Advances in Research on Instruction

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This chapter discusses what I regard as some of the most important instructional advancements of the last 30 years. These advancements came from three bodies of research: (a) research on cognitive processing, (b) research on teacher effects, that i s, studies of teachers whose classes made the highest achievement gain compared to other classes, and (c) intervention studies in which students were taught cognitive strategies they could apply to their learning. Although I would not advocate converting these ideas into another evaluation form, I suggest that the ideas represented by this research can and should be used to discuss and improve instruction.

I. Findings from Research on Cognitive Processing: The Importance of Well-Connected Knowledge Structures.

A major area of research, one with important implications for teaching, has been the research on cognitive processing, research on how information is stored and retrieved. This research has shown us the importance of helping students develop a well -connected body of accessible knowledge.

It is currently thought that the information in our long-term memory is stored in interconnected networks called *knowledge structures*. The size of these structures, the number of connections between pieces of knowledge, the strength of the connections, and the organization and richness of the relationships are all important for processing information and solving problems.

It is easier to assimilate new information and easier to use prior knowledge for problem solving, when one has more connections and interconnections, stronger ties between the connections, and a better organized knowledge structure. When the knowledge structure on a particular topic is large and well-connected, new information is more readily acquired and prior knowledge is more readily available for use. Having a well-connected network means that any one piece of information can serve to help retrieve the entire pattern. Having strong connections and a richness of relationships enables one to retrieve more pieces of the pattern. When information is "meaningful" to students, they have more points in their knowledge structures to which they can attach new information. Education is a process of developing, enlarging, expanding, and refining our students' knowledge structures. Helping students to organize information into well-connected patterns has another advantage. When a pattern is unified, it only occupies a few bits in the working memory. Thus, having larger and better connected patterns frees up space in ou r working memory. This available space can be used for reflecting on new information and for problem solving. For example, when U.S. history is organized into well-connected patterns, these patterns occupy less space in the working memory and the learner has additional space in the working memory to use to consider, assimilate, and manipulate new information. A major difference between an expert and a novice is that the expert's knowledge structure has a larger number of knowledge items, the expert has mo re connections between the items, the links between the connections are stronger, and the structure is better organized. A novice, on the other hand, is unable to see these patterns, and often ignores them. This development of well-connected patterns and the concomitant freeing of space in the working memory is one of the hallmarks of an expert in a field.

To summarize, well-connected and elaborate knowledge structures are important because (a) they allow for easier retrieval of old material, (b) they permit more information to be carried in a single chunk, and (c) they facilitate the understanding and integration of new information. There are three important instructional implications that follow from this research: (a) the need to help students develop background knowledge, (b) the importance of student processing, and (c) the importance of organizers.

1. Help students develop their background knowledge. What can be done to help students develop well-connected bodies of knowledge? One important instructional procedure is providing for extensive reading, review, practice, and discussion. Th ese activities serve to help students *increase* the number of pieces of information that are the long-term memory, *organize* those pieces, and *increase* the strength and number of these interconnections. The more one rehearses and review s information, the stronger these interconnections become. Thus, the research on cognitive processing supports the need for a teacher to assist students by providing for extensive reading of a variety of materials, frequent review, testing, and discussion and application activities.

2. Provide for student processing. New material is stored in the long-term memory when one processes it. The quality of storage can depend on the "level of processing." For example, if we were told to read a passage and count the number of times the word "the" appeared, the quality of storage would not be as strong as if we read the same passage and focused on its meaning. Similarly, the quality of storage would be stronger if one summarized or compared the material in the passage rather than simply reading it.

Processing of new material takes place through a variety of activities such as rehearsal, review, comparing and contrasting, and drawing connections. Thus, the research on cognitive processing supports the importance of a teacher initiating activities that require students to process and apply new information. Such processing strengthens the knowledge network that the student is developing. Asking students to organize information, summarize information, or compare new material with prior material a re all activities that require processing and should help students develop and strengthen their cognitive structures. In addition, Palincsar and Brown (1991) wrote:

understanding is more likely to occur when a child is required to explain, elaborate, or defend his position to others; the burden of explanation is often the push needed to make him or her evaluate, integrate, and elaborate knowledge in new ways.< /P>

Other examples of such processing activities include asking students to do any of the following:

extensive reading of a variety of materials

explain the new material to someone else

write questions/answer questions

develop knowledge maps

write daily summaries

apply the ideas to a new situation

give a new example

compare and contrast the new material to other material.

study for an exam

All these activities are useful in helping students develop, organize, strengthen, and expand their knowledge structures.

3. Help students organize their knowledge. As has been noted, new information is organized into knowledge structures. Without these structures, new knowledge tends to be fragmented and not readily available for recall and use. However, students frequently lack these knowledge structures when they are learning new material. Without direction, students might develop a fragmented, incomplete, or erroneous knowledge structure. Therefore, the research suggests that it is important for teachers to help students organize the new material.

