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Generative Processes of Comprehension

Merlin C. Wittrock
Graduate School of Education
University of California, Los Angeles

This article presents a model of the generative processes of reading comprehension. The article begins with a discussion of the four parts of the model: generation, motivation, attention, and memory. The discussion then reviews laboratory and classroom research relevant to the model. A series of experiments by the author and his colleagues are presented to support the instructional utility of the model. The article concludes with a discussion of the model and its relation to the teaching of reading comprehension in schools.

Within the last 20 years, many of the people who study reading have shifted their perspective, and consequently their research interests, to focus on the critical role that human cognitive processes, such as attention, motivation, knowledge acquisition, encoding, learning strategies, and metacognition, play in influencing comprehension (Wittrock, 1986b, 1989). The shift meant that we became less interested in how environments directly and automatically influence learning.

Instead, we became interested in how learners use background knowledge, or schemata, and thought processes, such as verbal elaborations and imagery, to construct meanings for the text. In short, reading became reading with understanding.

At a deeper level, the conception of the learners' roles in reading and in knowledge acquisition, as well as the teachers' roles in influencing both of them, changed. The learners became the sources of plans, intentions, goals, ideas, memories, strategies, and emotions actively used to attend to, select, and construct meaning from stimuli and knowledge from experience. The

Requests for reprints should be sent to Merlin C. Wittrock, Division of Educational Psychology, Graduate School of Education, University of California, Los Angeles, 321 Moore Hall, 405 Hilgard Avenue, Los Angeles, CA 90024–1521.

teachers became the facilitators of these cognitive and metacognitive processes of comprehension.

Gone then, or at least of less interest, were studies about how variables, such as the length of practice and the amount of time spent on a task, directly influence learning. In their places came studies about how these variables influence the learner's thoughts and feelings that together result in comprehension. In their places also came studies about how a teacher could influence the learner to think about tasks differently, to construct different meanings, to use different learning strategies, and to relate knowledge to the material to be learned (Wittrock, 1981a). People began to ask about which cognitive processes and learning strategies could be taught to learners (Wittrock, 1979). How and to whom could they be taught? In what contexts would they be used? Metacognition began to receive increased attention.

Many of these recent interests in cognitive processes fit well into the historical mainstream of thought about learning, memory, and their facilitation through teaching. Since the days of Aristotle, imagery has played a central role in memory, and associations among ideas have played a central role in retrieval. Since the days of the ancient teachers of rhetoric, such as Cicero and Quintillian, constructing relations between experience and new information, by generating interactive images between the old ideas and the new events, has been a favorite and effective pedagogical technique (Wittrock et al., 1977).

These interests also fit well with earlier but often forgotten 20th-century findings. Thorndike (1931) largely abandoned his law of exercise or frequency. He found that one could spend time practicing behavior and not profit or improve as a result of the practice alone. Other conditions, such as rewards and belongingness, were necessary for practice to produce learning.

Within the last two decades, we have again come to the view that reading comprehension depends on the learners' thoughts, feelings, schemata, and information-processing systems. With the return to this ancient perspective, new conceptions of reading, and of its learning and its teaching, arise in the research literature on comprehension. In this article, I present one of these conceptions – the model of generative reading comprehension. It focuses on the constructive or generative processes of reading usually considered characteristic of written composition.

RELATIONS BETWEEN READING AND WRITING

Reading and writing differ from each other in the thought processes and human behavior they represent. These well-known differences are summarized best by the commonly accepted belief that writing is the process of putting meaning on written pages, whereas reading is the process of getting meaning from the written pages. This conventional wisdom implies that writing is a constructive or generative skill but that reading is essentially an imitative or reproductive skill. I believe that this conventional and useful conception of reading and writing leads us to misunderstand the generative nature of reading comprehension. A more useful conception of reading can lead to improvements in the learning and teaching of reading through articulating the generative processes learners use to construct meaning for text.

Good reading, like effective writing, involves generative cognitive processes that create meaning by building relations (a) among the parts of the text and (b) between the text and what we know, believe, and experience. The generation of those two types of relations is the essence of reading comprehension. The meaning is not only on the page nor only in our memories. When we read, we generate meaning by relating parts of the text to one another and to our memories and knowledge.

When we write, we generate meaning by relating our knowledge and experience to the text. Writing also involves building relations among the words in sentences, the sentences in paragraphs, and the paragraphs in texts. In these important ways, generative reading comprehension and effective writing relate closely to each other (Wittrock, 1983b).

READING AND WRITING AS GENERATIVE PROCESSES

Young children generate spoken and sometimes written language before they learn to read. In conversations, young children construct rule-governed, syntactically correct sentences that communicate meaning to others. In these social interactions, young children generate meanings for the sentences they hear. We often take these remarkable generative, linguistic abilities for granted. Perhaps because they are so commonplace, we overlook one of their fundamental meanings—that language is a generative, cognitive process beginning with very young children's conversations.

Equally remarkable is the finding that 4- to 5-year-old preschoolers, taught to write letters for sounds, generate written words and rudimentary sentences (KEN I STA DAOON STERS) before they have learned to read (Chomsky, 1979). These invented spellings by children indicate again the generative nature of language and some of the similarities that underlie reading and writing. Try to make sense of the following sentence written by a 5-year-old (Bissex, 1976): "EFUKANOPNKAZIWILGEVUAKANOPENR."

THE MODEL OF GENERATIVE COMPREHENSION

Through their conversations and their invented spellings, preschool children show that they approach speaking and writing as if they were generative activities. Before these young children learn to read, they demonstrate generative language abilities developed in social interactions involving conversations and simple written compositions.

From our knowledge of the generative language abilities of young children, it is reasonable to ask if they learn to read in much the same way that they learn to speak, to invent spellings, and to write simple compositions. Have we misunderstood an important part of the nature and complexity of learning to read with understanding? Perhaps it is nearly as difficult to become an excellent reader as it is to become an excellent writer. Perhaps reading should be taught as a generative activity.

My model of generative reading comprehension explores these ideas, building on an analogy between reading with comprehension and writing, speaking, and listening with understanding. Although reading differs in obvious and subtle ways from speaking, listening, and writing, it shares important psychological and cognitive processes with them.

Briefly stated, the model includes four major components: generation, motivation, attention, and memory. In the model, comprehension involves the reader's active *generation* of two types of semantic and pragmatic relations: (a) among the parts of the text and (b) between the text and knowledge or experience. The active generation of these two types of relations implies a *motivation* or willingness to invest effort in reading and an ability to attribute success and failure in generating relations to one's effort. *Attention,* the third element in the model, directs the generative processes to relevant text, related stored knowledge, and memory of pertinent experience. *Memory,* including preconceptions, metacognitions, abstract knowledge, and concrete experience, comprises the fourth element of the model.

