the window would become blank again. The subject's job was to keep pressing the buttons, one at a time, for as long and as many times as needed, until the subject was able to recall the names for the whole series of pictures.

The results indicated large differences in the active, spontaneous rehearsal performance of children of different ages. Fourth graders were ten times more likely than nursery school children to engage in naming of objects from previous pictures and to practice by anticipating the name of an object before pressing the button. Fourth graders also engaged in repeating the name of a presented object more than twice as often as nursery school children. Apparently, by the time a child moves from nursery school to fourth grade, the child can make more use of rehearsal strategies and related techniques for memorizing new information.

A study by Hagen and Kail (1973) provides additional evidence that younger children are less likely to spontaneously rehearse as compared to older children. Flavell, Beach, and Chinsky (1966) have noted that in a list learning task almost all 10-year-olds moved their lips during learning—suggesting rehearsal—while almost no 5-year-olds moved their lips. In a training study, Kenney, Cannizzo, and Flavell (1967) identified

a group of first graders who spontaneously moved their lips during learning and a group of first graders who did not give evidence of rehearsing. As expected, the "rehearsers" performed better on the memory test than the "nonrehearsers." Both groups were then given explicit training in how to rehearse a list of items, including how to name the pictures during the retention interval. This training boosted the memory performance of the "nonrehearsers" but did not affect the performance of the "rehearsers." However, on subsequent list learning tasks, the "nonrehearsers" did not continue to use the rehearsal strategy they had been taught, and their memory performance fell. Based on results such as these, Flavell (1970; Flavell & Wellman, 1977) argues that some young children have rehearsal strategies *available* to them but generally fail to spontaneously *apply* them in learning tasks. Flavell refers to this phenomenon as a "production deficiency" because the child fails to produce appropriate rehearsal strategies when they are called for.

In a related study, Appel, Cooper, McCarrell, Sims-Knight, Yussen, and Flavell (1972) presented two lists to 4-, 7-, and 11-year-olds. For one list, the children were told to look at each picture; for the other list, subjects were told to memorize the pictures. The 4-year-olds tended to behave the same for both lists; for example, they did not rehearse more for the "memorize" list, and they did not remember it better than the "look" list. The 11-year-olds did behave differently for the two lists; for the list they were asked to memorize they engaged in much more rehearsal, and also performed much better on a test of recall list. The 7-year-olds tried to engage in more rehearsal for the "memorize" list but were not successful in boosting recall performance. Appel et al. (1972) suggest a "differentiation hypothesis" in which older children are better able to use learning strategies that are appropriate for particular goals.

These studies suggest that rehearsal strategies are learned by children as they progress from nursery school to fifth or sixth grade. Below age 5, children tend not to spontaneously use rehearsal strategies in learning lists of pictures, are not distracted by activities that limit rehearsal, and do not seem to use different approaches for tasks with different requirements. Apparently, these children do not have effective rehearsal strategies available to them. By age 6 or 7, children are often able to use rehearsal strategies when explicitly instructed to do so, but may not be able to generate useful strategies spontaneously. These children seem to have rehearsal strategies available but do not seem to know how to use them. Finally, by age 11 or 12, children tend to spontaneously rehearse during learning, to be distracted by activities that interfere with rehearsal, and to modify their rehearsal behavior in line with goals of the task. While the rate of this progression is influenced by the difficulty of the task and the sophistication of the learner, there does appear to be a distinct progression in the way that children use rehearsing to enhance learning.

## Rehearsal Strategies for Complex Learning Tasks

When the to-be-learned material is prose, such as a lesson from a science textbook, the rehearsal strategies can include repeating the material aloud (i.e., shadowing), copying the material, taking selective verbatim notes, and underlining the important parts of the material. In each case, the act of rehearsal involves the learner actively saying, writing, or pointing to parts of the presented material during learning. Two of the major cognitive goals of this strategy are: (1) selection—helping the learner to pay attention to important aspects of the passage, and (2) acquisition—making sure that the material is transferred into working memory for further study.

For example, in a research study, Mayer and Cook (1980) asked students to listen to a passage that described how radar works. After each phrase there was a pause, during which some students were instructed to repeat the words (shadowing group) while other students simply listened without repeating the words during each pause (control group). On a subsequent test, the shadowing group remembered more about the details and the verbatim wording of the passage, but the control group remembered more of the conceptual information and performed better on tests of creative problem solving using the radar information. Apparently, rehearsal strategies that are effective for basic learning tasks may not be as useful in some more complex tasks. One explanation of these findings is that shadowing prevented the students from actively building internal and external connections, while the control group had time to engage in these activities.