One way to do this is to provide students with "graphic organizers," that is, organizing structures for expository material. An outline is an example of such an organizer, concept maps are another example. These structures help students organize the elements of the new learning and such organization can serve to facilitate retrieval. In addition, having such organizers can enable the student to devote more working memory to the content.

Another approach is to teach students how to develop their own graphic organizers for new material. This process is facilitated by providing students with a variety of graphic organizer structures that they can use to construct their own graphic organizers. When teaching students to develop a graphic organizer, it is useful for the teacher to model the process and also provides models of thinking and thinking aloud as she/he constructs the maps.

In summary, the research on cognitive processing identified the importance of developing a well-connected knowledge structures. Such structures might be developed by encouraging extensive reading and practice, student processing of new information, and helping students organize their new knowledge.

II. Research on teacher effects.
A second important body of research is the teacher effects studies. The teacher effects research represents a line of studies that in which attempts were made to identify those teacher behaviors that were related to student achievement gain. The focus was on observing and recording classroom instruction and identifying those instructional procedures associated with the most successful and the least successful teachers.

In this research, the investigators first identified a number of instructional procedures to study. About 20 to 30 procedures would be selected, and these included a teacher's use of praise, a teacher's use of criticism, the number and type of questions that were asked, the quality of the student answers, and the responses of a teacher to a student's answers. Then achievement tests were given to the students in 20 to 30 classrooms. After the achievement tests, the investigators observed the classrooms and recorded the frequency with which the teachers used instructional behaviors such as those mentioned earlier. After three to six months a second achievement test was given to the same 20 to 30 classrooms.

After all the data were collected, the investigators used correlational statistics to specify the "adjusted gain" for each classroom. That is, the raw gain for each class, from pretest to posttest, was adjusted for the entry level of each classroom . In the final step, the investigators looked to instructional behaviors they had recorded for each class and correlated those behaviors with the measure of each class' adjusted achievement gain. Through the use of these procedures, the investigators were able to identify which instructional behaviors were associated or correlated with student achievement gain.

In many cases, these correctional results were tested in subsequent experimental studies in which one group of teachers were trained and helped to use these behaviors in their teaching and another group of teachers was told to continue their regular teaching. All the teachers were observed, and classes of all teachers were given achievement tests before the experiment began and at the end of the experiment. In most cases, students in the classes of the teachers who received the training had higher posttest achievement scores than those of students of teachers in the control classes.

Although a number of studies of this type were conducted by Barr (1948) and his associates, the modern era of this research began with the work of Medley and Mitzel (1959) and Flanders (1960). The largest number of teacher effects studies were conducted during the 1970's. The earliest studies were summarized by Rosenshine in 1971 and the studies that were conducted between 1973 and 1983 were summarized by Brophy and Good (1986) and by Rosenshine and Stevens (1986). The experimental studies have bee n summarized by Gage & Needles, (l989).

I suggest that the teacher effects era, between 1955 and 1980, was an impressive run of cumulative research. During this period, over 100 correlational and experimental studies were conducted using a common design and the different observation instruments shared many common instructional procedures. And it was cumulative: researchers cited and built upon the instructional findings of others.

Rosenshine and Stevens (1986) summarized this research and concluded that across a number of studies, when effective teachers taught well-structured skills and expository material, the teachers used the following procedures:

* Begin a lesson with a short review of previous learning.

* Begin a lesson with a short statement of goals.

* Present new material in small steps, providing for student practice after each step.

* Give clear and detailed instructions and explanations.

* Provide a high level of active practice for all students.

* Ask a large number of questions, check for student understanding, and obtain responses from all students.

* Guide students during initial practice.

* Provide systematic feedback and corrections.

* Provide explicit instruction and practice for seatwork exercises and, where necessary, monitor students during seatwork.

Rosenshine and Stevens (1986) further grouped these instructional procedures under six teaching "functions" as shown in Table 1. These teaching functions appear to be relevant today for teaching students skills that they can use to independently complete well-structured tasks.

Two findings from that research that are most relevant to teaching are (a) the importance of teaching in small steps and (b) the importance of guiding student practice. In addition, a third finding, the importance of extensive practice, is shared with the research on cognitive processing.

1. Present new material in small steps. We learned, in the teacher effects research, that the least effective teachers would present an entire lesson, and then pass out worksheets and tell students to work the problems. However, the most effective teachers taught new material in small steps. That is, they only presented small parts of new material at a single time, and after presenting the material the teachers then guided students in practicing the material that was taught.

This procedure of teaching in small steps fits well with the findings from cognitive psychology on the limitations of our working memory. Our working memory, where we process information, is small. It can only handle five to seven bits of information at once; any additional information swamps it. The procedure of first teaching in small steps and then guiding student practice represents an appropriate way of dealing with the limitation of our small working memories.

