9: CONVERGING FINDINGS ON CLASSROOM INSTRUCTION

EXECUTIVE SUMMARY

SUMMARY OF RESEARCH FINDINGS

The past 30 years have seen major advances in research on cognitive processing; in studies of teachers whose classes made the highest achievement gains compared to other classes; and in research on helping students learn and apply cognitive strategies in their learning. The research on cognitive processing underlies a major goal of education: helping students develop well-organized knowledge structures. A number of strategies have been found that consistently help students effectively acquire strong knowledge structures.

RECOMMENDATIONS

- Present new material in small steps so that the working memory does not become overloaded.
- Help students develop an organization for the new material.
- Guide student practice by supporting students during initial practice, and providing for extensive student processing.
- When teaching higher-level tasks, support students by providing them with cognitive strategies.
- Help students learn to use the cognitive strategies by providing them with procedural prompts and modeling the use of these procedural prompts.
- Provide for extensive student practice.

9: CONVERGING FINDINGS ON CLASSROOM INSTRUCTION

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The past 30 years have seen three major advances in research on instruction and teacher behavior. These advancements are:

1) research on cognitive processing,
2) studies of teachers whose classes made the highest achievement gain compared to other classes, and
3) research on helping students learn and apply cognitive strategies in their learning.

This report examines the impact that teacher behavior can have on the achievement of students, particularly of students living in poverty.

CLASSROOM INSTRUCTION RESEARCH

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. It is currently thought that the information in our long-term memory is stored in interconnected networks called knowledge structures. The size of these knowledge 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.

There is no underestimating the importance of background knowledge. Simon and Hayes wrote that "there is no substitute for having the prerequisite knowledge if one is to solve a problem."[1] In discussing how expertise is acquired, Chase and Chi wrote:

> The most obvious answer is practice, thousands of hours of practice. For the most part, practice is by far the best predictor of performance. Practice can produce two kinds of knowledge ... a storage of patterns and a set of strategies or procedures that can act on the patterns.[2]

It is easier to learn new information and easier to solve new problems when one has 1.) a rich, well-connected knowledge structure and 2.) stronger ties between the connections, 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. 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.[3]

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 space in our 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 more 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.[4]

To summarize, well-connected and elaborate knowledge structures are important because they allow for easier retrieval of old material; they permit more information to be carried in a single chunk, and they facilitate the understanding and integration of new information.

Helping Students Develop 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. These 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 reviews 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.

Providing 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, the quality of storage is stronger when we read a passage and focus on its meaning than it would be if we read to find a single word answer. Similarly, the quality of storage would be stronger if one summarized or compared the material in the passage, rehearsed, reviewed, and drew connections. The connections would be weaker if one hurriedly skimmed the material.

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. Classroom discussion and projects that require students to organize information, summarize information, or compare new material with prior material are all activities that should help students develop and strengthen their cognitive structures. In addition, Palincsar and Brown 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.[5]

Other examples of such processing activities include asking students to do any of the following: read a variety of materials; explain the new material to someone else; compare material from different sources; justify their conclusions; write papers and engage in inquiry; or write daily summaries.

Helping Students Organize Knowledge

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, there is the danger that students will develop a fragmented, incomplete, or erroneous knowledge structure.

Graphic Organizers

One way of helping students expand their knowledge structures in content areas and also allowing for a check on misconceptions is to teach students to use graphic organizers and develop concept maps. These structures allow a student to show connections between concepts. 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. Providing students with a variety of structures that they can use to construct their own graphic organizers facilitates this process. When teaching students to develop a graphic organizer, it is useful for the teacher to model the process and also provide models of thinking and thinking aloud while constructing the maps.

When students are encouraged to construct ideas and develop conclusions, there is also a danger they will develop misconceptions. Research shows we sometimes develop misconceptions in an effort to make sense of our environment.[6] (A notorious example is the belief that the sun is closer to the Earth during summer.) Allowing students to work independently before they are ready increases the danger that they may develop misconceptions. Therefore, teachers need to supervise students when they are working independently and to check their understanding before they begin independent work.