In another study, Arkes, Schumacher, and Gardner (1976) asked students to read a passage about Presidential candidates. Among the many treatment groups, some students were asked to copy the passage into their own handwriting (copy group), whereas other students were asked to perform a nonconceptual task such as circling every letter "e" (control group). Both groups were told that they would be expected to take a recall test. Results indicated that the copy group remembered approximately 50% more than the control group, but the copy group required nearly three times more study time than the control group. In another part of the study, students were not told to expect a recall test; in this case the copy group recalled approximately three times as much as the control group and also required approximately three times as much study time. Thus, while copying seems to enhance factual recall there is some reason to question its efficiency as a widely used learning strategy.

Another form of rehearsal is to copy or underline only the important parts of a lesson. For example, Rickards and August (1975) found that students who were asked to underline sentences in a passage were able to recall substantially more information than students who simply read the passage without underlining. It should be noted, however, that Brown and Smiley (1977) found that children below the sixth grade cannot adequately identify important information in prose.

Finally, Howe (1970) has found that facts that students correctly copy into their notes are far more likely to be learned than facts that are not copied into notes. For example, students were asked to take notes on a 160-word passage, and then take a recall test one week later. If a fact was in the notes, it was recalled 34% of the time; but if a fact was not in a student's notes, it was recalled less than 5% of the time. These results are consistent with the idea that rehearsal strategies serve to help the learner select information and to acquire the information. However, there is little evidence that these techniques help learners to construct internal connections or integrate the

information with prior knowledge. Several of the training programs described in subsequent sections use some rehearsal strategies, but supplement these strategies with others that are aimed at other cognitive goals.

## Elaboration Strategies for Basic Learning Tasks

Basic learning tasks include paired-associate learning, such as learning foreign language vocabulary; serial list learning, such as learning to recite the alphabet; and free recall list learning, such as learning to name all of the parts of the brain. Elaboration strategies that have been used for these tasks include forming a mental image or generating a sentence that connects two or more items. One major cognitive goal of elaboration strategies is construction—building of internal associations between two items (or among several items) in the to-be-learned material.

One of the most effective elaboration strategies for paired-associate learning involves using mental images to help relate and represent items in a pair. For example, to remember a word pair such as "apple-fish," a learner could form an image of a fish taking a bite out of an apple. Levin (1976) has distinguished between induced imagery strategies (in which the learner is instructed to generate and use visual imagery to associate items) and imposed imagery strategies (in which the experimenter or teacher provides an image and asks that the learner use that image to associate items). In a recent review, Reese (1977) has noted that imposed imagery tends to improve paired-associate learning performance for kindergarteners and first graders but induced imagery is better for sixth graders and adults. Apparently, younger children are not able to effectively generate images but are able to use imagery that is provided by a teacher; in contrast, older children who are able to generate their own idiosyncratic images may be distracted by the teachers' imagery suggestions.

The keyword method for acquiring foreign language vocabulary is one of the most popular attempts to teach a type of imaging strategy that also uses verbal elaboration (Atkinson, 1975; Atkinson & Raugh, 1975; Raugh & Atkinson, 1975). For example, in memorizing Spanish vocabulary such as "trigo" means "wheat," the keyword method involves two stages: first, a verbal *acoustic link* must be established in which the foreign language word is changed into an easily pronounced English "keyword." This keyword must sound like part of the foreign word; for example, "trigo" can be converted into "tree." Second, an *imagery link* must be formed between the keyword and the corresponding English word. For example, the learner could picture a tree that grows wheat stalks instead of leaves.

In a typical experiment, Raugh and Atkinson (1975) asked college students to learn 60 Spanish-to-English vocabulary pairs in 15 minutes. The experimental group was given training in the use of the keyword method; during learning the keywords were provided but subjects had to generate their own images. The control group learned the same 60 vocabulary pairs in the same amount of time, but were not given training in how to use the keyword method. The experimental group scored 88% on a recall test compared to 28% for the control group. In another study involving Russian vocabulary, students who used the keyboard method recalled 72% compared to 46% for the control group (Atkinson & Raugh, 1975).

Levin, McCormick, Miller, Berry, and Pressley (1982) asked fourth graders to learn definitions of 12 verbs, such as "persuade." The experimental group was given a keyword for each verb—such as "purse" for "persuade"—and were given pictures that showed the keyword interacting with a definition of the vocabulary word—such as a picture of a woman being "persuaded" to buy a "purse." Control subjects were given just as much time to learn, but were not given the keyword treatment. The experimental group recalled 83% of the definitions as compared to 55% for the control group. Levin et al. (1982) also found that pictures that do not explicitly connect the vocabulary word to the keyword do not improve memory performance. In a review of research studies involving adapting the keyword method to various school tasks, Levin (1981) points out that in addition to teaching foreign language vocabulary and English vocabulary, as described above, the keyword method has been successfully applied to memorizing unfamiliar medical terms, functions of various biochemicals, cities and their products, famous people and their accomplishments, states and capitals, and U.S. presidents by number.