2. Guide student practice. A second major finding from the teacher effects literature was the importance of guided practice. The concept of guided practice was developed by Hunter (1982) and it first appeared in the teacher effects literature in an experimental study by Good and Grouws (1979).

In the teacher effects research we learned that it was not sufficient to present a lesson and then ask students to practice on their own. The least effective teachers -- those teachers whose classes made the smallest gains -- would present an entire lesson, and then pass out worksheets and tell the students to work the problems. When this happened, it was observed that many students were confused and made errors on the worksheets. One reason for these errors was the aforementioned limitation of the working memory. For many students, particularly those who had not learned the previous material well, the amount of material presented in the lesson was too large, and therefore, swamped the working memory.

The most effective teachers -- those teachers whose classes made the greatest gains, -- taught differently. First, as noted, the most effective teachers presented only some of the material at a time, that is, they taught in small steps. After presenting a small amount of material, these teachers then guided student practice. This guidance often consisted of the teacher working a few problems at the board and discussing the steps out loud. This instruction served as a model for the students. This guidance also included asking students to come to the board, work problems, and discuss their procedures. Through this process the students at their seats would see additional models.

The process of guiding practice also includes checking the answers of the entire class in order to see whether some students need additional instruction. Guided practice has also included asking students to work together, in pairs or in groups, to quiz and explain the material to each other. Guided practice may occur when a teacher questions and helps a class with their work before assigning independent practice.

Another reason for the importance of guided practice comes from the fact that we construct and reconstruct knowledge. We do not, we cannot, simply repeat what we hear word for word. Rather, we connect our understanding of the new information to our existing concepts or "schema" and we then construct a "gist" of what we have heard. However, when left on their own, many students make errors in the process of constructing this gist. These errors occur, particularly, when the information is new and the student does not have adequate or well-formed background knowledge. These constructions are not errors so much as attempts by the students to be logical in an area where their background knowledge is weak. These errors are so common that there is a literature on the development and correction of student misconceptions in science (Guzzetti, Snyder, & Glass, 1992). When students are left on their own, without the guidance of someone who understands the new area, there is a danger that they will develop misconceptions. Providing guided practice, after teaching small amounts of new material, and checking for student understanding, are ways to limit the development of misconceptions.

Guiding practice also fits the cognitive processing findings on the need to provide for student processing. Guided practice is the place where the students, -- working alone, with other students, or with the teacher -- engage in the cognitive processing activities of organizing, reviewing, rehearsing, summarizing, comparing, and contrasting. However, it is important that *all* students engage in these activities. The least effective teachers often asked a question, called on one student to answer, and then assumed that everyone had learned this point. In contrast, the most effective teachers attempted to check the understanding of *all* students and to provide for processing by *all* students.

In summary, the most effective teachers differed from the others in that they (a) presented smaller amounts of material at any time and (b) guided student practice as students worked problems, (c) provided for student processing of the new material , (d) checked the understanding of all students, and (e) attempted to prevent students from developing misconceptions.

3. Provide for extensive practice. The most effective teachers also provided for extensive and successful practice. As noted in the cognitive processing research, students need extensive practice in order to develop well-connected networks. The most effective teachers made sure that such practice took place *after* there has been sufficient guided practice, so that students were not practicing errors and misconceptions.

III. The teaching of cognitive strategies.
The third, major instructional development in the last 30 years has been the concept of cognitive strategies. Cognitive strategies are guiding procedures that students can use to help them complete less-structured tasks such as those in reading comprehension and writing. The concept of cognitive strategies and the research on cognitive strategies represent the third important advance in instruction.

There are some academic tasks that are "well-structured." These tasks can be broken down into a fixed sequence of subtasks and steps that consistently lead to the same goal. The steps are concrete and visible. There is a specific, predictable algorithm that can be followed, one that enables students to obtain the same result each time they perform the algorithmic operations. These well-structured tasks are taught by teaching each step of the algorithm to students. The results of the research on teacher effects are particularly relevant in helping us learn how teach students algorithms they can use to complete well-structured tasks.