In summary, the research on cognitive processing has identified the importance of developing well-connected knowledge structures. Encouraging extensive reading and practice might develop such structures, student processing of new information, and helping students organize their new knowledge.

RESEARCH ON TEACHER EFFECTS

A second important body of research is the teacher effects studies. This line of research, which took place in the 1960s and 1970s, used extensive classroom observation in an attempt to identify those teacher behaviors that were most related to student achievement gain.

Design of the Studies

There were three parts to the design of these studies. The first part consisted of systematic observation of the instructional behaviors of teachers and students. Observers sat in a number of existing classrooms, usually 20 to 30 classrooms, and observed and recorded the frequency with which those teachers used a variety of instructional behaviors such as the cause, frequency, and type of praise, the cause frequency and type 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. Many investigators also recorded how much time was spent in activities such as review, presentation, guided practice, and supervising seatwork. Others recorded how the teachers prepared students for seatwork and homework, and the attention-level during teacher-led discussion and during seatwork.

At the end of the observation period or at the end of the semester, each class took a posttest in the subject that was observed, usually reading or mathematics. These class posttest scores were then statistically adjusted, using a variety of regression techniques, for initial or pretest scores of these students. That is, the pretest was used as the independent variable in the analysis, and was used to statistically adjust the posttest scores, the dependent variables, for initial standing. In the final step, each of the observed teacher and student behaviors, in each classroom were then, correlated with the adjusted posttest scores.

In effect, these are studies of master teachers. That is, based on the test scores, the investigators were able to identify those teachers whose classrooms made the greatest adjusted achievement gain during the semester, and those teachers whose classrooms made the least adjusted gain during the semester. The investigators were able to take the results of their systematic observation and use this to identify the instructional procedures that the master teachers used and compare these instructional procedures with those procedures used by the less-effective teachers. The significant results are described later in this section.

Usually 20-30 classrooms were in each study, although the study by Stallings and Kascovitz[7] involved 108 first grade and 58 third grade classrooms, and studies by Robert Soar and Ruth Soar involved 55 middle grade classrooms,[8] 59 fifth grade classrooms,[9] and 289 Follow-Through and comparison classrooms.[10]

Although a number of studies of this type were conducted as early as 1948 by Barr,[11] the two most famous studies that initiated the teacher-effects research were those by Flanders[12] and by Medley and Mitzel.[13] The best known of the later studies were those by Stallings and Kascovitz[14] in Follow-Through classrooms, Good and Grouws [15] in fourth-grade mathematics, and Brophy and Evertson[16] in first grade reading.

These correlational studies were frequently followed by experimental studies in which one group of teachers – the experimental group – was taught to use the findings of the correlational studies in their teaching and another group of similar teachers continued to teach in their usual manner. By and large, these studies were successful in that the teachers in the experimental groups used more of the new behaviors and the posttest scores of their classrooms – adjusted by regression for their initial scores – were significantly higher than scores in classrooms taught by the control teachers.

Rosenshine summarized the earliest studies in 1971.[17] The correlational studies and the experimental studies in this tradition are described in detail by Brophy and Good,[18] and the experimental studies are also described by Gage and Needles.[19]

<u>Validity</u>

One argument for the validity of these findings is that the correlational results were replicated in subsequent correlational studies. These studies represented cumulative research. Second, the correlational results were also replicated in a number of experimental studies. Finally, the instructional findings that emerged from this research also appear in an independent line of research, that of cognitive strategy instruction, a topic which will be covered later.

Rosenshine and Stevens concluded that those teachers whose classrooms made the greatest gains in reading or mathematics usually used the following procedures:[20]

- 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 individual exercises and, where necessary, monitor students during their individual work.