Pressley and his colleagues (Pressley, 1977; Pressley & Dennis-Rounds, 1980; Pressley & Levin, 1978) have found that younger children have difficulty in spontaneously generating useful keyword images, even when they are explicitly trained to do so. Thus, Levin (1981) and Pressley (1977) suggest that when the learners are children, the keyword method should be adapted to provide both keywords and pictures (showing the images). However, Jones and Hall (1982) were able to train eighth grade students to successfully carry out both steps. Students who participated in this educational treatment (five 20–30-minute sessions spaced over a 3-month interval) learned to both generate the verbal links and create effective compound images. Even more important, students who participated in this training subsequently used this strategy under appropriate task conditions and without explicit prompting. It appears that older students can learn to use this strategy effectively and to generalize its use to everyday school tasks.

In contrast to the keyword method, Beck and her colleagues (Beck, Perfetti, & McKeown, 1982) have developed an alternative method for teaching vocabulary to students. For example, in Beck's program students were given sets of related words so that they could explore the interrelationships among them. Initial results indicate that the program is useful in helping students learn the vocabulary words, and that this technique transfers well to learning of new vocabulary words. Unlike Levin's and Pressley's programs, which focus on learning of single associations, Beck's program involves the building of several associations among ideas. Thus, Beck's approach shares some of the characteristics of the organizational strategies described in the following section, and may have the effect of allowing students to build internal connections among words.

## Elaboration Strategies for Complex Learning Tasks

When elaboration strategies are applied to tasks such as prose learning, the types of activities include paraphrasing, summarizing, creating analogies, generative notetaking, and question

answering. The goals of these techniques include integration of presented information with prior knowledge — i.e., transferring knowledge from long-term memory into working memory and integrating the incoming information with this knowledge.

In a model of learning as a generative process developed by Wittrock (1974, 1978, 1981), the integrative processes used by the learner to relate new information to either concepts or schemas already in semantic memory, or distinctive memories of experience, are the key determinants of new learning and subsequent performance. Creating connections, or elaborations, between to-be-learned information and already established content and procedural knowledge is a major component of most knowledge acquisition frameworks based on schema theory (Schallert, 1982). Models have also been developed which relate research about levels of processing in memory to elaborative encoding (Bradshaw & Anderson, 1982).

In a recent study examining the use of summarization (Doctorow, Wittrock, & Marks, 1978), sixth graders studied commercially available reading materials. For half of the students, these materials contained paragraph headings while for the other half the entire text was presented without any inserted headings. In addition, half of the students in each of these two groups also received instructions to generate summary sentences for each paragraph right after they finished reading it. An analysis of the scores from a post-reading comprehension test indicated that students asked to generate summary sentences outperformed the control subjects. In addition, with time to learn held constant, the students receiving the passage with the inserted headings and the instructions to generate summary sentences outperformed the students in any of the other conditions.

Researchers have also investigated complex elaboration strategies singly or in combination with one or more other types of learning strategies. Weinstein (1982) examined whether students could be taught to use a variety of elaboration strategies and whether their use of these strategies would result in improvements in understanding and school performance. She created a diversified elaboration skills training program for use with ninth grade students. Instruction centered around the following five strategies: using verbal elaborators, using imaginal elaborators, creating analogies, drawing implications, creating relationships and elaborative paraphrasing (relating the material to what is already known while also restating it in one's own words). Instruction involved teaching students how to apply these strategies to a variety of learning tasks typically encountered in school, including paired-associate learning tasks, free recall learning tasks and reading comprehension tasks. The stimulus materials used during instruction were drawn from a ninth grade curriculum in science, history, English, foreign language and vocational education.

For this study, ninth grade students were randomly assigned to one of three groups: training, control, or posttest-only. The training group participated in a series of five 1-hour elaboration skill training sessions, administered at approximately 1-week intervals. Students were exposed to a set of 19 learning tasks. They were required to create a series of elaborations for each of these tasks. Experimenter-provided directions for the early tasks emphasized the properties of an effective elaboration strategy. The later training session provided opportunities for additional practice in using these skills with little or no experimenter-provided instructions. The control group was exposed to the same stimulus materials, but their task was simply to learn the information without any type of strategy prompts or directions. A posttest-only group was not exposed to the stimulus materials but did participate in the posttesting sessions. The immediate posttest was administered 1 week after the conclusion of the training, and the delayed posttest was administered approximately 1 month later. Both immediate and delayed posttests consisted of two reading comprehension tasks, two trials of paired-associate learning and serial recall, and a one-trial free recall task.