In contrast, reading comprehension, writing, and study skills are examples of less-structured tasks -- tasks that cannot be broken down into a fixed sequence of subtasks and steps that consistently and unfailingly lead to the goal. Because these tasks are less-structured and difficult, they have also been called higher-level tasks. These types of tasks do not have the fixed sequence that is part of well-structured tasks. One cannot develop algorithms that students can use to complete these tasks. < /P>

Until the late 1970's, students were seldom provided with any help in completing less-structured tasks. In a classic observational study of reading comprehension instruction, Durkin (1979) noted that of the 4,469 minutes she observed in reading instruction in grade 4, only 20 minutes were spent in comprehension instruction by the teacher. Durkin noted that teachers spent almost all of the instructional time *asking* students questions, but they spent little time *teaching students comprehension strategies* they could use to answer the questions. Duffy, Lanier, and Roehler (1980) noted a similar lack of comprehension instruction in elementary classrooms:

There is little evidence of instruction of any kind. Teachers spend most of their time assigning activities, monitoring to be sure the pupils are on task, directing recitation sessions to assess how well children are doing and providing corrective feed back in response to pupil errors. Seldom does one observe teaching in which a teacher presents a skill, a strategy, or a process to pupils, shows them how to do it, provides assistance as they initiate attempts to perform the task and assures that they can be successful (p. 4).

As a result of these astonishing findings, and as a result of emerging research on cognition and information processing, investigators began to develop and validate procedures that students might be taught to aid their reading comprehension. In the field of reading, the research consisted of developing and teaching students to use specific cognitive strategies that help them to perform higher-level operations in reading. Other research focused on developing, teaching, and testing cognitive strategies that are specific to writing, mathematical problem solving, and science comprehension.

The research design usually consisted of the investigator locating or developing a cognitive strategy such as teaching students to generate questions about the material they have read. Then one group of students would be taught this strategy and would practice using this strategy; they would practice generating questions and answering other students' question. Another group of similar students continued with their regular lessons.

After period of four to twenty groups, both groups would take a comprehension test and the scores of the two groups were compared. This section focuses on the results of those intervention studies in which cognitive strategies were developed and taught.

Cognitive strategies are heuristics. A cognitive strategy is not a direct procedure; it is not an algorithm to be precisely followed. Rather, a cognitive strategy is a heuristic or guide that serves to support or facilitate the learner as she or he develops internal procedures that enable them to perform the higher level operations. Teaching students to generate questions about their reading is an example of a cognitive strategy. Generating questions does not directly lead, in a step-by-step manner , to comprehension. Rather, in the process of generating questions, students need to search the text and combine information, and these processes serve to help students comprehend what they read.

In the late 1970's, investigators began to teach students specific cognitive strategies such as question-generation and summarization that could be applied to reading comprehension (Paris, Cross & Lipson, 1984; Raphael & Pearson, 1985; Alvermann, 1981). Cognitive strategy procedures have also been developed and taught in mathematics problem solving (Schoenfeld, 1985), physics problem solving (Larkin & Reif, 1976), and in writing (Englert & Raphael, 1989; Scardamalia & Bereiter, 1985).

The concept of cognitive strategies represents at least two instructional advances. First, when teachers are faced with difficult areas they can now ask "What cognitive strategies might I develop that can help students complete these tasks?" The concept of cognitive strategies provides us with a general approach that can be applied to the teaching of higher-order tasks in the content areas. Second, researchers have completed a large number of intervention studies in which students who were taught various cognitive strategies obtained significantly higher posttest scores than did students in the control groups. The cognitive strategies that were taught in these studies and the procedures by which these cognitive strategies were taught can now be use d as part of regular instruction. These intervention studies, in reading, writing, mathematics, and science, together with a description of the cognitive strategies and the instructional procedures were used, has been assembled in an excellent volume by Pressley et al. (1995)

We can be proud of our progress as a profession. In place of Durkin's observation that there was little evidence of cognitive strategy instruction in reading, we now have a large number of intervention studies, studies that have been successful in providing instruction in cognitive strategies in a number of domains.

Instructional Elements in the Teaching of Cognitive Strategies

How have cognitive strategies been taught? This section attempts to identify and discuss the instructional elements that have been used to teach cognitive strategies. It is hoped that a knowledge of these elements might add to our knowledge of instruction and might be applied to the teaching of other cognitive strategies. Such information might serve as an aid that teachers can use to help teach cognitive strategies to their students.

Scaffolds

Cognitive strategies cannot be taught directly, as one teaches an algorithm. Rather, cognitive strategies are taught by providing students with a variety of support structures or *scaffolds* (Palincsar & Brown, 1984; Wood, Bruner, & ; Ross, 1976). Many of these instructional elements to be described here serve as scaffolds for the learner. A scaffold is a temporary support used to assist a learner during initial learning. This support is usually provided by the teacher to help students bridge the gap between current abilities and the goal. Examples of scaffolds include simplified problems, modeling of the procedures by the teacher, thinking aloud by the teacher as he or she solves the problem, prompts, suggestions, and guidance as students work problems. Scaffolds may also be tools, such as cue cards or checklists. A model of the completed task against which students can compare their work is another example of such support (Collins, Brown, & Newman, 1990; Palincsar & Brown, 1984). Cognitive apprenticeship, (Collins et al., 1989) is a term for instructional process by which teachers provide and support students with scaffolds as the students develop cognitive strategies.