The essence of the generative learning model (Wittrock, 1974a, 1974b, 1978a, 1978b, 1981b, 1983b) is that the mind, or the brain, is not a passive consumer of information. Instead, it actively constructs its own interpretations of information and draws inferences from them. People ignore some information and selectively attend to other information. In other words, although our brains often respond reflexively to incoming stimulation, our minds are much more than "blank slates" that passively learn and record incoming information (Wittrock, 1980). The stored memories and information-processing strategies of our cognitive systems interact with the sensory information received from the environment, selectively attend to this information, relate it to memory, and actively construct meaning for it.

Generation is a fundamental cognitive process in comprehension. Generation is not the same as semantic processing, an often cited cognitive explanation of meaningful learning. Generation is more than the fitting of information into slots or schemata, an explanation of understanding frequently presented by schema theorists. Generation is the active construction of relations among parts of the text, and between the text and knowledge and experience. Generation can result in assimilative learning, that is, schema fitting. Generation can also result in accommodative learning, leading to the construction of new schemata.

Relations between text and memory, text and experience, and among the parts of the text facilitate comprehension because they are generated, not just because they are semantic in nature or because they involve effort or because they involve schema fitting. In addition to these important factors, generation is a process of constructing relations that contributes to comprehension and that can occur in reception learning and discovery learning, in laboratories and in lectures. This part of the model, which I first published in 1974 (Wittrock, 1974b) does not occur in other cognitive models of meaningful learning, semantic processing, information processing, or schema fitting.

According to this model of generative comprehension, to learn with understanding a learner must actively construct meaning. To comprehend what we read, we invent a model or explanation that organizes the information selected from the experience in a way that makes sense to us, that fits our logic or real-world experiences or both. People retrieve information from long-term memory and use their information-processing strategies to generate meaning from the incoming information, to organize it, to code it, and to store it in long-term memory.

Motivation

The model of generative reading comprehension leads to several implications about understanding and facilitating the teaching of reading. In the area of motivation, the model implies that students should become mentally active, generative learners who hold themselves accountable and responsible for constructing verbal and imaginal relations between what they know and what they read.

Teachers can facilitate this active student role in comprehension by attributing learning to student effort. Only when the learners attribute successful comprehension to their own effort at generating relations among the text and knowledge or experience will the instructor's actions enhance motivation in the sense of persistence and sustained interest in learning. Success, reward, praise, reinforcement, and feedback do not necessarily facilitate generative learning. Success and teacher approval should be attributed by the learners to their efforts, not to the activities of other people nor even to the students' own abilities. When students attribute learning to other people or to factors external to themselves, the effort they invest in learning, that is, their motivation, tends to decline.

These ideas about motivation derive from recently developed models of academic achievement, for example, as discussed by Bernard Weiner (1979). These ideas are neither original nor unique to generative learning. They imply that the learners' attributional processes must sometimes be modified before reading comprehension can be facilitated. The meaning the learners generate about the causes of learning influences their motivation and their willingness to become active in generative learning.

These ideas contrast sharply with commonly practiced principles of accountability *only* for teachers, of mentally passive learners acquiring knowledge with little or no effort, of time to learn, or of practice and reinforcement as adequate to produce learning. These principles are not wrong. They are useful, provided that you understand how they operate. For example, rewards do not invariably bring about learning or feelings of success. Instead, rewards produce these effects when students value them and attribute them, at least in part, to their own actions. Success is not enough. Its effects depend on students' interpretations of its causes and meaning.

From this perspective, how can one change student attributions? Richard deCharms (1976) taught teachers and students in St. Louis to perceive themselves as causes of their own actions and to take responsibility for their own success or failure as teachers in inner-city schools.

deCharm's origin training program continued over 2 years. As a result, both teachers and students changed. They each increased in the responsibility they took for their own actions. The children's achievement in mathematics (arithmetic) and language also increased. The gains in reading, unfortunately, were less than those in arithmetic and language, suggesting that to increase reading comprehension improve more than motivation.

From a different perspective, Barbara McCombs (1983) taught military personnel to modify their learning strategies and motivation to match the requirements of the learning tasks. The motivational skills training program improved performance in technical training.

Attention

Another old but recently revived concept, attention, offers some insights into the problems of teaching reading and of understanding some learning disabilities (Wittrock, 1986a). Recent research has analyzed mental retardation and learning disabilities into cognitive processes, such as attention, that lead to a deeper understanding of the practical problems and their possible remedies.

Attention develops slowly in many children. Most normally developing children from about age 5 years to age 15 years show a gradual increase in ability to learn and to remember centrally important information, but they show no increase in ability to remember incidental or irrelevant information. Attention consists of several components, among them are a short-term, orienting response, and a long-term or sustained voluntary response. These two types of attention, along with other types, have been studied extensively in neuropsychology (see Wittrock, 1980) and in special education.

Krupski (1975) studied short-term involuntary reactions and long-term voluntary reactions of mentally retarded children. She found that mentally retarded children react normally to short-term attention tasks but abnormally slowly to sustained attention tasks in an academic setting. In nonacademic settings, however, mentally retarded children improved their performance. In other studies (see Hallahan & Reeve, 1980), mentally retarded children have also shown deficiencies in short-term voluntary attention. Apparently, their attentional problems primarily involve volition, or self-control, something that might respond to appropriate training.

Consistent with Krupski's findings are Hallahan and Reeve's (1980) results derived from over several years of study of attentional processes in learning-disabled and mentally retarded children. They found that many of these children lag about 2 to 3 years behind in their ability to ignore incidental information and to selectively attend to relevant information. These children usually do not use rehearsal strategies as well or as frequently as do normal children. An important educational implication of this research is that these deficiencies in attention, rehearsal, and self-control might be remediated, at least partially, by appropriate cognitive training.

Hyperactivity is a disorder that seems to involve attention. Hyperactive children are distracted primarily by task-related, but sometimes by task-irrelevant, stimuli. An attentional hypothesis explains the so-called paradoxical effect of stimulant drugs reducing hyperactivity among learning-disabled children by suggesting that the drugs steepen the gradient of attention. Further, if hyperactivity involves a flat gradient of attention, then an attentional hypothesis suggests that cognitive intervention strategies that stress self-control over attention might ameliorate the problem, at least under some conditions.

Following this reasoning, Meichenbaum and Goodman (1971) taught second graders, who were either hyperactive or had poor self-control, to use a strategy that asked them to control their impulsive behavior and to "stop, look, and listen" before they acted. The strategy reduced the learners' impulsivity on the Matching Familiar Figures Test, but the effects did not generalize to the classroom.

Camp (1980) used training procedures modeled after Meichenbaum's self-instructional techniques. She taught impulsive elementary school-aged boys to ask themselves what problem they faced, how they were to try to solve it, whether they were following their plan, and how well they did. After 30 training sessions, she showed gains in IQ, reading, and social behavior. In addition, these gains generalized to the classroom.

Douglas, Parry, Martin, and Garson (1976) also developed a self-instructional cognitive training program to teach 7- and 8-year-olds to use self-verbalization to control their impulsive behavior. After 3 months of training, scores increased on the Matching Familiar Figures Test, on tests of planning, and on tests of reading comprehension, although reading was not taught in this program.

