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Research on teachers' efforts to influence the ways in which children approach memory tasks and understand and regulate their own memory processes has been limited, possibly because of the restrictive views of memory held by cognitive theories that have previously guided research efforts. A more complex perspective on the memory skills that develop over the elementary school years has been elaborated by developmental psychologists and information-processing theorists, but their work has had limited influence on either teacher-training practices or research in teaching. In order to begin to apply this newer perspective to an understanding of classroom teaching processes, research needs to consider teacher practices and expectations for children's learning and memory. A program of research that has been concerned with how teachers teach memory and metacognitive skills and with teachers' views of memory processes is summarized in this article, and implications for teacher training are discussed.

The manner in which memory is used and encouraged in the elementary school classroom is of interest both to psychologists and educators. Developmental psychologists have described the development of memory skills in children (see, e.g., Kail & Hagen, 1977; Ornstein, 1978) and have demonstrated that children are responsive to various training manipulations designed to increase their use of task-appropriate memory strategies (Flavell, 1970; Hagen, Jongeward, & Kail, 1975; Pressley, Heisel, McCormick, & Nakamura, 1982). Despite this strong interest in memory development, factors in the child's environment that contribute to developmental changes in

memory have received little research attention. There is limited information concerning the manner in which children are instructed in memory strategies and metamemory concepts in their day-to-day activities. The assumption guiding our work, then, is that it is reasonable to look to the school as a setting for the exercise, instruction, and refinement of memory skills during the elementary school years.

From an educational perspective, there has been increasing interest in an information-processing approach to children's acquisition and retention of knowledge (Snow, 1978; Wang, 1980). In particular, there appears to be an increasing awareness of the importance of memory as an aspect of cognition (Bromage & Mayer, 1981; Mullally, 1977; Wittrock, 1979) as well as an interest in applying research findings on memory development and memory strategy use to classroom activities (Corno, 1980; Higbee, 1979; Pressley & Levin, 1983a, 1983b; Wittrock, 1978). This represents a considerable change in emphases from the cognitive/learning theories that influenced both research and teacher training through the mid-1970s. As Dunkin and Biddle (1974) indicate, predominant theories guiding research on knowledge and intellectual aspects of teaching relegated memory processes to a very low level and implicitly devalued teaching that focused on memory. Both Bloom's taxonomy of educational objectives (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Seddon, 1978) and Guilford's model of the intellect theory (Guilford, 1967) view memory as a simple, automatic skill that teachers should emphasize less while they encourage in their students more abstract, complex, and advanced cognitions.

More recent theorists, presumably influenced by research in information processing and memory development, have conceptualized memory in more complex and multifaceted ways. R. M. Gagné (1977) for example, describes "cognitive strategies," which are defined as "internally organized skills that modify the learner's own processes of learning and thinking . . . They serve to select, modify, and control the processing that is carried out by the learner in attending, perceiving, encoding, retrieving, generalizing, and organizing responses" (p. 178; see also Gagné & White, 1978). Recent theorizing by Hakstian and Cattell (1978), Pellegrino and Glaser (1979), and Sternberg (1980, 1985) emphasizes components of intelligence in which memory factors and metacognitive skills play important roles. Developmental psychologists have shown that training experiences can substantially influence memory strategy use and generalization (Brown, Bransford, Ferrara, & Campione, 1983; Pressley et al., 1982), a finding with direct relevance for education. In particular, recent work on the training of metacognitive skills in children (Ghatala, Levin, Pressley, & Lodico, 1985; Leal, Crays, & Moely, 1985; Lodico, Ghatala, Levin, Pressley, & Bell, 1983; Pressley, Borkowski, & O'Sullivan, 1984) is important in showing that children can be taught to regulate their own memory activities on the basis of self-produced feedback about the quality of performance.