Rosenshine and Stevens further grouped these instructional procedures under six teaching "functions" as shown in Table 9.1.[21]

Table 9.1
FUNCTIONS FOR TEACHING WELL-STRUCTURED TASKS

1. Review
a) Review homework
b) Review relevant previous learning
c) Review prerequisite skills and knowledge for the lesson

2. Presentation
a) State lesson goals or provide outline
b) Present new material in small steps
c) Model procedures
d) Provide positive and negative examples
e) Use clear language
f) Check for student understanding
g) Avoid digressions

3. Guided Practice
a) Spend more time on guided practice
b) High frequency of questions
c) All students respond and receive feedback
d) High success rate
e) Continue practice until students are fluent

4. Corrections and Feedback
a) Provide process feedback when answers are correct but hesitant
b) Provide sustaining feedback, clues, or re-teaching when answers are incorrect
c) Re-teach material when necessary

5. Independent practice
a) Students receive overview and/or help during initial steps
b) Practice continues until students are automatic (where relevant)
c) Teacher provides active supervision (where possible)
d) Routines are used to provide help for slower students

6. Weekly and monthly reviews

SMALL STEPS, PRACTICE, AND SUCCESS

Four strategies that are particularly relevant to teaching are:

1) teaching in "small steps,"
2) guiding student practice,
3) ensuring a high student success rate, and
4) providing extensive practice.

Present New Material in Small Steps

When the most effective teachers in these studies taught new material, they taught it in "small steps." That is, they only presented small parts of new material at a single time, and then guided students in practicing this material. In contrast, the least effective teachers in these studies would present an entire lesson, and then pass out worksheets and tell students to work the problems.

The importance of teaching in small steps fits well with the findings from cognitive psychology on the limitations of our working memory. Our working memory, the place where we process information, is small. It can only handle a few bits of information at once – too much information swamps our working memory. The procedure of first teaching in small steps and then guiding student practice represents an appropriate way of dealing with the limitation of our working memory.

Guide Student Practice

A second major finding from the teacher effects literature was the importance of guided practice.[22]

As noted, the most effective teachers presented only small amounts of material at a time. After this short presenting, 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.

In contrast, the least effective teachers 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 and the teachers would be seen going from student to student and explaining the material. In this case, the amount of material that was presented was too large, and swamped the working memory.

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.

Guided 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.

Another reason for the importance of guided practice comes from the fact that we construct and reconstruct knowledge. 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 mental summary: “the gist” of what we have heard. However, when left on their own, many students make errors in the process of constructing this mental summary. 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. Providing guided practice after teaching small amounts of new material, and checking for student understanding, can help limit the development of misconceptions.

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.

Provide for a High Success Rate

In two of the major teacher-effects studies the investigators found that students in classrooms of the more effective teachers had a higher success rate as judged by the quality of their oral responses and their individual work. The need for a high success rate follows from the previous research on the need to provide extensive and successful practice.

Yet, teachers often struggle to obtain a high success rate, particularly when they are teaching whole-class to heterogeneous students. One solution is the above-mentioned “teaching in small steps.” Another solution is for students to meet in heterogeneous groups during the independent practice and work problems together. In these settings, students who have learned the material re-explain the material to the other students.

Other schools have dealt with this problem by regrouping students, by achievement, across classrooms, for reading and for mathematics. In such settings, it is easier for the teachers to explain, supervise, and re-teach to the entire class because all the students in this setting are at similar levels.

The need for a high success rate, and the need for students to master one step before they proceed to the next step is the major idea behind Mastery Learning. In Mastery Learning there is explicit provision for bringing all students to mastery on one section of the material before they proceed to the next section.

TEACHING COGNITIVE STRATEGIES

The third, major instructional advance has been the development and teaching of cognitive strategies. Cognitive strategies are guides that support learners as they develop new internal procedures, procedures that enable them to perform higher-level operations in areas such as reading comprehension and scientific problem solving.