Scaffolds operate to reduce the complexities of the problems and break them down into manageable chunks that the child has a real chance of solving (Bickhard, 1992). "The metaphor of a scaffold captures the idea of an adjustable and temporary suppo rt that can be removed when no longer necessary" (Brown & Palincsar, 1989, p. 411). The scaffolds assist the learner in learning a cognitive process and are gradually withdrawn or faded as learners become more independent, although some students may continue to rely on scaffolds when they encounter particularly difficult problems.

Scaffolds can be applied to the teaching of all skills, but they are particularly useful, and often indispensable, for teaching higher-level cognitive strategies. A number of investigators (Collins, Brown & Newman, 1990; Pressley et al., 19 95; Rosenshine & Meister, 1994) have studied the intervention studies and identified instructional procedures that teachers might use to teach cognitive strategies. Through this process, thirteen major instructional elements were identified. These are listed in Table 2 .

The search of this literature, in which we looked for the on instructional procedures that were used to teach cognitive strategies, led to the identification of scaffolds, such as cue cards, as well as the identification of other instructional procedures such as extensive independent practice. These elements are described and discussed below.

1. Provide Procedural Prompts or Facilitators.
In these studies, the first step in teaching a cognitive strategy was the development of a *procedural prompt.* These procedural prompts (or procedural facilitators, a term used by Scardamalia & Bereiter, (1985)) supply the students with specific procedures or suggestions that facilitate the completion of the task. Learners can temporarily rely on these hints and suggestions until they create their own internal structures (Scardamalia & Bereiter, 1985). For example, the words "who," "what" "why" "where" "when" and "how" are procedural prompts that help students learn the cognitive strategy of asking questions about the material they have read. These prompts are concrete references on which students can rely for support as they learn to apply the cognitive strategy.

Another example of procedural prompts comes from a study by King (1990), where students were provided with and taught to use a list of question stems that served to help the students form questions about a particular passage:

How are _____ and _____ alike?

What is the main idea of __________?

What do you think would happen if __________?

What are the strengths and weakness of __________ ?

In what way is _____ related to ______ ?

How does _____ affect _____?

Compare _____ and _____ with regard to _____.

What do you think causes __________?

How does _____ tie in with what we have learned before?

Which one is the best _____ and why?

What are some possible solutions for the problem of _____?

Do you agree or disagree with this statement: __________? Support your answer.

What do I (you) still not understand about . . .? (p. 667).

Procedural prompts are scaffolds that are specific to the cognitive strategy. Procedural prompts have been used, successfully, in a variety of content areas. Prompts have been used to assist teaching the strategy of summarization (Alvermann, 1981; Baumann, 1984) and writing (Englert & Raphael, 1989; Scardamalia & Bereiter, 1985). Procedural prompts have also been used to assist college students to solve problems in physics (Larkin & Reif, 1976; Hiller & Hungate, 1985) and mathematic al problem solving (Schoenfeld, 1985). Pressley and his associates (1995) have compiled a summary of research on instruction in cognitive strategies in reading, writing, mathematics, vocabulary, and science, and in almost all of these studies, the student learning was mediated through the use of procedural prompts.

Procedural prompts are an important concept that might be applied to the teaching of a variety of cognitive strategies. Procedural prompts are discussed in more detail in a later section.

2. Teach the cognitive strategy using small steps.
An earlier idea, which came from the teacher effects literature, the importance of teaching new material in small steps, also appears in the research on teaching cognitive strategies. When teaching cognitive strategies, it is easier for the learner if cognitive strategy is taught in small steps because teaching too much of the cognitive strategy at once would swamp the working memory. This idea of teaching in small steps, then, has extensive support. It fits the research on cognitive processing on the limitations of the working memory, it was also derived from studying the classrooms of the teachers who obtained the highest achievement gain, and it was also an instructional procedure that was used in intervention studies to teach students cognitive strategies.

3. **Provide Models of the Appropriate Responses.**
Modeling is particularly important when teaching cognitive strategies because we cannot specify all the steps in these strategies. Therefore, models provide an important scaffold for the learner. Almost all of the researchers in these studies provided models of how to use the procedural prompt they had selected or developed. Models and/or modeling were used at three different places in these studies: (a) during initial instruction, before students practiced, b) during practice, and c) after practice. Each approach is discussed here.