The results of the data analyses for the immediate posttest revealed significant differences between group means on the free recall task and Trial 2 of the paired-associate learning task. In each instance, the training group's performance surpassed the performance of the control and posttest-only groups, which did not differ significantly from each other. On the delayed posttest, a significant difference was obtained for the reading comprehension tasks and Trial 1 of the serial learning task. Again, these differences favored the training group.

Probably the most common form of complex rehearsal strategy involves notetaking. In a study by Carrier and Titus (1981), which is typical of much of the research in this area, high school juniors and seniors were trained to use a notetaking system developed by the Study Skills Center at the University of Minnesota. This system is designed to teach students to (a) distinguish between superordinate and subordinate information, (b) abbreviate words, (c) paraphrase in one's own words, and (d) use an outline format. Each student participating in the training listened to an explanation of the rationale for using the system and a description of each of the four components. Next, participants observed demonstrations where each component was applied in a set of model notes. Finally, the students practiced using the entire system while listening to three minilectures; the topics of these lectures included political problems in Latin America, the structure and function of cell membranes, and the characteristics of the moon. Following each minilecture, participants compared their notes to a set of model notes distributed by the experimenter and then discussed any problems they encountered or any questions they had about the task.

Students who received the training for using the notetaking system, and a control group of students who were directed to take notes just as they normally would, both listened to a 20-minute lecture describing the evolution of the brain. Prior to hearing the lecture, one-third of the students were told they would be given a multiple choice test over the material; another third were told they would have an essay test; and the final third were told only that there would be a posttest. In actuality, all students completed a 35-item objective test immediately after the lecture and a free recall test 1-week later. A notetaking efficiency score was also calculated for each participant; this score was the ratio of the number of correct information units contained in the student's notes to the total number of words recorded. Efficient notes were defined as those containing the greatest amount of information using the fewest number of words.

An analysis of the efficiency scores revealed a performance

advantage for students anticipating a multiple choice test. In addition, trained students anticipating a multiple choice test outperformed their non-trained counterparts on both types of tests. While these results lend some support to the usefulness of teaching notetaking as a learning strategy, they also highlight some of the problems with research in this area. For example, it is difficult to separate the encoding function and the storage function of notetaking. DiVesta and Gray (1972, 1973) define the encoding function as the transformation of information into more meaningful and useable forms and the storage function as the external maintenance of the information for later review. Thus, the purposes for which notes are taken and later used can have a large impact on the underlying processes used and the learning outcomes produced (Barnett, DiVesta, & Rogozinski, 1981).

Similarly, Peper and Mayer (1978) studied notetaking as a generative activity. Mayer (1980) asked college students to read a manual on a computer programming language. After each section in the manual, some subjects were asked to explain how the material related to material in another section of the manual (or to a familiar situation). These subjects performed better on tests of creative problem solving using the new language, as compared to subjects who simply read the manual without answering elaboration questions. For a critical review of the role of elaboration in prose learning, see Reder, 1980.

## Organizational Strategies for Basic Learning Tasks

One strategy for remembering a list of items is to sort them into some larger organizational framework, such as grouping items into taxonomic categories. The term *clustering*, originally used by Bousfield (1953), refers to a strategy used in free recall list learning in which the learner organizes the items from a list into groups on the basis of shared characteristics or attributes. For example, although a list might be presented in the order, "table, bus, hat, van, desk, shoes, truck, belt, sofa," a learner could organize the list by taxonomic category such as, "table, desk, sofa — bus, van, truck — hat, shoes, belt." The use of this kind of an organizing strategy requires the learner to be actively involved in the task.

In a typical research study (Moely, Olson, Hawles, & Flavell, 1969), children ranging in age from 5 to 11 years were given a set of pictures to memorize. The pictures included objects from various categories such as animals, furniture, vehicles, and apparel, but no pictures from the same category were adjacent to one another in the set. The children were allowed to move and rearrange the pictures. The results indicated that children in the 5–7-year-old range did not tend to rearrange the pictures while children in the 10–11-year-old range did make strong use of the organizing strategies by rearranging the pictures by taxonomic category.

The failure of the younger children to use organizing strategies during free recall learning may be due either to lack of availability of the strategies or what Flavell (1970) has called a production deficiency. In order to examine these explanations, Moely et al. (1969), conducted an instructional study using 9-year-olds who did not spontaneously categorize. The children were readily able to rearrange pictures into categories when instructed to do so but did not normally use this strategy in a list learning task. When they were taught how to apply the organizing strategy to list learning, the students were able to do so and their recall performance was boosted. Apparently, children at this intermediate level give evidence of a production deficiency in which they possess the appropriate skill but fail to spontaneously use it during learning.