Among children who are not learning disabled, selective attention sometimes presents a problem that might be remediated by training with verbal strategies. Paris, Lindauer, and Cox (1977) found that 7- and 8-year-old "normal" children can, but rarely do, spontaneously construct inferences about sentences they read as a way to achieve a goal, such as remembering what they have read. In this same study, children learned to construct stories from the sentences they read. The strategy of constructing stories facilitated comprehension and increased memory of the sentences. The goal apparently influenced selective attention. The construction of stories probably enhanced comprehension by facilitating the construction of relations across the sentences in the stories.

Malamuth (1979) used cognitive techniques, similar to methods developed by Meichenbaum and Goodman (1971), to improve self-management among poor readers who were not hyperactive. Sustained attention increased as a result of the training, and reading scores also improved, indicating the utility of cognitive training programs for some normal children with reading problems.

These cognitive training programs show that children, including hyperactive students, can show improvements in reading. Most effective training programs teach the children strategies of self-control that provide an explicit set of steps for them to follow that usually involves analyzing visual stimuli carefully before responding to them. Most of the successful programs also involve extensive training.

Generalization of these training programs is a problem, but the cognitive training programs usually provide the greatest amount of generalization, compared with the behavioral and drug programs (Keogh & Glover, 1980).

Memory

This massive topic includes preconceptions, abstract knowledge, everyday experience, domain-specific knowledge, learning strategies, and metacognition. This topic is too extensive to expand on here (see Wittrock et al., 1977). The essential point is that generation functions by creating relations between this vast store of organized information in long-term memory and the text to be comprehended. The construction of these relations leads to comprehension.

Generation

Essentially, reading comprehension is the process of actively generating relations among the parts of the text and between the text and one's memories, knowledge, and experience. I believe that to comprehend text we must invent a model or explanation for it that organizes its parts in a way that makes sense to us, that fits our logic and our world knowledge. The invention or generation of a sensible model of the text and its relations to us does not preclude our learning from direct instruction or from someone else, such as a teacher. Even when a teacher tells us an answer, or when we look it up in the back of the book to comprehend it, we must still discover its intended meaning. Being given the answer does not necessarily aid or deter comprehension. It depends on what we do with that information, what we think about it, and how we relate it to our knowledge. Also, being given an explanation by a teacher does not preclude our need to invent that same explanation for ourselves to comprehend the intended meaning. Generation, not discovery, is the process of comprehension.

From the perspective of my model, the teaching of reading and the teaching of writing share subtle and important generative processes. Writing is more than the construction of text for meaning, and reading is more than the construction of meaning for text. Writing is also a process of constructing meaning, which gets revised and made more precise as one edits, revises, and generates (Wittrock, 1983b). Reading involves reconstructing the text in familiar terms, examples, and experiences that allow us to relate our knowledge and memory to the message and to the perspective of the author. In generative learning, students' knowledge, experience, and learning strategies are crucially important because, as strange as it may seem, answers given to learners must still be generated by them (i.e., related to context and to knowledge and experience) before they can comprehend them.

A teacher facilitates these generative processes of comprehension. The art of generative teaching is knowing how and when to facilitate the learners' construction of relations among the parts of the text and their knowledge. In addition, teachers can teach the learners how to increase their ability to control their generative processes so that reading comprehension becomes increasingly independent for them. An important goal is for the learners to learn to control their own generative processes.

There are fundamental ways to stimulate generative processes. Table 1 lists some of these techniques. In addition to learners' voluntary control, teachers can use the characteristics of the text itself, the familiarity of the words, stories, analogies, metaphors, diagrams, headings, underlined words, and pictures to stimulate generative processes (Kourilsky & Wittrock, 1987).

Second, the teacher can give explanations, main ideas, inferences, summaries, advanced organizers, questions, metaphors, analogies, examples, paraphrases, and blanks to be completed either before or after the students read the passages.

Third, the teacher can ask the students to construct headings, subheads, inferences, summaries, questions, metaphors, analogies, answers, pictures, flow charts, tables, rebuttals, alternative explanations, and critiques while they are reading and after they have read the passage.

Fourth, the teacher can teach metacognitive strategies useful for solving problems (e.g., Wittrock, 1967) or for comprehending story grammars and types of discourse.

With this introduction to the model and some of its educational

TABLE 1
Ways to Stimulate Generation

Teacher Given	*Learner Constructed*
Among Concepts Presented in Instruction	
Titles	Compose titles
Headings	Compose headings
Questions	Write questions
Objectives	State objectives
Summaries	Write summaries
Graphs	Draw graphs
Tables	Prepare tables
Main ideas	Construct main ideas
Between Instruction and Prior Knowledge	
Demonstrations	Student demonstrations
Metaphors	Compose metaphors
Analogues	Propose analogues
Examples	Give examples
Pictures	Draw pictures
Applications	Solve problems
Interpretations	Develop explanations
Paraphrases	Put into own words
Inferences	Draw inferences

applications, I turn next to the empirical research on generation. First I discuss laboratory research on generation. Then I discuss applied research on generative reading comprehension.

LABORATORY RESEARCH ON GENERATION

Laboratory studies, usually with college students learning word lists and word pairs, have investigated the generation effect and have tried to explain it. Wittrock and Carter (1975) gave college students hierarchially arranged words and asked the learners to process them generatively, that is, to relate them to one another and to construct the proper hierarchical relations among them. Whether the words were conceptually related to one another or were chosen at random from a dictionary, generative processing of them sizably increased, usually doubled, their retention.

In two experiments, Wittrock and Goldberg (1975) studied children's and college students' learning and memory of words that they were asked to put into sentences, a story, or an interactive image. The high-imagery words were best remembered by the college students and the children. The directions to group the words into stories, sentences, or images facilitated recall for the children but not for the college students. The results imply that the effectiveness of the directions depends on the learners' developmental level and on the cognitive processes they have learned to use. Instructional aids, such as directions, can help learners only if they are not already spontaneously performing the generative activities mentioned in the instructions.

In three experiments with fourth and fifth graders, the type of instruction necessary to teach the children how to generate a concept depended heavily on the previously learned relevant concepts (Wittrock, 1978b). When the training focused on a relevant but not highly salient concept, transfer increased quickly and markedly.

In five experiments with college students, Slamecka and Graf (1978) compared memory for words that were either read or generated. For all measures in all five studies, the generation of words enhanced memory. The generation phenomenon held across different rules and materials, across timed or self-paced learning, and across different types of tests and different experimental designs.

In the third experiment, they tested selective attention as the sole explanation for the generation effect. The responses, which were generated by the learners, but not the stimuli, which were not generated by the learners, were better recognized later. If selective attention were the sole explanation of the generation effect, then the stimuli would have been as well recognized as the responses, because the learners selectively attended to both of them. However, the data from the fifth experiment are less clear cut on this issue, making it difficult to establish any firm conclusions about the role of attention in generation. The authors, however, concluded that their data eliminate overt responding, frequency, exercise, time to learn, and levels of processing as explanations of the generation effect. Therefore, both distinctive encoding and effort are still possible explanations.