Models during initial instruction. In some studies, the teachers began by modeling responses based on the procedural prompts. Nolte and Singer (1985), for example, provided students with questions based on elements of the story grammar (e.g., What action does the leading character initiate? What do you learn about the character from this action?). Then they began by modeling questions based on this story grammar. In other studies, students received models of questions based on the main idea and then practiced generating questions on their own (Andre & Anderson, 1978-79; Dreher & Gambrell, 1985; MacGregor, 1988),

Models given during practice. Models were also provided *during* practice. Such modeling is part of reciprocal teaching (Palincsar & Brown, 1984; Palincsar, 1987). In reciprocal teaching, the teacher first models askin g a question and the students answer. Then, the teacher guides students as they develop their own questions, to be answered by one of their classmates, and the teacher provides additional models when the students have difficulty. Other studies also provided models during practice (Braun, Rennie, and

Labercane, 1985; Gilroy and Moore, 1988; Helfeldt and Lalik, 1976; Labercane and Battle, 1987; Manzo, 1969).

Models given after practice. In studies on question-generation, teachers also provided models of questions for the students to view *after* they had written questions relevant to a paragraph or passage (Andre & Anderson, 1978-79; Dreher & Gambrell, 1985; MacGregor, 1988). The intent of this model was to enable the students to compare their efforts with that of an expert (Collins, Brown, & Newman, 1990).

4. Think Aloud as Choices are Being Made.

Another scaffold, similar to modeling, is *thinking aloud*, that is, the vocalization of the internal thought processes one goes through when using the cognitive strategy. For example, when teaching students to generate questions, the teacher describes the thought processes that occur as a question word is selected and integrated with text information to form a question. A teacher might think aloud while summarizing a paragraph, illustrating the thought processes that occur as the topic of the passage is determined and then used to generate a summary sentence.

Anderson (1991) provides illustrations of thinking aloud for several cognitive strategies in reading:

1. For clarifying difficult statements or concepts:

I don't get this. It says that things that are dark look smaller. I know that a white dog looks smaller than a black elephant, so this rule must only work for things that are about the same size. Maybe black shoes would make your feet look smaller than white ones would.

2. For summarizing important information:

I'll summarize this part of the article. So far, it tells where the Spanish started in North America and what parts they explored. Since the title is "The Spanish in California," the part about California must be important. I'd sum up by saying that Spanish explorers from Mexico discovered California. They didn't stay in California, but lived in other parts of America. These are the most important ideas so far.

3. For thinking ahead:

So far this has told me that Columbus is poor, the trip will be expensive, and everyone's laughing at his plan. I'd predict that Columbus will have trouble getting the money he needs for his exploration.

As individual students accepted more responsibility in the completion of a task, they often modeled and thought aloud for their less capable classmates. Not only did student modeling and think alouds involve the students actively in the process, but it allowed the teacher to better assess student progress in the use of the strategy. Thinking aloud by the teacher and more capable students provided novice learners with a way to observe "expert thinking" which is usually hidden from the student. Indeed, identifying the hidden strategies of experts so that they can become available to learners has become a useful area of research (Collins et al., 1989).

"Thinking aloud" by the teacher while solving problems is an important scaffold that has been used when teaching students higher-level cognitive strategies. Garcia and Pearson (1990) refer to this process as the teacher "sharing the reading secrets " by making them overt. Thinking aloud is also an important part of a cognitive apprenticeship model (Collins, Brown, & Newman, 1990). Thinking aloud was only described in one study, that of Ritchie (1985) who had "the teacher model the thinking involved in each step for finding the main idea" (p. 3).

5. Anticipate and Discuss Potential Difficulties.
Another instructional scaffold found in these question-generation studies was anticipating the difficulties a student is likely to face. In some studies, the instructor anticipated common errors that students might make and spent time discussing these errors *before* the students made them**.** For example, in a study by Palincsar (1987) the teacher anticipated the inappropriate questions that students might generate. The students read a paragraph followed by three questions one might ask about the paragraph. The students were asked to look at each example and decide whether or not that question was about the most important information in the paragraph. In one choice, the children were shown a question that could not be answered by the information provided in the paragraph, and the students discussed why it was a poor question. In another choice, the students were shown a question that was too narrow, that focused only on a small detail, and the students discussed why it was a po or question. The students continued through the exercise discussing whether each question was too narrow, too broad, or appropriate.

Another example of anticipating problems occurred in the study by Cohen (1983) where the students were taught specific rules to discriminate (a) a question from a non-question and (b) a good question from a poor one:

A good question starts with a question word.

A good question can be answered by the story.

A good question asks about an important detail of the story.

Although only two studies discussed this scaffold of anticipating student difficulties, (Cohen, 1983; Palincsar, 1987), this technique seems potentially useful and might be used for teaching other skills, strategies, and subject areas.

6. Regulate the Difficulty of the Material.
Some of the investigators attempted to regulate the difficulty of the material. Some did this by having the students begin with simpler material and then gradually move to more complex materials. For example, when Palincsar (1987) taught students to generate questions, the teacher first modeled how to generate questions about a single *sentence*. This was followed by class practice. Next, the teacher modeled and provided practice on asking questions after reading a *paragraph*. Finally, the teacher modeled and then the class practiced generating questions after reading an entire *passage*.