In another study, Rossi and Wittrock (1971) examined children's free recall of twelve-word lists. They found that 2-year-olds spontaneously tend to organize words most frequently on the basis of their sound (e.g., sun-fun), while 3- and 4-year-olds tend to use taxonomic category (e.g., leg-hand), and 5-year-olds tend to use serial ordering. Furthermore, rhyming reached its peak at age 2, syntactical organization (e.g., men-work) reached its peak at age 3, organization by taxonomic category reached its peak at age 4, and serial ordering reached its peak at age 5. According to the authors, although serial ordering seems to be a more elementary type of interstimulus organization than clustering by taxonomic category, its frequency and peak level at age 5 may be due to the fact that the ability to memorize 12 words is sufficiently developed that grouping them according to their common properties or common membership in one class requires more effort than memorizing them in serial order. However, longer lists may require a superior type of organization to recall all their members.

These studies suggest that there is a developmental progression in children's bases for organizing pictures during a memorization task. In general, spontaneous use of an organizing strategy based on taxomonic category seems to emerge at about age 10 or 11. However, the availability of this strategy may emerge at an earlier age, as evidenced in the study conducted by Moely et al. (1969). The same may be true in the case of list learning tasks. Although in the study conducted by Moely et al., the 9-year-old children did not normally use this strategy in a list-learning task, it seems that its availability emerges at an earlier stage as evidenced in the study conducted by Rossi and Wittrock (1971). Moreover, this latter study showed that spontaneous use of this strategy may even occur at much younger ages when the word lists are short.

In a more recent study, Bjorklund, Ornstein, and Haig (1977) focused on the structure students impose on items to be recalled at the time of study (i.e., input organization). They also examined the effects of training students to use adult sorting patterns. Three related studies were conducted using third, fifth, and seventh grade students. An analysis of the results led to the identification of four general sorting strategies: high semantic, low semantic, orthographic, and random.

The tendency to group words on the basis of meaning increased with grade level. Furthermore, the level of sophistication of a sorting style tended to predict recall performance irrespective of grade level. Subjects who grouped words on the basis of meaning showed greater recall than subjects who sorted in a random or orthographic fashion.

It was also demonstrated that children can be trained in the use of organizational techniques to aid recall. Young children, who for the most part failed to sort words into meaning-based groups in a free-sort situation, demonstrated significant improvements in recall as a result of organizational training.

## Organizational Strategies for Complex Learning Tasks

A significant amount of time is spent studying from textbooks by students in the upper elementary grades, high school, and college (Cole & Sticht, 1981). Part of a student's text reading task is to identify the main ideas and important supporting details and to relate these to one another in a way that will facilitate encoding and recall. Outlining and organizing the material are commonly used to achieve these goals. Thus, two cognitive goals served by organizational strategies are selection of information to be transferred into working memory and construction of relations among ideas in working memory.

Mayer (1982, 1984) has referred to this encoding process as "building internal connections." The building of internal connections may be enhanced by explicit training in strategies for outlining and organizing items in meaningful learning tasks, such as training in the types of structural relations among ideas in a passage. Training in organizing strategies may be most important for expository prose, since most students have had much more experience in reading narrative prose (Graesser, 1981).

Outlining is a type of organizational strategy that has traditionally received much attention. In topic outlining, major and minor points are written in an abbreviated form using key words or phrases. In symbolic outlines, such as arrays, key concepts, words, or phrases are functionally related in a two-dimensional diagram. Hansell (1978) found that seventh graders could be taught to effectively outline a text passage using either a topic outline or an array. Several more specific versions of outlining are discussed below.

Dansereau and his colleagues (Dansereau, 1978; Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979; Holley, Dansereau, McDonald, Garland, & Collins, 1979) have developed a technique called *networking* which trains students to identify the main internal connections among ideas in a passage. For example, six major types of links are:

- Part link. For example, the process of wound healing has three parts, namely, lag phase, fibroplasia phase, and construction phase.
- Type link. For example, two types of wounds are open and closed.
- Leads to link. For example, the growth of a scab leads to a scar.
- Analogy link. For example, a scab is like a protective bandage.
- Characteristic link. For example, an open wound involves a break in the skin.
- Evidence link. For example, an x-ray test can reveal that a bone is broken.

As can be seen, networking involves breaking a passage down into parts and then identifying the linking relations among the parts.

Holley et al. (1979) tested the effectiveness of networking training for college students. Students learned to recognize the types of links, to apply the networking procedure to sentences, to apply the networking procedure to passages, and to apply the networking procedure to their own textbooks. The training lasted about $5\frac{1}{2}$ hours spread over four sessions. On subsequent reading comprehension tests, the trained subjects outperformed nontrained subjects on remembering the main ideas. The effects of training were particularly strong for students with low GPA's, presumably because high GPA students had already developed their own techniques for organizing prose material. These results have been replicated in a learning strategy class consisting of 24 hours of training (Dansereau, 1983; Dansereau et al., 1979).