Despite this interest in memory processes in the fields of education and psychology, little research has been conducted to determine how teachers use concepts of memory development, strategy use, and metacognition in their teaching (Dunkin & Biddle, 1974; Simon & Boyer, 1974). Also, educational psychology textbooks generally give very little space to describing memory development and training. In a recent survey, Goetz and Chatman (1985) reported low coverage of important theorists and key concepts in the area of cognitive psychology in 24 introductory educational psychology textbooks. Similarly, we find that textbooks such as those of Biehler and Snowman (1982) or Davis (1983) often allot limited space to information processing, memory, and memory facilitation; more important, they present very little information concerning how either developmental changes or deliberate training efforts can affect these processes. Other textbooks we have examined provide even less information on memory and factors affecting its development. Metacognition and metamemory are only briefly considered, if at all, and few suggestions for how teachers might enhance memory and metacognitive capabilities in their students are discussed.

From the perspectives of both educational psychology and developmental psychology, then, an interest in memory development and the factors affecting it can be justified. We began our work with a concern for ways in which elementary school teachers, in the apparent absence of emphasis on memory in their training, would create procedures by which to regulate memory activities in the classroom. We also wondered what kinds of expectations teachers would hold for memory and metacognitive skills in the children they teach. In order to learn about teachers' practices and views, we carried out an observational study with teachers of elementary school children and asked these teachers to give us information about their expectations for children's memory and metamemory skills. We then conducted a study with children whose teachers varied in their use of strategy suggestions.

There were a number of questions that motivated this research: What kinds of strategy suggestions do teachers give children as ways of aiding their efforts to retain and recall information? How often are such suggestions made? How is the use of strategy suggestions related to other teaching activities? Do teachers show awareness of developmental levels in their suggestions for strategy use? What kinds of memory skills do teachers expect of the children in their classrooms? Are teachers' expectations developmentally appropriate in relation to previous research on memory development? And finally, how are children's memory skills affected by variations in their teachers' tendencies to offer strategy suggestions in the classroom?

TEACHING COGNITIVE SKILLS

In the first study, 69 teachers of Grades K through 6 were observed as they carried out language arts (reading, spelling, or language activities) or mathe-

matics instruction with children. Teachers were volunteers from public schools located in urban and suburban areas of a southern city. Teachers were grouped into a lower grades group that included kindergarten and first grades ($n = 17$), an intermediate grades group that included second and third grades ($n = 24$), and a higher grades group that included fourth through sixth grades ($n = 28$). Observations were made on five different days, usually over a period of several weeks, in order to sample different contexts and activities in the classroom (Powell, 1979).

In developing our observational scheme, we examined previous work on the teaching of cognitive activities (Dunkin & Biddle, 1974; Hyman, 1975; Simon & Boyer, 1974). None of the observational schemes we examined were explicitly concerned with teachers' efforts to guide children's memory activity, with teaching children about their own memory, or with regulating their memory activities. Therefore, we defined categories for our scheme that would allow us to code teachers' suggestions about strategy use, rationales that the teacher might give about the potential use or effectiveness of strategies, efforts to inhibit children's use of certain strategic activities, as well as a general category that coded any suggestions teachers might make about ways to process information in a lesson. In order to see how these behaviors would be related to cognitive instructional categories traditionally used in teacher observations, we also included a number of categories derived from previous research (Dunkin & Biddle, 1974; Simon & Boyer, 1974; Stallings, 1977).

A factor analysis of the observational data yielded a four-factor description of teaching activities. We described these factors in the following ways: First, and of particular interest for our work, is the factor that included teachers' suggestions to children about how to study, a factor we termed Cognitive Processes and Strategies. Items loading on this factor included a category scored when teachers gave suggestions about cognitive processes to be used by children in carrying out a lesson, one scored when learning or memory strategies were specifically suggested, another indicating a rationale for strategy use, another category scored when teachers attempted to suppress strategy use, and a final category scored when teachers encouraged children to verbalize their questions or problems with learning tasks.

Teachers do instruct children in the use of learning or memory strategies and give feedback about how such strategies can affect performance. However, such teaching activities do not occur with high frequency. On the average, teachers were observed to give strategy suggestions during only 2.28% of the 300 20-sec intervals in which they were observed; they gave a rationale about strategy use in less than 1% of the observation intervals. Such infrequent use of strategy rationales is distressing in light of the extensive work demonstrating the effectiveness of strategy training in promoting improved memory task performance, especially when children are informed about the

value of the strategy (Black & Rollins, 1982; Brown et al., 1983; Kennedy & Miller, 1976; O'Sullivan & Pressley, 1984).