Jacoby (1978) compared reading with generating solutions to simple word problems. Compared with reading the words, generating the response words increased their recall when the problems were seen only once earlier or were seen repeatedly in a spaced pattern. In massed practice, reading or generation made no difference in recall, apparently because massed practice trivializes generative reading. The learner can recall the answer directly from short-term memory. When the interval between presentations of a problem is longer than short-term memory, the learner must construct rather than recall the solution. Jacoby concluded that overt responding is not enough to facilitate learning. Reading the answer immediately prior to the problem reduced performance. He concluded that effort was critical to improving recall in this study. These two results seem incongruous. Apparently something more than effort is necessary for generation to be effective, otherwise overt responding, which is effortful, would be a sufficient explanation.

Generation has also been studied with sentences. Slamecka and Katsaiti (1987) argued that the common use of within-subjects designs in the studies of the effects of generating words may have led the learners to rehearse selectively the generate items more than the read items. Hirschman and Bjork (1988) tested this hypothesis. They showed that with across-subjects designs, the word-generation effect occurs in cued recall by enhancing the relations between the stimulus and the response terms. Wittrock and Carter (1975) found that the generation of hierarchical relations among words also facilitates free recall. The word-generation effect seems to be robust and does not seem to be due to procedural artifacts.

In five experiments with college students, Graf (1980) compared generating meaningful and anomalous sentences from words given to learners with simply reading the same sentences contrasted by the experimenter. Generation of the sentences enhanced word recognition with meaningful and anomalous sentences. Generation enhanced word-pair recognition, a measure of sentence organization, with meaningful sentences but not with anomalous sentences. The results indicate that generation enhances intraword organization with both types of sentences but enhances integration of sentences only if they are meaningful. He concluded that reading should stimulate bringing words to mind simultaneously and constructing meaningful relations among them.

McFarland, Frey, and Rhodes (1980) compared the effects on memory of learner-generated words missing in sentences with experimenter-given words in the same sentence. The generation of the missing words by the college undergraduates consistently increased their free recall, even across different types of congruity between the word and its context, and across different levels of processing, such as a phonemic level or a semantic level.

McFarland et al. (1980) concluded that generation is distinct from the phenomena called elaboration and levels of processing, such as phonemically processed and semantically processed words. In their study, phomenically encoded words, as well as semantically encoded words, evidenced a generation effect. For example, learner-generated rhymes (phonemically processed) were remembered better than experimenter-given semantically related words, a result not predicted by levels-of-processing or elaboration theory, which predicts that semantic processing, but not phonemic processing, enhances long-term memory.

Another interesting finding in the McFarland et al. study is that the usual encoding congruity effect, in which a word must be well-integrated with its context, was reversed for the learner-generated words. The generation of semantic incongruities facilitated recall sizably. These authors disagree with Slamecka and Graf (1978), who posited that generation enhances the congruity between a word and its context. McFarland et al. (1980) suggested that congruity is important for experimenter-given words but not for learner-generated words. They also posited that Jacoby's (1978) and Slamecka and Graf's (1978) data can be explained by an effort hypothesis, an explanation that is difficult to defend.

In sum, the interesting interpretation given by McFarland et al. (1980) is that reading, as different from generation, does not ensure a phonemic or semantic analysis of words nor an integration between words and their context. I would add that reading also does not ensure an integration between words and the learner's experience and knowledge.

McFarland et al. (1980) stated that generation is independent of depth or type of processing. In this experiment, generation produced a bigger effect than did semantic encoding, although the semantic-encoding effect did ocur with experimenter-given words. They concluded that the actual operations performed on the words, more than their phonemic or semantic characteristics, determined learning from generation. What are these operations? They conjectured (a) personal relevance and (b) effort used in connection with episodic memory. They offered little explanation for the processes involved in generation from semantic memory, as it differs from episodic memory.

In summary, McFarland et al. (1980) agreed with many earlier studies in the classroom and in the laboratory when they concluded that "an individual's memory will improve dramatically if he provides some of the to-be-remembered information himself" (p. 224).

Stein, Morris, and Bransford (1978) also found that semantic processing of sentences is not always more effective than other types of processing at enhancing comprehension and retention. In this study, enhancement depended on the relation between the learner's elaboration and the rest of the sentence. When the elaboration made the sentence meaning more precise, comprehension increased. Other types of semantically congruous elaborations also debilitated retention. In a related study, Stein and Bransford (1979) compared learner-generated and experimenter-given elaborations. Again, when the elaboration contributed to the development of the tested meaning, or when learners were led to generate relevant questions that lead to precise relations among the parts of the sentence, comprehension increased.

Dee-Lucas and DiVesta (1980) gave college students, or asked them to generate, headings, related sentences, or topic sentences as they read a text about minerals. These instructional aids enhanced most types of learning only when they were generated by the learners. Generation of topic sentences produced the greatest enhancement of learning from the text. Giving learners these instructional aids enhanced learning of subordinate information but not of the structure of the passage. The learning of structural information was enhanced or reduced by generation, depending on the relevance and appropriateness of the generative activity to the learning measured on the test. Fluent learners sometimes learned as much from given information as from generated information. The results depended on what the learners knew and what they did spontaneously. In Dee-Lucas and DiVesta (1980), generation seemed to facilitate selective attention. Generative activities worked primarily when learners would not have spontaneously performed them. The learning of material already salient to the learner did not profit from generative activities that enhanced selective attention.

Dee-Lucas and DiVesta reported important findings about the teaching of generative activities. They showed that an instructional intervention enhances learning or comprehension only when it induces learners to perform activities they would not otherwise perform or not perform as well. It is not enough then to induce generative processing. In addition, one must enhance the learner's generative processes appropriate for the situation, in this case to read with comprehension.

From this review of laboratory studies on the generation effect, at least two findings are supported. First, the generation effect is a real one. It is not synonymous with semantic processing or elaboration, although it produces a sizable impact on reading with comprehension and on retention. Second, the nature of the generation effect is only partially understood. It seems to involve a number of cognitive processes in much the same way that language production, as in speaking or writing, involves them. Reading does not always involve these same constructive processes. When we can make reading become more like written composition, and engage generative activities, it seems that we can increase reading comprehension.

APPLIED RESEARCH ON GENERATIVE READING COMPREHENSION

The data collected by my students and me on the model of generative comprehension relates closely to research on learning strategies, reading comprehension, and students' cognitive processes. For example, see Claire Weinstein's work on learning strategies (Weinstein, Goetz, & Alexander, 1988; Weinstein & Mayer, 1986); Richard Mayer's research on problem-solving and learning strategies (e.g., Mayer, 1980); and the recent research on teacher and student cognitive and metacognitive processes, conducted by Walter Doyle (1980), Penelope Peterson (e.g., Peterson & Swing, 1982), and Donald Dansereau (1978). The findings of these studies often parallel the results of our studies.