Using a somewhat different approach, Meyer (1975, 1981; Meyer, Brandt, & Bluth, 1980) has identified five top-level structures that describe the relationship among the main ideas in expository passages. Using a passage presenting information about supertankers as an example, the five structures are:

- Covariance. For example, lack of power and steering in supertankers leads to oil spills.
- Comparison. For example, ground stations for supertankers are like control towers for aircraft.
- Collection. For example, three ways to improve supertanker safety are training of officers, building safer ships, and installing ground control systems.
- Description. For example, oil spills kill wildlife as is indicated by 200,000 seabirds being killed.
- Response. For example, a problem is that supertankers spill oil and a solution is to improve their safety.

In a recent study, Meyer et al. (1980) asked ninth graders to read and recall the supertanker passage. Good readers (as measured by a standard reading achievement test) recalled the top-level structure of the passage much better than poor readers. In other words, good readers were far more likely to organize their recall for the supertanker passage around the response format. Similarly, Taylor (1980) found developmental trends in which recall of the top-level structure increases dramatically with age.

In another training study, Bartlett (1978) gave ninth graders practice in identifying four major types of top-level structures and in using these structures as aids in recall. The trained group outperformed a control group on tests of reading comprehension. Apparently, students can be taught to be sensitive to the organizational structure of expository material, and using this organization aids comprehension.

More recently, Cook (1982) has developed a training procedure to help students identify prose structures that are found in science textbooks. The five structures are:

- Generalization—The passage explains, clarifies or extends some main idea.
- Enumeration—The passage lists facts sequentially.
- Sequence—The passage describes a connected series of events or steps in a process.
- Classification—The passage groups material into categories or classes.
- Compare/contrast—The passage examines the relationship between two or more things.

These structures differ from Meyer's and Dansereau's in that Cook focused only on chemistry, biology, and physics prose.

In a preliminary study, Cook (1982) found that college students could be taught to classify passages into the five categories listed above. The next step was to develop a 10-hour training program in which students were taught to recognize the major prose structures and to outline passages from their own chemistry textbook. Trained subjects showed substantial pretest-to-posttest gains in recall of high-level material and in problem solving as compared to a control group, even though the tests involved material from unfamiliar biology and physics textbooks.

## Comprehension Monitoring Strategies

The term metacognition has been used to refer to both students' knowledge about their own cognitive processes and their ability to control these processes by organizing, monitoring, and modifying them as a function of learning outcomes (Brown, 1975, 1978; Cavanaugh & Perlmutter, 1982; Flavell, 1970, 1981; Flavell & Wellman, 1977). The use of metacognitive strategies is most often operationalized as comprehension monitoring. Comprehension monitoring requires the student to establish learning goals for an instructional unit or activity, to assess the degree to which these goals are being met, and, if necessary, to modify the strategies being used to meet the goals. Comparisons of good and poor comprehenders have consistently shown that poor comprehenders are deficient in the use of active learning strategies needed to monitor understanding (Golinkoff, 1976; Meichenbaum, 1976; Ryan, 1981).

In two recent studies by Paris and Myers (1981), comprehension and memory skills of fourth grade good and poor readers were compared. The students' ability to monitor understanding of both difficult and anomalous information was measured by three different means: by spontaneous self-corrections during oral reading, by directed underlining of incomprehensible words and phrases, and by observed study behaviors. Spontaneous monitoring was measured by the percentages of anomalous words and phrases for which students hesitated, repeated, or self-corrected. Directed underlining was measured by the percentages of anomalous words and phrases underlined. In addition to observing students' study behaviors, student ratings of effectiveness were collected on 20 reading strategies that could potentially affect memory for story content. Finally, understanding was measured by responses to oral questions and a free recall test.

Comparing the performance of the good and poor readers revealed that poor readers engaged in less comprehension monitoring on all measures; these differences were also correlated with lower scores on the oral question and free recall posttests. The student ratings of perceived reading strategy effectiveness indicated that, although poor readers gave the same ratings to positive and neutral factors as did good readers, they were less aware of the detrimental influences on comprehension of negative factors. Thus, whereas many children may gradually acquire the processing skills needed for good comprehension, poor comprehenders appear to be relatively deficient in the use of active monitoring strategies.