A second factor, Interactive Teaching, consisted primarily of the use of questions and positive feedback during lessons. Teachers' use of questions categorized as convergent, memory, divergent, and evaluative was a central part of this factor, as were their positive responses to children, which were coded as acknowledgments of correct responses and praise. The most frequently observed behaviors in this factor were convergent questions and acknowledgment of children's correct responses. Least often observed were evaluative questions.

A third factor, Teacher Responses to Errors, consisted of several different responses a teacher could make to a child's error. Most often, teachers simply indicated that the child had made a mistake; sometimes, they gave a hint or rephrased a question the child had failed to answer correctly or told the child the correct answer; or finally and least often, they explained to the child the reason that his or her answer was not correct.

The fourth factor, Communication of Task-Related Information, involved transmission of information from the teacher to the students in a rather traditional fashion. Most frequently observed was the teacher's conveying of specific (factual) information about the content of lessons. We also observed teachers reviewing a previous lesson as a way of introducing a new topic, giving information about the goals and objectives of the lesson, instructing the child to remember something without giving any suggestions about how this was to be accomplished, and presenting lesson-relevant information in the form of abstract principles.

A question of particular interest was the extent to which teachers' interactive patterns would vary as a function of grade level taught. A developmental perspective on memory and cognitive skills (Rogoff & Wertsch, 1984; Wertsch, McNamee, McLane, & Budwig, 1980) would lead to the expectation that teachers would modify their suggestions regarding cognitive processes to fit the grade level of the child. For the other factors derived from our observational scheme, past research has not often focused on the question of grade differences. Therefore, we were interested in describing possible variations across grade level for these three factors, even though previous work did not give us a basis for proposing formal hypotheses about the nature of change. Differential use of the four factors over grade level was not strong, but it did show trends for a peak at Grades 2 and 3 for the factor representing cognitive processes, decreases over grade level in factors representing interactive teaching and responses to error, and an increase with grade level for the factor representing communication of task-related information. Subject matter primarily influenced the use of the cognitive processes factor, with instruction that included mathematics involving more suggestions regarding cognitive processes than did instruction in the language arts area.

STRATEGY SUGGESTIONS MADE BY TEACHERS

One of the goals of our study was to gain insight into the kinds of suggestions teachers make in order to aid children's memory and learning efforts and to assess whether such suggestions are developmentally appropriate. Therefore, as part of the observational procedure, in-class observers were trained to identify instances in which teachers either suggested cognitive strategy use or attempted to suppress cognitive strategy use by children. Observers coded as a strategy any instruction of a voluntary activity that children could employ toward the goal of learning or remembering information. For each of these occurrences, observers wrote a brief narrative description, noting the time interval and general situational context in which the suggestion was made. A classification scheme was developed to describe teachers' strategy instructions, using both the content of the observations and strategy definitions found in the literature as a basis for delineating categories (Table 1). After reliability of the 12 category definitions was established, raters were able to successfully classify 307 narratives describing 292 strategy suggestions and 15 attempts to suppress children's strategy use.

Teachers at all grade levels gave their students suggestions about preferred techniques for processing information, including recommendations for strategy use in dealing with mathematics and language arts lessons. However, strategy suggestions varied widely in frequency among teachers, with 10% (seven teachers) of the sample producing no such suggestions. Second- and third-grade teachers averaged 5.83 strategy suggestions over all observations, kindergarten and first-grade teachers gave an average of 4.0 suggestions, and fourth- through sixth-grade teachers averaged 3.0 suggestions. Examination of individual teachers' records indicated that every one of the second- and third-grade teachers made at least two strategy suggestions during observations.