Over the last 20 years, my students and I have completed a series of empirical studies designed to test implications for teaching of the model of generative reading comprehension. In separate studies (all except one were experiments involving individual random assignment of the learners to the treatments), we have asked elementary school children, junior high school students, and college students, as they read a text, to generate paragraph headings, summaries, interpretations, images, and pictures that related the parts of the text to one another and to their knowledge and experience. We have also tried giving children familiar words to induce the generation of sentence meanings and familiar stories to induce the generation of meanings for unfamiliar and undefined vocabulary words.

In one experiment (Doctorow, Wittrock, & Marks, 1978), 488 public school, sixth-grade students were individually randomly assigned to eight treatments. In this study, we asked the students in one group to generate a summary sentence for each paragraph they read in stories taken from a commonly used, commercially published reading textbook appropriate in difficulty for their reading ability. Another group was also given paragraph headings to use in the summary sentences they were asked to construct. As seen in Table 2, with time to read and to learn held constant across all treatments, the students who generated the paragraph summaries sizably and statistically significantly increased their retention and comprehension of the text, from a mean of 35 for the control group to a mean of 51 for an experimental group. The group given the paragraph headings and asked to generate summaries of the paragraphs doubled their retention and comprehension, from an average of 35 for the control group to an average of 68 for

TABLE 2
Treatment Means (and Standard Deviations) for Comprehension and Recall Test Scores

	High-Ability Readers		*Low-Ability Readers*	
Treatment	*Comprehension*	*Retention*	*Comprehension*	*Retention*
Generate summary using two-word heading	18.67 (4.09)	67.66 (21.84)	13.16 (1.88)	18.29 (5.22)
Generate summary using one-word heading	16.80 (4.14)	60.83 (20.19)	12.10 (2.91)	17.93 (5.39)
Generate summary	15.43 (4.86)	51.26 (23.59)	12.03 (3.27)	15.32 (6.27)
Two-word heading	15.50 (5.11)	50.17 (23.97)	10.65 (2.91)	14.81 (5.59)
One-word heading	15.27 (4.41)	45.87 (21.55)	10.00 (3.66)	13.84 (5.95)
Control	10.77 (4.51)	35.06 (19.89)	7.19 (2.85)	9.13 (3.92)

Note. From "Generative Processes in Reading Comprehension" by M. J. Doctorow, M. C. Wittrock, and C. B. Marks, 1978, *Journal of Educational Psychology, 70,* p. 115. Copyright 1978 by the American Psychological Association.

the experimental group. The control group read the same stories, but they were not asked to generate summaries. The active generation of relations among the sentences in a paragraph sizably facilitated comprehension and retention.

In another study (Wittrock, Marks, & Doctorow, 1975), we gave 468 fifth- and sixth-grade public school students familiar stories in which we embedded unfamiliar and undefined vocabulary words. Compared with the control groups given the same vocabulary words embedded in unfamiliar stories, all the generative groups increased, from 50% to 100%, the number of new vocabulary words they could correctly define on a vocabulary test. The study implies that students use familiar story contexts to generate meanings for vocabulary words.

In a related study (Marks, Doctorow, & Wittrock, 1974) with 230 sixth-grade students, we substituted one familiar vocabulary word per sentence (e.g., boy for lad) for one unfamiliar word per sentence in stories from commercially published reading stories. Comprehension of the stories increased at least 50%, and sometimes 100%, with time to learn held constant across the treatment groups. The generation of sentence and story meaning seems to depend heavily on understanding all of the parts of the sentences, as the model of generative learning implies.

With 87 fifth-grade students, we examined whether generating pictures for vocabulary words would enhance memory of definitions, compared with usual teaching procedures that emphasize memorizing definitions (Bull & Wittrock, 1973). The drawing of pictures statistically, but not sizably, enhanced the memory of the definitions.

Next, I report the results of four related studies on generative reading comprehension. The first study, reported in Table 3, used college students. The next two studies (see Tables 4 and 5) were done with junior high school students. The last study (see Table 6) used elementary school students.

In the study reported in Table 3, we increased reading retention and comprehension by asking college students to construct either verbal analogies or summary sentences (that consisted only of their own words) as they read a chapter in Rachel Carson's book *The Sea Around Us* (Wittrock & Alesandrini, in press). Self-generated analogies or self-generated verbal summaries facilitated reading. Scores on the Street Test (a measure of spatial–holistic ability) correlated positively with reading scores in the imagery condition but not in the verbal analogy condition. Scores on the Similarities subscale of the Wechsler Adult Intelligence Scale (a measure of verbal–analytic ability) correlated positively with reading scores in the verbal analogy condition but not in the imagery condition. Scores in the summary condition correlated positively with analytic and holistic abilities. Although these data are tentative, they imply that different cognitive processes can be stimulated and used to construct meaning for text. Their effectiveness also relates to the learner's relative ability to use the verbal or imaginal strategies.

In the study reported in Table 4 (in preparation), several hundred junior high school students read the stories entitled "Conductor Moses" and "The Mirror." In this experiment, all generative procedures facilitated compre-

TABLE 3
Treatment Means (and Standard Deviations) for Recall, Time to Learn, Analytic Ability, and Spatial Ability

Treatment	*Read Text*[a]	*Summarization*[b]	*Analogy*[b]
Recall	22.4	29.8	27.2
	(9.21)	(7.72)	(6.25)
Time (minutes)	76.1	86.3	85.2
	(23.51)	(18.6)	(15.3)
Holistic ability	8.2	8.4	7.5
	(2.0)	(2.2)	(2.6)
Analytic ability	16.9	16.6	18.0
	(2.8)	(4.0)	(3.2)

[a]$n = 21$. [b]$n = 19$.

Note. From "Generation of Summaries and Analogies and Analytic and Holistic Abilities" by M. C. Wittrock and K. A. Alesandrini, in press, *American Educational Research Journal.* Copyright by American Educational Research Association. Adapted by permission.

TABLE 4
Treatment Means for the Comprehension and Retention Tests

Treatment	*Control (Read) n = 129*	*Generate n = 63*	*Heading Given n = 59*	*Heading Given, Generate Summary n = 60*	*Generate TS n = 66*	*Generate TS, Heading Given n = 69*	*Generate TS & Paragraph Head n = 67*	*Generate TS Using Given Head n = 60*	*Generate TS Relating Test to Experience n = 63*	*Generate Experimental Sentence, Head Given n = 62*	*Generate Experimental Sentence Using Paragraph Head n = 63*	*Generate Experimental Sentence Using Given Heading n = 64*
Comprehension												
Story A	10.4	14.1	13.8	12.9	13.0	12.1	12.6	12.7	13.4	12.0	12.3	12.4
Story B	9.0	12.2	11.6	12.4	12.2	11.9	11.6	11.9	12.4	11.8	11.6	11.1
Retention												
Story A	8.7	13.0	11.9	11.2	12.0	12.1	11.8	11.9	12.4	11.7	11.8	11.4
Story B	8.3	19.6	17.2	19.3	19.2	21.0	17.1	17.0	19.5	18.5	18.0	17.0

Note. TS = topic sentence.

hension and retention, sometimes by large amounts (100% or more) but usually by 25% or so.