A number of different approaches have been used to teach comprehension monitoring strategies. For example, Meichenbaum and Asarnow (1979) reviewed the research concerning training designed to teach self-control for various academic tasks. The training programs in this area are based on the use of cognitive–functional analysis of task performance to identify the processes engaged in by successful learners. These analyses are then used to diagnose the deficiencies of problem learners and to plan a course of instruction. A typical training sequence proceeds from modeling the teacher's or experimenter's instructions, to overt rehearsal, and finally to covert rehearsal. This sequence is designed to help the learner develop self-statements to use in guiding and controlling performance on target tasks. The types of performance-relevant skills focused on by these programs include (a) problem identification and definition or self-interrogation skills ("What is it I have to do?"); (b) focusing attention and response guidance which is usually the answer to the self-inquiry ("Now, carefully stop and repeat the instructions"); (c) self-reinforcement involving standard setting and self-evaluation ("Good, I'm doing fine"); and (d) coping skills and error-correction options ("That's okay ... Even if I make an error I can go slowly"). Such cognitive training is conducted across tasks, settings, and people (trainer, teacher, parent) in order to ensure that children do not develop task-specific response sets, but instead that they develop generalized strategems (Meichenbaum & Asarnow, 1979, pp. 13–14).

Bommarito and Meichenbaum (cited by Meichenbaum & Asarnow, 1979) used this model to teach seventh and eighth graders strategies they could use to monitor their reading comprehension. Thus, teaching about learning strategies needed for comprehending written material, such as finding the main ideas and elaborating on important information, was embedded in a program of self-instructional training to teach comprehension monitoring. The major instructional device used in the teaching of both types of strategies was modeling of the cognitive strategies and self-statements. The students then practiced, at first out loud and then silently, using these methods to learn from passages appropriate to their reading levels (all participants had reading scores at least one grade level below their actual academic grade).

Students who participated in the six 45-minute sessions performed better on a test of reading comprehension than did students who did not participate in the training and students who studied the learning strategies materials but did not learn to use the self-instructional technique. This superior performance was maintained after a 1 month follow-up of all students from the study. It appears that comprehension monitoring can be taught using relatively brief educational programs. Furthermore, the results seem to be stable over time. Similar results have been found by Wong and Jones (1980) and Malamuth (1979).

Other methods have also been used to teach comprehension monitoring. Smith (1973) taught seventh grade students to generate pre-reading questions to guide their reading activities. Learning disabled children's recall was improved by teaching them a strategy for identifying certain types of information while listening (Maier, 1980). Markman (1979) taught students error detection strategies to find inconsistencies in reading passages.

### Affective Strategies

Many current approaches to classroom learning emphasize the role of the learner in creating, monitoring, and controlling a suitable learning environment. Research in this area has focused on the strategies learners use to focus attention, maintain concentration, manage performance anxiety, establish and maintain motivation, and manage time effectively. Prototypical of the research in this area are the studies examining performance, or test, anxiety.

For many years high test anxiety was regarded as a behavioral reaction to stress originating in the environment. Since the forces creating anxiety were presumed to be outside of a student's control, little attention was paid to the possible mediating role of the student's own thought processes. In modern conceptions of test anxiety it is the learner's perceptions or appraisals of events that make them stressful (Wine, 1980). Many students who worry about their success in school, especially about how well they will do on tests, turn their attention inward and focus on self-criticism, feelings of incompetence, and expectations of failure. Attention is directed away from learning and studying and is focused on themselves as inadequate students. This decreased attention to study and school-related tasks often produces a spiral effect where poor performances confirm students' fears and intensify their anxiety. For a recent review of this literature see Sarason (1980).

Research about methods that can be used to help students cope with debilitating performance anxiety has resulted in a number of different types of programs and interventions (Morris, Davis, & Hutchings, 1981; Phillips, Martin, & Meyers, 1972; Ribordy & Billingham, 1980; Tryon, 1980; Wildemuth, 1977). A number of these educational interventions derive from clinical approaches to anxiety treatment such as systematic desensitization (e.g., Deffenbacher & Parks, 1979), desensitization with modeling (e.g., Richardson, O'Neil, & Grant, 1977), cognitive modification (e.g., Vagg, 1977/1978), anxiety management training (Deffenbacher, Michaels, Michaels, & Daley, 1980), and rational restructuring (Osarchuk, 1976). Other approaches derive more from the traditional areas included within study skills, such as test-taking skills training (Kirkland & Hollandsworth, 1980).

In a study typical of those done with older adolescents, Goldfried, Linehan, and Smith (1978) investigated the effects of a rational restructuring strategy on the reduction of test anxiety for college students. The students who participated in the rational restructuring started out by observing a model illustrating the use of coping self-statements. These statements were designed to reduce anxiety by focusing attention away from self-deprecating thoughts and towards a simulated test. For example, instead of saying something like, "There is no way I will pass this test ... Boy! Am I stupid!," the experimenter modeled more appropriate thought such as, "O.K. It's more likely I will not fail since I did study, but even if I did fail, it does *not* mean that I am stupid." After observing the model create a number of these thinking-aloud protocols, the students were then asked to imagine a scene from a test anxiety hierarchy, to identify any negative self-statements or evaluations that came into their mind during this time, and to reduce their anxiety by substituting more rational and positive self-talk. The students were asked to visualize a total of 15 scenes.