The fact that second- and third-grade teachers made significantly more strategy suggestions than did teachers at other grade levels indicates some awareness of the value of strategy training with children at these grades. Second- and third-grade children are often characterized as "production deficient" for the use of certain fairly complex memory strategies such as organization or self-testing (Flavell, 1970; Flavell, Friedrichs, & Hoyt, 1970; Moely, Olson, Halwes, & Flavell, 1969). Children of these grades are also responsive to training manipulations designed to increase their effective use of memory strategies (Bjorklund, Ornstein, & Haig, 1977; Borkowski, Peck, Reid, & Kurtz, 1983; Leal et al., 1985; Moely et al., 1969; Pellegrino, Posnansly, & Vesonder, 1977). There are other considerations that may also be important in accounting for grade level differences. First, it is possible that subject-matter demands for memory activity increase at second and

third grades, requiring greater emphasis on memory processes than was necessary at kindergarten or first-grade levels (Leal et al., 1985). Second, by the fourth grade and beyond, teachers may find that children have mastered many strategies. For example, Leal et al. found that children tested at fourth grade were able to execute a self-testing strategy without having had prior instruction. Similarly, children of these higher grades are able to rehearse effectively without training (Flavell, Beach, & Chinsky, 1966; Ornstein, Naus, & Liberty, 1975; Ornstein, Naus, & Stone, 1977) and to organize material during study (Moely, 1977; Moely et al., 1969). Of course, there are many higher order, more complex strategies that these and older children do not produce spontaneously and for which instruction might be very useful (Pressley, Levin, & Bryant, 1983). But we rarely saw teachers attempt to instruct strategies of high complexity, as indicated by the category decriptions given in Table 1.

Changes in the type of strategy suggested at different grade levels also indicate that teachers were sensitive to developmental aspects of children's cognitive abilities. For instance, the strategy suggestion category that appeared most frequently overall and most frequently at earlier grade levels (K through 3) was the use of specific external aids in memorizing and problem solving (see Category 9, Table 1). Teachers frequently suggested the use of such aids as fingers or blocks to solve math problems, indicating that teachers at the lower grade levels try to aid children in their learning and problem-solving efforts by providing concrete representations of abstract concepts. Teachers suggested the use of attentional aids, as in Category 4 (e.g., using paper markers to follow along when reading), most often at the lower grade levels when children would be expected to have problems concentrating on the tasks at hand. Similarly, instructions to utilize general learning aids (see Category 10) such as dictionaries and glossaries were also age appropriate in that they peaked in Grades 4 through 6 when children may be expected to have the necessary skills and knowledge to utilize such aids correctly.

Although teachers rarely attempted to suppress spontaneous strategy use by children, such efforts tended to occur in conjunction with positive suggestions about cognitive processes and strategies. For example, attempts to suppress strategy use often involved admonitions to children not to count on their fingers in doing math problems; such instructions were sometimes accompanied by suggestions for the use of other external aids that would allow the representation of larger quantities.

We also found that subject matter is related to the kind of strategy suggested. For 4 of the 12 strategy categories, teachers' suggestions varied with subject matter in ways that reflect the demands of lesson content and goals. Effective mathematics instruction involves helping the child access the meaning of concepts, which can be facilitated by concrete representation through

TABLE 1

Classification of Teachers' Strategy Suggestions

1. *Rote Learning* (10.3% of all suggestions made).

Rote learning strategies are instructed for simple repetitive learning. Children are told to rehearse stimuli verbally or to write, look at, go over, study, or repeat the stimuli in some other way. The children may be instructed to rehearse items just once, a finite number of times, or an unlimited number of times. Rote learning strategies do not include any explicit activities that would add meaning to the stimulus or cause it to be processed to a deeper level or in terms of more extensive associative relationships.

2. *Elaboration* (8.6%).

The elaboration strategy is instructed for use with stimulus materials that generally do not have much intrinsic meaning to children, such as the definition or pronunciation of words. Children are instructed to use elements of the stimulus material and assign meaning by, for instance, making up a phrase or sentence, making an analogy, or drawing a relationship based on specific characteristics found in the stimulus material.

3. *Attention* (12%).

These strategies are suggested by teachers to direct or maintain children's attention to a task. For example, teachers may instruct children to "follow along" or "listen carefully" during lessons.

4. *Specific Attentional Aids* (7.9%).

This strategy is similar to the attention strategy, but children are instructed to use objects, language, or a part of their body in a specific way to maintain orientation to a task. Although these aids are employed in a specific way for the attentional task, they may have other uses ordinarily.

5. *Transformation* (6.8%).