The study reported in Table 5 (Wittrock & Roberts, in preparation) tested whether the generation of relations between text and experience increases literal comprehension. The control group of junior high school students wrote the same sentences generated by their yoked counterparts in the free generation experimental group. The generation effect occurred again, indicating that comprehension is influenced by the active process of generating representations for the meanings in the text, not only by effort or by practice, or by writing, or by the additional information in the inserted sentences, all of which were controlled by this design.

In a study with 58 fourth- and fifth-grade public school students (Linden & Wittrock, 1981), we compared conventional reading instruction, where the children's regular reading teacher taught reading in her usual fashion, with two experimental conditions in which the children were taught to generate and to describe aloud (a) interpretations of the paragraphs in their readings and (b) images relating to sentences of the stories to one another. These children were also taught to generate relations between the stories they read and their own experience. As indicated in Table 6, on a test of comprehension of the stories they read, the two experimental classes scored means of 31 and 29, whereas the control class taught by the children's regular teacher averaged 22. A second control class, taught by the teacher of the experimental classes but without using the generative exercises, averaged 18 on this same test of comprehension. These mean differences are statistically significant and indicate an increase in comprehension of about 50% due to generative activities, again with time to learn held constant across all treatments. In this study, the teaching occurred in groups in realistic classroom settings using conventional reading materials. The teacher variable was also controlled by using the children's regular teacher in one control group and the teacher of the experimental or generative

TABLE 5
Means (and Standard Deviations) of the Treatment Groups

Treatment	*Facts (20 Items)*	*Inferences (18 Items)*
Free generation[a]	14.2*	10.8**
	(3.1)	(3.0)
Written generation[b]	13.1	9.3*
	(3.2)	(3.7)
Yoked control[c]	12.1	7.8
	(3.2)	(3.0)

[a]$n = 30$. [b]$n = 35$. [c]$n = 25$.
*$p < .05$, higher than the control group. **$p < .01$, higher than the control group.

TABLE 6
Means (and Standard Deviations) of the Generation, Retention, and Comprehension Scores of the Treatment Groups

Treatment	*Number of Generations*	*Fact Retention (35 Items)*	*Comprehension (49 Items)*
Imaginal to verbal	13.0	27.6	28.6
generation[a]	(4.8)	(3.3)	(6.3)
Verbal to imaginal	10.7	23.3	31.3
generations[b]	(2.5)	(3.2)	(5.7)
No instructions to	0.0	25.1	17.7
generate[b]	(0)	(3.1)	(8.6)
Classroom teacher		21.57	21.6
taught control[b]		(7.12)	(12.7)

[a]$n = 16$. [b]$n = 14$.

Note. From "The Teaching of Reading Comprehension According to the Model of Generative Learning" by M. Linden and M. C. Wittrock, 1981, ***Reading Research Quarterly,*** *17,* p. 52. Copyright 1981 by the International Reading Association. Adapted by permission.

groups in a second control group. The results of this study indicate that generation of relations between the text and experience, and among the parts of the text, facilitates comprehension in realistic classroom group teaching situations.

A series of three applied studies was conducted over a period of 2½ years in basic skills classes taught at four Army bases in California and in Hawaii (Wittrock & Kelly, 1984). Soldiers with low reading ability, regularly enrolled in these classes, learned in 9 hr to increase their reading comprehension of Army manuals and texts as well as nontechnical materials.

In the first and second of the three studies, five different curricula, each using paragraphs from Army manuals and from magazines and newspapers, were used in basic skills classes. A comparable control group of soldiers given customary Army basic skills instruction, taught by regular basic skills teachers, offered on the same Army bases in the same classrooms for the same amount of classroom time, was used to evaluate the effectiveness of the new materials and teaching procedures. Pretests and posttests were also given to all experimental and control classes to provide a second measure of effectiveness of the experimental curricula and the generative teaching methods.

The soldiers in each of the experimental groups showed statistically significantly greater ($p < .01$) improvement in reading comprehension than did the soldiers in the control group. The second measure of effectiveness, the gains from the pretest to the posttest, also showed the same statistically significant increase ($p < .01$) in reading comprehension only in the experimental treatments. The control treatment showed no gain (see Tables 7 and 8).

TABLE 7
Means, Standard Deviations (in Parentheses), and Gain Scores of the Experimental and Control Groups of Study 1

Treatments	*Pretest*	*Posttest*	*Gain*	*t*	*p*	*% of Gain Over Pretest*
Experimental Groups						
Imagery strategy[a]	22.2 (4.6)	26.7 (2.7)	+4.5	5.8	.001	20.3
Verbal strategy[b]	20.6 (5.6)	23.8 (4.5)	3.2	3.7	.01	15.5
Verbal strategy (posttest only)[c]		24.2 (4.1)				
Control Groups						
Control: Conventional Instruction						
Pretest and posttest	21.1 (5.4)	20.8 (5.4)	−.3	−.4	ns	—
Posttest only[c]		18.2 (7.4)				

[a]$n = 23$. [b]$n = 24$. [c]$n = 19$.
Note. ns = nonsignificant.

TABLE 8
Means, Standard Deviations (in Parentheses), and Gain Scores of the Experimental and Control Groups of Study 2

Treatment	*Pretest*	*Posttest*	*Gain*	*t*	*p*	*% of Gain Over Pretest*
Summaries, headings, and inferences strategy[a]	18.9 (4.1)	22.6 (3.9)	+3.7	5.9	.0001	19.6
Metacognitive strategy[b]	20.5 (3.6)	23.1 (4.2)	+2.6	4.2	.001	12.7
Metacognitive and examples strategy[a]	17.9 (5.7)	22.1 (4.6)	4.1	6.7	.0001	22.9
Control group[c]	21.1 (5.4)	20.8 (5.4)	−.3	.4	ns	—

[a]$n = 29$. [b]$n = 26$. [c]$n = 16$.
Note. ns = nonsignificant.

In the third study of the series, the curricula and teaching procedures developed in the first and second studies were rewritten for use with microcomputers. The rewritten materials were presented by microcomputers to regularly enrolled basic skills students at two Army bases in California. Statistically significant gains in improvement in reading comprehension again occurred (see Table 9). In addition, the time needed for the instruction dropped sizably, from an average of 450 min (nine 50-min class hours) to an average of 251 min (about five 50-min class hours).

The research indicates that, through generative learning procedures, reading comprehension can be sizably increased, at no added cost or time, in typical basic skills classes offered on Army bases by regularly employed basic skills teachers working with normally enrolled soldiers. Under these realistic and typical conditions, the reading comprehension instruction and curricula should teach soldiers how to generate meaning by relating their knowledge and background to the manuals and other texts they read and by generating relations among the sentences in the text. These two basic principles may lead to inexpensive but useful modifications in teaching and to increases in ability to read with comprehension. The research also implies that, with microcomputers and appropriate curricula, reading comprehension can be increased, and training time can be markedly reduced, at least with some soldiers.