Until the late 1970s, students were seldom provided with any help in reading comprehension. Durkin[23] observed 4,469 minutes of reading instruction in fourth-grade classrooms and noted that only 20 minutes of this total was spent in comprehension instruction. Durkin found that teachers spent almost all of the instructional time asking questions, but spent little time teaching students comprehension strategies they could use to answer the questions. Duffy and Roehler[24] 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 feedback 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.[25]

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 cognitive strategies that could help students. For example, one approach that has been used successfully to help students improve their reading comprehension has been to teach students to ask themselves questions about their reading. In these studies students would read passages and use prompts such as "who" and "why" to ask questions about the passage. And, as a result of this practice, comprehension improved when the students were tested on new passages.

What happened? Asking oneself a question, obviously, does not lead directly to improved comprehension on new passages. Rather, it is believed that the process of asking questions changed the way students read – it led them to search the text and combine information – and it was this change in processing that led to improved comprehension on new passages.

Throughout the 1980s, investigators began to develop and teach students specific cognitive strategies such as question-generation and summarization that could be applied to reading comprehension.[26] Cognitive strategy procedures have also been developed and taught in mathematics problem solving,[27] physics problem solving,[28] and in writing.[29] 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.[30]

The concept of cognitive strategies provides a general approach that can be applied to the teaching of higher-order tasks in the content areas. The profession has made much progress. In place of Durkin's observation that there was little evidence of cognitive strategy instruction in reading, there are now studies that have succeeded in providing instruction in cognitive strategies in a number of content areas.

Instructional Elements in Teaching of Cognitive Strategies

The process of teaching students cognitive strategies is distinctive in that the investigators used a variety of supports, or scaffolds, to teach students to use the strategies. Many of these instructional elements had not appeared in the teacher-effects literature. These elements – which are described in this section – can now be used by teachers, profitably, to help students not only in the learning of cognitive strategies, but also in variety of other learning situations.

Scaffolds

Cognitive strategies are taught by providing students with cognitive supports or scaffolds.[31] A scaffold is a temporary support that is used to assist a learner during initial learning. 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.[32] Scaffolds help students bridge the gap between their current abilities and the goal. The scaffolds are gradually withdrawn as learners become more independent, although some students may continue to rely on scaffolds when they encounter particularly difficult problems. 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, or a model of the completed task against which students can compare their work.[33]

Collins, Brown, and Neuman originated the term Cognitive Apprenticeship to refer to the entire process of teaching cognitive strategies and providing scaffolds to aid students.[34] Students are learning strategies during this apprenticeship that will enable them to become competent readers, writers, and problem solvers. They are aided by a Master who models, coaches, provides supports, and withdraws the supports and scaffolds as the students become independent.

A number of these supports and scaffolds, drawn from the research, are presented here.

1) Provide Procedural Prompts That Can Guide Student Processing.

In these studies, the first step in teaching a cognitive strategy was the development of a procedural prompt.[35] Procedural prompts are concrete aids that 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.[36]

As noted, 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.[37] 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,[38] who also taught students to generate questions. In her studies, however, she provided students with a list of question stems:

How are _____ and _____ alike?
What is the main idea of __________?
What do you think would happen if __________?
What are the strengths and weaknesses of __________ ?
In what way is _____ related to ______?
What do you think causes __________?
How does _____ tie in with what we have learned before?
What do I (you) still not understand about . . .?

Students practiced in groups, using these stems to ask each other questions about passages. King found that students who practiced using these prompts were superior to control students in comprehension of new material. Apparently, using these stems to develop and answer questions led the students to develop new internal approaches to reading text, and these approaches helped them when they now read new material.

A wide variety of excellent procedural prompts have been developed for reading comprehension, for writing, and for vocabulary. Investigators have also developed a number of “concept maps” and “graphic organizers” that have been shown to help students learn from text. Twenty-four of these procedural prompts and details on their use – mostly derived from successful studies – have been assembled in a useful book published by the Wisconsin State Department of Public Instruction.[39]

2) Demonstrate use of the prompt through modeling and thinking aloud.

On one hand, demonstration of use of the procedural prompts is similar to traditional demonstrations by a teacher. What is new is the addition of two cognitive supports: modeling of the cognitive strategy, and "thinking aloud" that provides an insight into how experts solve problems. These supports would seem useful in a variety of instructional situations.