Transformation is a strategy suggested by teachers for transforming unfamiliar or difficult problems into familiar or simpler ones that can then be solved more easily. Transformations are possible because of logical, rule-governed relationships between stimulus elements. Teachers identify these relationships and tell children either that a problem can be rewritten or that it can be reformulated if the method of solution is related or derived from rules and procedures learned previously. Due to the emphasis on logical, rule-governed relationships, this strategy is usually suggested in mathematics.

6. *Deduction* (11.3%).

In deduction, children are instructed to use their general knowledge, in combination with any clue from the material that seems helpful, to deduce and construct the correct answer. Teachers might direct children to use contextual information (e.g., pictures accompanying a text or parts of the text) or to analyze the item into smaller units (e.g., looking for root words, analyzing words phonetically).

TABLE 1 *(Continued)*

7. *Exclusion* (3.1%).

This is a strategy to help children answer test or workbook questions even if they don't know the correct answer initially. Children are told to eliminate incorrect options systematically, either by doing the problems they know first and then trying to match questions and answers that are left over or by trying out all possibilities and selecting the one that seems correct.

8. *Imagery* (3.8%).

This strategy usually consists of nonspecific instructions to remember items by taking a mental picture of them or to maintain or manipulate them in the mind. It also refers to visualizing procedures or characters.

9. *Specific Aids for Problem Solving and Memorizing* (15.4%).

This strategy involves the use of specific aids in problem solving or memorizing. Even though these aids may have other uses, the teacher instructs one specific application of them. Teachers may give explicit instructions on how to use the aids in the task at hand. Thus, children are instructed to use objects, food items, body parts, or assigned reading materials in learning and memory tasks. For example, teachers often tell children to use blocks or other counters to represent addition or subtraction operations in a concrete way.

10. *General Aids* (6.8%).

In contrast to specific aids, teachers recommend the same general aid for a variety of different problems. These aids are designed and used to serve a general reference purpose. Children often have prior training in their use and, once familiar with them, are expected to utilize them without further explanation. Examples include the use of dictionaries or other reference works.

11. *Self-Checking* (8.2%).

Teachers instructing this strategy suggest that children check their work for errors before turning it in. It includes procedures children can use on their own to make sure they are doing a task correctly. Teachers may also suggest that children test themselves or have someone else test them. Or children might be encouraged to keep track of all steps involved in a task so that they can later identify where they made a mistake. The instructions for this strategy are often not specific, but rather a general remark to "check" the work.

12. *Metamemory* (5.8%).

Teachers instructing this strategy tell children that certain procedures will be more helpful for studying and remembering than others, and sometimes teachers may also explain why this is so. The strategy frequently includes giving hints about the limits of memory, asking children about the task factors that will influence ease of remembering, or helping them understand the reasons for their own performance. Teachers may ask children how they can focus memory efforts effectively or what they can do to remember. Teachers also tell children that they can devise procedures that will aid their memory or indicate the value of using a specific strategy.

the use of specific aids (Category 9) or by the use of transformation strategies (Category 5) that show the relationship between the concept being learned and some simpler concepts that the child has already mastered.

Language arts instruction, on the other hand, often requires the child to use the materials given (e.g., letters, words, sentences, or picture context) in order to deduce the meaning of a word or larger unit of text when such meaning is not initially available (Category 6). Exclusion (Category 7), a less frequent strategy suggestion, was sometimes mentioned as a technique for dealing with language arts workbook exercises or tests in which some variant of a multiple-choice format was presented.

Teachers' provision of rationales for strategy use were also examined. Although such rationales occurred infrequently, as mentioned earlier, they more often accompanied strategy suggestions made by teachers of Grades 4 and above than those made by teachers of younger children. In accord with research that has shown greater effects of metacognitive training among relatively more mature children, then, teachers were showing some sensitivity to developmental level in their instruction (Brown, Campione, & Barclay, 1979; Ringel & Springer, 1980). Greater use of rationales at all grade levels would be desirable, however, as indicated earlier.