THE FACILITATION OF READING COMPREHENSION

From this review of laboratory and applied research, there is substantial support for the model of generative-comprehension generation and for its practical utility in improving reading comprehension among school children and young adults. There are also good reasons to believe that effective generative activities interact with the developmental level and ability of the learners, the type of reading material, and the teachers and curriculum writers' goals in the design of the instruction. For example, prior to about

TABLE 9
Means, Standard Deviations (in Parentheses), and Gain Scores of the Experimental Groups of Study 3

Army Base	*Pretest*	*Posttest*	*Gain*	*t*	*p*	*% of Gain Over Pretest*
Fort A[a]	19.38 (6.57)	23.83 (5.15)	4.25	4.7	.005	21.9
Fort B[b]	19.36 (3.46)	20.77 (2.83)	1.41	2.2	.025	6.8

[a]$n = 8$. [b]$n = 22$.

age 8, children do not often increase their reading comprehension by generating pictures appropriate for the text; however, these children do use pictures and high-imagery words quite effectively to improve their reading comprehension (Levin, 1981). We also know that when they are asked, children 5 years and older can construct their own verbal aids—headings, summaries, inferences, and answers to questions—to enhance their reading comprehension. In addition, we know that children can use these same verbal organizational aids, when they are given to them in a text or by a teacher, to facilitate their reading comprehension.

To facilitate reading comprehension, the research on the model of generative comprehension implies that we stimulate the learners to construct relations (a) among the parts of the text and (b) between the text, on the one hand, and the readers' knowledge and experience, on the other. To facilitate comprehension, these constructed relations should have the following characteristics. First, they must be relations that the reader would not equally well construct without our intervention. Second, the relations must not trivialize comprehension. They must involve more than the learner's short-term memory and more than the surface structure of the text. They should involve the learner's long-term memory of experience or the learner's knowledge or both of these. They should involve the text's deep significance in the construction of one or more of its legitimate meanings.

We have learned through our research studies discussed in the previous section that we can stimulate the construction of relations having these two characteristics by designing the reading materials appropriately for the interests and abilities of the learners and by directing them to generate meaning for the text as they read. Whether we should make the relevant relations explicit or ask the learners to construct them is not the central issue. In either case, so long as we do not trivialize learning, the learners can and should be actively engaged in the understanding of the relations and in the text's meaning. When the learners can attend to the task and can construct the text's meaning or meanings, then they should be given the instructions and the direction appropriate for their developmental level, knowledge, and background. When the learners cannot adequately attend to the task or cannot construct important meanings from it, they should be helped to attend to the meaning of the text, and they should be given the relations to be learned, which they can elaborate on in an attempt to understand and to remember them.

More precisely, the model implies that when the readers *cannot attend* to the text, then training in self-management techniques, in cognitive strategies of focusing attention, and in rehearsal techniques are appropriate ways to improve the learners' attention, as are appropriate goals and objectives. The model also implies that the text can be changed to provide more interesting or more appropriate reading materials for the learners' objectives.

When the readers can attend to the text, have the appropriate focus and knowledge, decoding skills, and vocabulary, but *cannot generate* the significant relations discussed in the previous section of this article, then the relations should be given to the learners in verbal statements or in pictures, diagrams, graphs, and the like. To avoid trivializing learning, the readers should not be asked to memorize these verbal statements nor should they be asked to copy these spatial representations. The readers should be actively engaged in testing these relations against the parts of the text or against their knowledge and experience.

When the readers attend to the text, have the appropriate background and knowledge, decoding skills, and vocabulary, and *can but do not generate* legitimate meaning for it, then teachers should teach them learning strategies and metacognitive processes; question them about its meaning; give them objectives to attain; ask them to draw pictures; make predictions; look for main ideas, sequences, cause-and-effect relations; draw inferences; infer conclusions; construct summaries; make comparisons; and evaluate the significance of the text. In addition, the text should include metaphors, similes, analogies, pictures, questions, objectives, inferences, comments, and comparisons that do not state the relations to be learned but that do lead to their construction by the learners.

Last of all, when the readers attend to the text, have the appropriate background knowledge, decoding skills, and vocabulary, and *do generate* legitimate meaning for it, then the teacher, or the directions in the text, should subtly suggest alternative, deep meanings that might otherwise be omitted.

The abilities and background knowledge of the readers influence the choice of generative activities, as this progression of teaching methods clearly indicates. Other considerations also influence the choice and the use of generative reading tasks. First of all, the type of text or discourse will influence the choice of generative activities. For a technical manual, the generative activities will sometimes be different from those chosen for an expository text. The type of comprehension of the skills of comprehension emphasized in a given problem will also influence the choice of generative activities.

Even more important than the choice of a generative task is the understanding of the nature of a generative task. Almost any of the just-mentioned tasks or activities can be trivialized. Take metaphor for example. In a well-written chapter on generative metaphor, Schon (1980) showed the significance for social policy of metaphors that lead to a new understanding of old social problems. An urban area often described as a slum receives quite different treatment from a city government that has learned through generative metaphor to view it as home to people whose dislocation because of urban renewal would destroy stable social relations and disrupt individuals' lives.

Not all constructions are generative for every reader. A generative activity should be chosen to lead to a new or better relation. In a nontrivial sense, a generative task must lead to the construction of a relation among the parts of the text or between the learner's knowledge and the text.

PRINCIPLES OF THE TEACHING OF GENERATIVE COMPREHENSION

Our studies and the related research discussed in the previous sections support the following inferences about the teaching of comprehension.

1. The teaching of comprehension is the process of getting the learners to generate relations (a) among the parts of the text and (b) between the text and their experience.
2. Learners' knowledge, preconceptions, and experience are critical to the design of generative instruction (Osborne & Wittrock, 1983).
3. The relations constructed by the learner must be relevant to the comprehension that is taught and tested. When learners underline irrelevant words in a text, construct inappropriate comments, or view misleading pictures about the text, their comprehension usually declines markedly. This finding supports the belief that we are working with a powerful variable for influencing comprehension. When learners are taught to use it appropriately, generation sizably and regularly enhances comprehension. When learners are led to generate inappropriately, it distracts from their comprehension.
4. The generation of summaries, analogies, and related constructions functions by increasing learners' construction of relations among the meanings in the text and between the text and learners' knowledge and experiences. Effective summaries and related constructions involve learners' own words and experiences.
5. To be effective, generative teaching activities induce learners to construct relevant representations that they would not compose spontaneously.
6. There is a developmental progression in children's ability to learn from teachers' elaborations and from their own generations. Children learn from teacher-given elaborations before they can learn as well from their own generations.
7. Generative teaching can be either direct or indirect, structured or less well structured, depending on the learner's background knowledge, ability,

and learning strategies. Discovery is not the issue. Generation of appropriate relations is the issue.

8. Metacognitive strategies of comprehension can be directly taught to learners to facilitate their ability to organize, monitor, and control their generative thought processes.