Provide Models of the Appropriate Responses

The literature on cognitive strategies has introduced us to the concept of a teacher modeling appropriate responses. Excellent teachers have undoubtedly modeled difficult learning for centuries, but it was the cognitive strategy literature that highlighted this important instructional procedure.

As noted, prompts were "who," "what" and "where," then a teacher would model questions starting with those words. This modeling occurred at the start of the lessons and also during the lesson when students were having problems developing questions.[40]

Modeling is particularly appropriate when using prompts for writing essays or arguments. The author once watched a class where the teacher spent the entire period modeling and leading the class as he completed an essay prompt using material from the play *Macbeth*, which the class had read and discussed. The next day, he led the class as they completed the prompt using a second argument. The third day, he supervised the students as they worked alone and used the prompt to develop a third argument.

Think Aloud, as Choices are Being Made

Another scaffold, similar to modeling, is thinking aloud: literally vocalizing the internal thought processes one goes through when using the cognitive strategy. A teacher might think aloud while summarizing a paragraph – illustrating the thought processes that occur as one first determines the topic of the paragraph then uses the topic to generate a summary sentence.

Thinking aloud by the teacher and more capable students provides novice learners with a way to observe "expert thinking" that is usually hidden from the student. Garcia and Pearson (1990) refer to this process as the teacher "sharing the reading secrets" by making them overt.[41] Indeed, identifying the hidden strategies of experts so that they can become available to learners has become a useful area of research.[42]

Anderson[43] worked with adolescent readers who were competent decoders but poor in comprehension. These readers were reluctant to identify or to attempt to solve problems that occurred during their reading. The students met in groups, read somewhat difficult passages, and attempted to make sense of the passages. Anderson illustrated the procedure she was trying to teach by modeling how one might attempt to clarify a difficult passage:

> 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.
>
> Anderson also modeled how they might summarize 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) Guide Initial Practice through Techniques That Reduce the Difficulty of the Task.

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.[44]

Much of this guided practice is similar to the guided practice that emerged from the teacher effects research.[45] Now, however, the guided practice is being applied to the learning of higher-level tasks. A number of investigators also developed procedures that facilitate practice by reducing the initial demands on the students. These procedures, described next, would seem useful for teaching a variety of skills, strategies, and concepts, not just those illustrated here.

Regulate the Difficulty of the Task

One approach to guided practice has been to regulate the difficulty of the material by having the students begin with simpler material and then gradually move to more complex materials. For example, when Palincsar taught students to generate questions, the teacher first modeled how to generate questions about a single sentence.[46] 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. Similar procedures were used by other investigators.[47]

The same simple to complex procedure was used to teach the strategy of summarizing.[48] Students first learned to write summaries of single paragraphs, and then progressed, with guidance and modeling from the teacher, to producing a summary of longer passages.

In another study where summarization was taught, the initial difficulty was reduced by starting the practice with material that was one or two grade levels below the students' reading level.[49] In a study by Blaha,[50] the teacher divided up the strategy. She first taught a part of a strategy, then guided student practice in first identifying and then applying the strategy. After that, the teacher taught the next part of the strategy, and guided student practice. Finally, the parts of the strategy were combined. In many of these studies, the prompts were diminished after students had learned the task. In all these examples, the initial difficulty of the higher-level task was reduced by beginning with simpler materials or by teaching the strategy in small steps.

Anticipate and Discuss Potential Difficulties

One characteristic of experienced teachers is their ability to anticipate student errors prior to instruction and then focus instruction around these potential problems. This practice occurred in some of these studies. For example, in a study by Palincsar the teacher anticipated the inappropriate questions that students might generate.[51] After the students had read a paragraph, 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 poor question. The teacher then showed the students a question that could not be answered by the information provided in the paragraph, and the students discussed why it was a poor question. They continued through the exercise discussing whether each question was too narrow, too broad, or appropriate.

Provide a Cue Card when Appropriate

Another support used in these studies was providing 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. In a number of studies, the students were given cards that contained the procedural prompts. In all these studies, the investigators modeled the use of the cue card.