In summary, it appears that teachers suggest a variety of strategy suggestions, ranging from fairly rote (nonmeaningful) procedures to those that allow children to apply existing skills in combination with clues from the learning situation to achieve meaningful learning and problem solving. Rationales for strategy use and feedback regarding the effect of strategies on performance were given infrequently, although more were given to children in the higher grades. Greater emphasis on such metacognitive instruction at all grades would be highly desirable. The fact that teachers' suggestions vary over grade level suggests that elementary school teachers have some awareness of both developmental limitations and age-related improvements in children's cognitive strategy use.

TEACHERS' EXPECTATIONS FOR CHILDREN'S MEMORY

We also addressed questions concerning teachers' expectations for children's memory task performance. Of the teachers who had participated in the first study, 65 completed a questionnaire constructed on the basis of our review of the memory development literature. The questionnaire included items designed to assess teachers' perceptions of their children's use of memory strategies, knowledge of memory processes (metamemory), and ability to monitor or regulate their own memory processes (memory monitoring). In each part of the questionnaire, teachers were asked to make judgments about

the skills of students in their classrooms who were high, moderate, and low in achievement level. From these data, we were able to ask about teachers' awareness of developmental changes from two perspectives. First, because teachers evaluated the skills of their high, moderate, and low achievers, a comparison could be made of how similarly teachers saw children of these varying levels. Second, comparisons of teachers across grade-level groups (K–1, 2–3, 4–5–6) could be made to determine developmental differences not as seen by individual teachers, but as seen across teachers who worked with children of varying grades.

The first section of the questionnaire concerned teachers' views of memory strategy use by children. Teachers read descriptions of ways that children might deal with serial recall, free recall, and recall readiness tasks, and they were asked to identify strategies that their high, moderate, and low achievers would use in dealing with the tasks. Items were constructed on the basis of previous research so that one choice was a description of a clearly useful strategy (e.g., cumulative rehearsal for serial recall, conceptual organization of list items for free recall, or self-testing to determine recall readiness). Two alternative choices were descriptions of strategies sometimes shown by relatively immature learners (e.g., looking at or saying the names of stimulus items in preparation for serial or free recall, saying items a fixed number of times in preparation for recall in a recall readiness task), and one item represented nonstrategic study or a minimally effective strategy (e.g., brief examination of items followed by distraction for serial or free recall). These descriptions were derived from research reports of serial recall performance (Flavell et al., 1966; Hagen & Stanovich, 1977; Kellas, McCauley, & McFarland, 1975; Ornstein et al., 1977), free recall performance (Moely, 1977; Moely et al., 1969), and recall readiness (Brown et al., 1979; Flavell et al., 1970).

Teachers responded to each item by selecting the strategy a specified group of children (high, moderate, low achievers in their classroom; an ideal learner of the same grade level) would be expected to use. Their responses were coded on a 3-point scale to represent expectations ranging from relatively less to more mature (or effective) strategies. On the free recall and recall readiness tasks, teachers' expectations for strategic behavior varied both as a function of achievement level (with relatively higher achievers expected to show more sophisticated strategies) and across the grade level taught. Teachers of older children were more likely than those of younger children to expect their students to show mature strategies. However, on the serial recall task, which requires a simpler strategy (rehearsal), no achievement-level or grade-level differences were obtained because teachers at all grade levels expected rehearsal skills of their students. Variations in teachers' expectations for the different recall tasks are consistent with research findings indicating greater increases across elementary school grades in the use of organization and self-testing

strategies than in the use of rehearsal. Rehearsal, at least in a rudimentary form, has been found to occur in younger children. Keeney, Cannizzo, and Flavell (1967), for example, showed spontaneous rehearsal by more than two thirds of a group of first graders screened for the use of such a strategy. Teachers also showed developmentally appropriate expectations for several other strategies (saying or writing items, self-testing). These findings provide evidence that teachers do hold a relatively accurate developmental view of children's strategic skills, expecting mature learners to use more advanced memory strategies than less able learners.

Teachers' views of their students' knowledge about memory was assessed by giving the teachers descriptions of how children might answer several metamemory questions (of the form used by Kreutzer, Leonard, & Flavell, 1975) and asking them to identify the answers they might expect of their high, moderate, and low achievers. In general, teachers expected higher achievers to have greater knowledge of their own memories. Differences in expectations for metamemory knowledge by teachers of different grade levels were less notable.