9. Learners' thought processes can be adapted to instruction, just as instruction can be adapted to learners. Analytic and holistic abilities can be differentially employed by different generative activities to facilitate comprehension.

FOR THE FUTURE

We need further research on the following issues in the teaching of the generative processes of comprehension.

1. *Types of main ideas and how to generate them.* There are different types of main ideas. In a narrative, the main ideas often involve understanding relations about characters. In other types of discourse, the main ideas are of a different nature.

2. *Story endings.* What are the different categories of story endings that children generate? How do the story endings follow from the earlier text? How can learners be taught to generate a good story ending?

3. *Summaries.* The type of summaries that I teach learners to generate differs from the conventional types of summaries taught in other research studies or in other curriculum studies. I do not have the readers select or modify a sentence in the text to construct a summary. Instead, I have them use only their own words to generate summary sentences that do not appear in the text but that do relate information from different sentences in the text and that relate the text to their experience. We need research on the generation of this type of summary in narration, exposition, and other types of discourse. We need to study how to teach what a summary does in each of the different types of discourse.

4. *Titles.* We need to learn the characteristics of a good title, how to construct it, how to recognize it, and how to use it.

5. *Paragraph headings and subheads.* Generation of both of these types of information facilitates comprehension. We need exercises to teach students the characteristics of good paragraph headings and subheads and of ways to construct them.

6. *Plot structure.* We need to study how to teach students the types of plot structure, how to recognize them, and how to generate them. We need more explicit teaching of the types of plot structure, their differences from each other, and how to construct them.

7. *Types of paragraphs.* Descriptive paragraphs, summary paragraphs, and the like differ in their functions in a passage. We need to teach students how to recognize the function of a paragraph and to generate its contribution to understanding the text.

8. *Functions of similes, metaphors, and analogies.* We teach similes and metaphors, but we need to teach their essential functions in comprehension, one of which is to relate previous experience to new events and situations in order to transfer knowledge from familiar to new situations.

9. *Relating past experience to text.* This fundamental process in the teaching of comprehension requires research. It needs to be approached in a multitude of ways, including explicit teaching of how to adopt different perspectives, to think of examples, to apply knowledge, and to test information against what one knows or believes.

10. *Generating examples and applications.* This is a subhead of 9, but it deserves special attention because of its importance in the teaching of comprehension. Many students lack the ability to move between the abstraction and the specific applications, which we should try to develop through instruction.

11. *Revising stored concepts by reading text.* Accommodation of organized memory is different from assimilating text to memory. It is important to comprehension of new paradigms and new systems.

12. *Relating pictures to text.* The interactive qualities of pictures, that is, their ability to show relations among the parts they juxtapose (the characters or the elements of a story or diagram), need to be taught to children. We also need to study how to teach them the construction of interactive images as a way to facilitate memory and comprehension.

13. *Asking questions as one reads.* Recently, this topic has been widely studied. It is an important area that involves metacognitive research and the goals of reading. It leads into the teaching of metacognitive strategies that help answer learners' questions about cognition during reading: For example, What questions should you ask yourself before you read a text? while you are reading it? after you finish reading it?

METACOGNITIVE STRATEGIES OF GENERATIVE READING COMPREHENSION

One of the most promising lines of research in generative reading comprehension is the teaching of metacognitive strategies. Our work with the difficult reading comprehension problems of functionally illiterate young readers indicates some encouraging possibilities. Learners need to be aware of and to control their use of different generative learning strategies, whose appropriateness depends on the task and its context. For example, a main idea is different in a narrative than in an exposition. To get the main idea and other important information, one should read a narrative story differently from the way one should read an expository text.

It is important to teach learners the differences among types of text. It is also important to teach children when to use different learning strategies appropriate for different types of texts. Although it may not seem likely, it is quite possible for children to learn a cognitive strategy in a rote or blind fashion and to apply it without thinking.

It is important for readers to be aware of what they are doing, and why they are doing it, as they learn to comprehend what they are reading. The recent research on metacognition cited earlier indicates a facilitation in learning due to awareness of and control over what one is doing while reading. For this same reason, it is important to teach children how to monitor and to evaluate their comprehension activities as they read. What is their purpose in reading the passage? What comprehension strategy is best for this type of text? What type of relation (sequence, cause and effect, main idea, or relations among characters) across the parts of the text should they be generating? What is the best strategy to use to generate the main idea or another type of relation? What knowledge, schemata, perspective, or experience is best related to the text? How well are they building relations between the text and their background knowledge?

To teach them a strategy for reading a story, we need to teach them the following information. A story has a grammar or a structure, including a theme, a setting, characters, location, episodes, and a resolution. Some stories have a structure that begins with a stable situation that is followed by a change or disruption, a solution to the problem, and a restoration of a desired state.

Next we need to teach them to ask themselves questions that would direct their reading toward the progression of events in the story and to organize its characters and events around the goals, obstacles, and outcomes that involve the central characters in the development of the plot. We must also teach them to see a more general significance to the story theme that would enable them to extract its meaning or implication for their lives. Last of all we should, if we think it is not too difficult, teach them to evaluate the form of the story, the importance of its content, and the quality of the affect or feelings it arouses about oneself, friends, and human emotions.

We also need to teach them to identify the type of discourse; to choose an appropriate strategy for it; to generate appropriate main ideas, summaries, themes, and relations between the text and their experience and knowledge.

In expository text, the pattern or relations among the parts is often different from that found in a narrative. But some of the same generative techniques are still useful—for example, constructing main ideas, cause-and-effect relations, summaries, headings, contrasts, inferences, questions to guide reading, purpose for reading, topic sentences, details, semantic mapping, and categorizing. All these devices take a new role in expository text. We need to organize them, at least the most important ones, into a coherent strategy that would teach the learners to be aware of their choice among strategies, to monitor the strategy they were using, to construct the structure of the expository passage, to direct their reading with self questions, to construct appropriate main ideas and summaries, to apply the abstractions in the exposition to their own experience, and to relate their background knowledge to the text.

The advantages of putting comprehension activities, such as main idea, summary, self-questions, and reader's purpose, into a coherent strategy is that it organizes and sequences the individual generative activities that we have studied and found to be useful.

We also need research on the development and measurement of cognitive and metacognitive processes. Much of our research on individual differences and cognitive development deals with aptitudes and variables, such as sex and IQ, that could be but are not process oriented. They do not help us greatly to understand the different ways people acquire knowledge by organizing experience and by generating relations between experience and memory. For example, we need to know more about the development of imagery strategies and verbal strategies. We need tests of what learning strategies children can use on request at different ages. We also need to study the strategies we can teach to children at different developmental levels to facilitate their ability to control attention and to acquire knowledge.

SUMMARY

Comprehension is not the process of transforming a stimulus on a page into a product. That digestive metaphor does not capture the generative nature of comprehension. The neural system provides a better metaphor. Neural systems, especially cognitive ones, are control systems. They do not transform input into output. They generate signals, strategies, and plans that relate events to one another and to memory to give them meaning and significance important for understanding and survival. Comprehension involves these generative processes.

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