Similarly, in studies by Andre and Anderson (1978-1979) and Dreher and Gambrell (1985) the students began with a single paragraph, then moved to a double paragraph, and from there to a 450 word passage. Another example comes from the study by Wong, Wong, Perry, and Sawatsky (1986). Here, students began by generating questions about a single, simple paragraph. When the students were successful at that task, they moved to single, complex paragraphs and, lastly, to 800 word selections from social studies texts.

In another study, (Wong & Jones, 1982) the researchers regulated the difficult of the task by *decreasing* the prompts. First, students worked with a paragraph using procedural prompts. After they were successful at that level, they were moved to a passage with prompts and finally to a passage *without* prompts.

7. Provide a Cue Card.
Another scaffold was the provision of a cue card containing the procedural prompt. A cue card might support a student during initial learning by reducing the strain upon the working memory. With a cue card, students can put of their limited short-term memory into the application of the strategy instead of having to use some short-term memory to store the procedural prompts. One example appeared in a study by Billingsley and Wildman (1984), who provided students with cue cards listing the signal words (e.g., who, what, why...) which could be used as prompts for generating questions. Singer and Donlan (1982) presented a chart listing

the five elements of a story grammar which the students were taught to use as prompts for generating questions. Wong and Jones (1982) and Wong et al. (1986) gave each student a cue card which listed the steps in developing a question about the main idea. In all four of these studies, the investigators modeled the use of the cue card.

Cue cards were also used in studies where students were provided with generic questions. In these studies (Blaha, 1979; Wong et al., 1986) students were provided cue cards listing specific questions to ask after they had read paragraphs and passage s (e.g., "What's the most important sentence in this paragraph?"), and King (1989, 1990, 1992) provided students with question stems (e.g., How are ___ and ___ alike?; What is a new example of ...?).

8. Guide Student Practice

In many of these studies, the teacher guided the students during their initial practice. Typically, after the modeling, the teacher guided students during their initial practice. As they worked through text. the teacher gave hints, reminders of the prompts, reminders of what was overlooked, and suggestions of how something could be improved (Cohen, 1983; Palincsar, 1987; Wong et al., 1986). This guided practice was often combined with the presentation, as in the study by Blaha (1979) where the teacher first taught a part of a strategy, then guided student practice in identifying and then applying the strategy, then taught the next part of the strategy, and then guided student practice. This type of guided practice is the same as the guided practice that emerged from the teacher effects research (Rosenshine & Stevens, 1986).

The reciprocal teaching setting is another example of guided practice. As noted earlier, in reciprocal teaching the teacher first models the cognitive process being taught and then provides cognitive support and coaching (scaffolding) for the students as they attempt the task. As the students become more proficient, the teacher fades the support and students provide support for each other. Reciprocal teaching is a way of modifying the guided practice so that students take a more active role, eventually assuming the role of co-teacher.

A third form of guided practice occurred when students met in small groups of two to six, without the teacher, and practiced asking, revising, and correcting questions and provided support and feedback to each other (Nolte & Singer, 1985; King , 1989; King, 1990, King, 1992; Singer & Donlan, 1982). Such groupings allow for more support when revising questions and for more practice than can be obtained in a whole-class setting. Nolte and Singer (1985) applied the concept of diminishing support to the organization of groups. Here, students first spent three days working in groups of 5 or 6, then three days working in pairs, and eventually working alone.

9. Provide Feedback and Corrections

Providing feedback and corrections to the students most likely occurred in all studies, but was explicitly mentioned in only a few. In these studies, there were three sources of feedback and corrections: the teacher, other students, and a computer.

Teacher feedback and corrections occurred during the guided practice as students attempted to generate questions. Feedback typically took the form of hints, questions, and suggestions. A second form of feedback, group feedback was illustrated in the three studies by King (1989, 1990, 1992) and in a study by Ritchie (1985). In the King studies, after students had written their questions, they met in groups, posed questions to each other, and compared questions within each group. The third type of feedback, computer-based, occurred in the computer-based instructional format designed by MacGregor (1988). In this study students asked the computer to provide a model of an appropriate question when they made an error.

10. Provide and Teach a Checklist.

In some of the studies, students were taught to use another scaffold, a self-evaluation checklist. In a study by Davey and McBride (1986) a self-evaluation checklist was introduced in the fourth of five instructional sessions. The checklist listed the following questions:

How well did I identify important information?

How well did I link information together?

How well could I answer my questions?

Did my "think questions" use different language from the text?

Did I use good signal words?

Wong and Jones (1982) wrote that students in their study were furnished with the "criteria for a good question," although these criteria were not described in the report. In the three studies by King (1989, 1990, 1992) students were taught to ask themselves the question "What do I still not understand?" after they had generated and answered their questions.