4) Provide Feedback and Self-Checking Procedures.

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.

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[52] 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?

In another study[53] the students were taught specific rules to discriminate a question from a non-question and 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.

Provide Models of Expert Work

In some studies, students would view an expert's model after they had completed their own work.[54] The intent of this model was to enable the students to compare their efforts with that of an expert.[55]

Suggest Fix-Up Strategies

Fix-up strategies are strategies students learn to use when their writing or reading or project is not going well. In two studies, student reading comprehension improved when they were taught fix-up strategies.[56] Some of the fix-up strategies that were taught included:

Re-read the difficult portion of the text.
Read ahead to see if the problems clear up.
Formulate the difficulty as a problem.

These strategies came from studies of expert readers, and teaching these strategies resulted in improved comprehension.

Feedback in Groups

Another 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.[57] 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 applied the concept of diminishing support to the organization of groups.[58] Students first spent three days working in groups of five or six, followed by three days working in pairs, and then began to work alone.

5) Provide Independent Practice with New Examples

Extensive and successful independent practice is required for learning cognitive strategies. Such practice can lead to "automatic responding," which means that the students use the strategy automatically and do not have to stop to recall it. Another result of extensive practice is "unitization" of the strategy, that is, the blending of elements of the strategy into a unified whole. This extensive practice, and practice with a variety of material, also frees the learning from its original limited context so that it can be applied easily and unconsciously to various situations.[59] One can also practice transfer during independent practice. For example, in a study by Dermody[60] the last phase of the study involved application of cognitive strategy to a different content area than was used for the original instruction.

<u>Increase Student Responsibilities</u>

As students become more competent during guided practice and independent practice, the teacher diminishes the use of models and prompts and other scaffolds, and also diminishes the support offered by other students. The responsibilities of the individual student and the complexity and difficulty of the material are 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.

<u>Assess Student Mastery</u>

After guided practice and independent practice, some of the studies assessed whether students had achieved a mastery level, and provided for additional instruction if that level had not been reached. On the fifth and final day of instruction, Davey and McBride required students to generate three acceptable questions for each of three passages and re-teaching was provided.[61] Smith stated that student questions at the end of a story were compared to model questions, and re-teaching took place when necessary.[62] Wong, Wong, Perry, and Sawatsky required that students achieve mastery in applying the self-questioning steps; students had to continue doing the exercises, with assistance, until they achieved mastery.[63] Unfortunately, the other studies cited in this review did not report the level of mastery students achieved in generating questions.

Table 2
INSTRUCTIONAL ELEMENTS IN TEACHING COGNITIVE STRATEGIES.

1. Provide procedural prompts that can guide student processing.
2. Demonstrate the use of the prompts through modeling and thinking aloud.
a) Model the use of the prompt.
b) Think aloud as choices are being made.
3. Guide initial practice.
a) Regulate the difficulty of the task.
b) Anticipate and discuss potential difficulties.
c) Provide a cue card when appropriate.
4. Provide feedback and self-checking procedures.
a) Provide and teach a checklist.
b) Suggest fix-up strategies.
c) Arrange for feedback in groups.
5. Provide independent practice with new examples.
a) Increase student responsibility.
b) Assess student mastery

RECOMMENDATIONS

Since the publication of the first *Handbook of Research on Teaching*[64] nearly 40 years ago, and with the investment of public and private funds in research, we have undertaken an extensive program of research and development in education. The profession has come a long way. How might the results from these three areas of research fit together?

The research on cognitive processing underlies a major goal of education: helping students develop well-organized knowledge structures. In well-organized 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.

- Present new material in small steps so that the working memory does not become overloaded.

- Help students develop an organization for the new material.
- Guide student practice by supporting students during initial practice, and providing for extensive student processing.
- When teaching higher-level tasks, support students by providing them with cognitive strategies.
- Help students learn to use the cognitive strategies by providing them with procedural prompts and modeling the use of these procedural prompts.
- Provide for extensive student practice.

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