The results of the study indicated that participants in the rational restructuring strategy training reported greater reductions on several different measures of test anxiety than did participants in either of two control groups. Thus, it appears that training designed to enhance a student's repertoire of the strategies needed to cope effectively with stress can help to reduce self-reported levels of anxiety.

Methods to teach students strategies they can use to cope effectively with performance anxiety are often embedded in other programs. For example, in the Bommarito and Meichenbaum study (cited by Meichenbaum & Asarnow, 1979) discussed in the last section, the teachers not only modeled the task-relevant statements about problem solving but also coping self-statements that could be used to reduce frustration and anxiety reactions. Anxiety reduction components can also be found in a number of the programs that will be discussed in the next section.

## Implementing Learning Strategies Instructional Programs

For purposes of the present discussion we have created a taxonomy of learning strategies and have discussed prototypical research studies within each of the eight areas. It is important, however, to note that many research studies, particularly those investigating classroom applications or adjunct interventions with students, investigate study systems, alternative curriculum supplements, or experimental courses that combine one or more strategies from both within and across the different categories. The purpose of many of these research studies is to either develop specific school applications or courses, or to investigate the effectiveness of already existing methods. For example, Jones and her colleagues (Jones et al., 1983), and Sticht (1979) have focused on embedding diversified learning strategies instruction into regular reading curriculum materials. Jones' work is part of the Chicago Mastery Learning Reading Program. Strategies from each of the eight categories are taught, reinforced, and cued within the curriculum materials.

Dansereau (1985), McCombs (1981), and Weinstein (Weinstein & Underwood, 1985) have all focused on creating adjunct programs for post-secondary students in job or college settings. These experimental, integrated learning strategies instructional programs have been used to investigate strategy component interactions, instructional procedures, and generalization of teaching effects. For example, Weinstein (1982) reports substantial gains in reading comprehension, academic performance and stress reduction for college students participating in an experimental undergraduate learning strategies course.

This work has also led to the creation of experimental courses at the elementary and high school levels. For example, the Cypress-Fairbanks Independent School District in Texas is implementing a study skills curriculum for all ninth graders. The Prince George's County Public Schools in Maryland has adapted a kindergarten through grade twelve learning strategies program to be incorporated into the regular instructional programs in other content areas. The Rhode Island Depart-

ment of Education has developed guidelines for implementing study skills instruction into the state's reading programs.

McCombs (1981, 1982a, 1982b) has developed self-instructional instructor-augmented learning strategies materials in the areas of time management, study skills, and self-motivation. Implementation of these materials with military technical training students led to improved test scores and lower test failure rates as well as student-reported increases in motivation and ability to take increased responsibility for learning.

It appears that learning strategies research is creating a useful data base from which applications can and will be derived. As this literature continues to mature and develop, the implications for classroom teaching, educational practice, and educational research will continue to expand.

## Conclusion

In conclusion, this chapter has explored techniques for enhancing learning in basic school tasks (such as list and paired-associate learning) as well as complex school tasks (such as meaningful prose learning). The learning strategies of rehearsing, elaborating, and organizing represent three kinds of resources that may be available for an active learner. Management strategies (such as comprehension monitoring) and affective strategies (such as anxiety reduction techniques) involve the effective use of available resources. This chapter has provided evidence for the hypothesis that learning strategies can be described and taught to learners who are at appropriate levels of maturity.

Some warnings are in order, however. This chapter is concerned with explicit teaching of learning strategies, that is, general techniques for more effective learning. It should be pointed out that general techniques are just part of the arsenal of knowledge that a learner needs for effective learning. Learning is also enhanced when the learner possesses a great deal of domain-specific knowledge. Simon (1980) summarizes this point as follows: "The scissors does indeed have two blades and ... effective ... education calls for attention to both subject-matter knowledge and general skills" (p. 86). Thus, while teaching of learning skills represents an important part of an educational program, it cannot substitute for teaching of domain-specific content.

A related issue concerns the distinction between non-directed training and more directed or guided training for learning strategies. Several researchers argue for the need to make instruction more explicit and directed (see Segal, Chipman, & Glaser, 1985). In addition, these authors argue that explicit training is most useful for less skilled learners.

Another warning concerns the time costs of learning strategies. The use of any technique must take into account its time costs as well as its benefits (Anderson & Armbruster, 1982).

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