There were differences between the studies with regard to when checklists were introduced into a lesson. Wong and Jones and King presented checklists during the presentation, while Davey and McBride (1986) presented them during the guided practice, and Ritchie presented them after initial practice.

11. Provide Independent Practice with New Examples
Independent practice refers to student practice in applying the cognitive strategy with diminishing help from the teacher and other students. One goal of the independent practice is to develop automatic responding so the students no longer have to recall the strategy and thus, more of their limited working memory can be applied to the task. Another goal of independent practice is to achieve "unitization" of the strategy, that is, the blending of elements of the strategy into a unified whole. This unitization is usually the result extensive practice, practice that help students develop an automatic, unified approach. This extensive practice, and practice with a variety of material also decontextualizes the learning. That is, the strategies become free of their original "bindings" and can now be applied easily and unconsciously to various situations (Collins, Brown, & Newman, 1989).

Another purpose of independent practice is to facilitate transfer to other content areas. One hopes that the reading comprehension skills that are taught in one content area, such as social studies, might also be applied to another content areas su ch as science. Such transfer might be facilitated if students receive guided practice in applying their skills to *different* content areas. For example, in a study by Dermody (1988) the last phase of the study involved application of cognitive strategy to a different content area that was used for the original instruction.

12. Increase Student Responsibilities.
As students become more competent, during guided practice and independent practice, the scaffolds are diminished and student responsibilities are increased. Thus, as students become more competent, the teacher diminishes the use of models and prompts and other scaffolds, diminishes the support offered by other students. In addition, the complexity and difficulty of the material is gradually increased. In reading, for example, one begins with well-organized, reader-friendly material and then increases the difficulty of the material. That way, students receive practice and support in applying their strategies to the more difficult material they can expect to encounter in their regular reading.

13. Assess Student Mastery
After guided practice and independent practice, some of the studies assessed whether students had achieved a mastery level, and provided for additional instruction when necessary. On the 5th and final day of instruction, Davey and McBride, (198 6) required students to generate three acceptable questions for each of three passages. Smith (1977) stated that student questions at the end of a story were compared to model

questions, and reteaching took place when necessary. Wong, Wong, Perry, and Sawatsky (1986) required that students achieve mastery in applying the self-questioning steps and students had to continue doing the exercises (sometimes daily for two months) until they achieved mastery. Unfortunately, the other studies cited in this review did not report the level of mastery students achieved in generating questions.

Fitting Things Together

How might the results from these three areas of research fit together?

First, the research allows us to articulate a major goal of education: helping students develop well-organized knowledge structures. In well-developed structures the parts are well-organized, the pieces are well-connected, and the bonds between the connections are strong.

We also know something about how to help students acquire these structures.

1. Present new material in small steps to that the working memory does not become overloaded.

2. Help students develop an organization for the new material.

3. Guide student practice by (a) supporting students during initial practice, and (b) providing for extensive student processing.

4. When teaching higher-level tasks, support students by providing them with cognitive strategies.

5. Help students learn to use the cognitive strategies by providing them with procedural prompts and modeling the use of these procedural prompts.

6. Provide for extensive student practice.

Summary

Thirty years ago, particularly with the publication of the first Handbook of Research on Teaching (Gage, 1963) and the investment of public and private funds into research, we began an extensive program of research and development in education. This article is an attempt to highlight some of the major results that have been obtained in the area of instruction, results which have relevance for today's teachers and students.

Table 1

Functions for Teaching Well-Structured Tasks

1. Review
Review homework

Review relevant previous learning

Review prerequisite skills and knowledge for the lesson

2. Presentation
State lesson goals or provide outline

Present new material in small steps

Model procedures

Provide positive and negative examples

Use clear language

Check for student understanding

Avoid digressions

3. Guided Practice
Spend more time on guided practice

High frequency of questions

All students respond and receive feedback

High success rate

Continue practice until students are fluent

4. Corrections and Feedback
Provide process feedback when answers are correct but hesitant

Provide sustaining feedback, clues, or reteaching when answers are incorrect

Reteach material when necessary

5. Independent practice
Students receive overview and/or help during initial steps

Practice continues until students are automatic (where relevant)

Teacher provides active supervision (where possible)

Routines are used to provide help for slower students

6. Weekly and monthly reviews

Table 2.

Instructional Elements Used in the Teaching of Cognitive Strategies.

1. Provide procedural prompts specific to the strategy being taught.

2. Teach the cognitive strategy using small steps.

3. Provide models of appropriate responses.

4. Think aloud as choices are being made

5. Anticipate potential difficulties.

6. Regulate the difficulty of the material.

7. Provide a cue card.

8. Guide student practice.

9. Provide feedback and corrections.

10. Provide and teach a checklist.

11. Provide independent practice

12. Increase student responsibilities.

13. Assess student mastery.

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