The questionnaire also contained items that assessed teachers' views of the ability of their students to monitor the state of their knowledge or to use appropriate control processes to regulate study. As with the metamemory items, teachers showed significantly different expectations as a function of the child's achievement level, but there were few differences as a function of grade level taught. Overall, there were fewer differences among teachers of different grades in their expectations for memory knowledge and memory monitoring than might be expected on the basis of the research literature.

In summary, teachers are aware of developmental changes in several aspects of memory skill: They accurately expect more mature learners, whether indexed by achievement level or grade, to use more sophisticated recall strategies than less mature learners. This view is supported by research literature (Flavell, 1970; Kail & Hagen, 1977; Moely, 1977; Ornstein, 1978). In the area of metamemory, an indication that teachers were aware of developmental change is the differentiation made between expectations for high, average, and low achievers, as well as some variation in expectations across grade level. For certain aspects of memory, then, teachers showed awareness of developmental changes. At the same time, however, there were areas in which research has described notable developmental change during the elementary school years, but in which teachers did not show differences in their grade-related expectations. Teachers in the earlier grades, especially kindergarten and first grade, expected more mature and sophisticated memory knowledge and self-monitoring skills than their children would be likely to demonstrate. It is possible that these relatively covert cognitive skills are more difficult for a teacher to evaluate accurately than is the child's overt use of memory strategies.

CHILDREN'S MEMORY SKILLS

Finally, a further aim of our research was to find out whether children are affected in their learning styles by exposure to teachers holding different orientations toward cognitive instruction. On the basis of observations made in the first study, it was possible to identify a number of competent and interested teachers who varied in their use of the several behaviors involving cognitive processing instructions (including strategy suggestions). We selected eight teachers who very often suggested cognitive strategies and five who rarely did so. Teachers in these two groups were similar in their use of the observational categories included in the factors Interactive Teaching, Responses to Errors, and Communication of Task-Related Information. The two groups did not differ in age, years of teaching experience, years since completing the bachelor's degree, or the number of children in their classrooms at the time the research was done. From the classrooms of these 13 teachers, we selected 64 children from Grades 1, 2, and 3 who varied in achievement (as indicated by standardized test scores and teacher evaluations). The aims of the study were to compare the performance of children varying in grade, achievement level, and their teacher's teaching style on several tasks requiring memory activity.

The tasks varied in their similarity to tasks the child might encounter in school. A free recall task, in which children could remember items effectively by employing a category grouping strategy, was used to assess initial strategy use and also to evaluate the effects of a simple training procedure on performance immediately following training and at a later point in an individual test session. This task was probably quite different from tasks typically found in the school setting. Two other tasks, which were more similar to school activities, were used as well. One of these was a spelling task employing artificial words, a task developed in previous research on children's memory skills (Leal et al., 1985). The other task assessed strategy use and understanding in mathematics, an area in which we often saw teachers making suggestions about cognitive processes and strategies. Neither of the latter tasks involved strategy training. Instead, they were used to determine whether classroom experiences might be related to the ways in which children typically approach these familiar tasks.

The free recall task was used to examine grade, teacher, and achievement-level differences in children's use of a strategy before, immediately following, and subsequent to a brief, individually administered instruction in the use of the strategy. For several measures—including the proportion of list items recalled, the extent to which items were recalled in category groupings, and (especially among first graders) the extent to which items were sorted by category during study—differences were found in the extent of training maintenance: Average and low achievers whose teachers very often made sug-

gestions about cognitive processes and strategy use were more likely to continue using the trained strategy on the final learning trial than were similar children whose teachers rarely made such suggestions. For children who were high achievers, the nature of teachers' emphases did not make a difference in maintenance of the trained strategy. It was primarily in moderate and low achievers, then, that a relationship between teacher characteristics and performance was important. Similar suggestions regarding the greater influence of teacher characteristics on lower rather than higher achievers have been described in other studies (Mishra & Elkhanjari, 1983). On the spelling and arithmetic tasks, few differences appeared between children of teachers varying in strategy and cognitive suggestions.

Thus, a clear relationship between the extent of the teachers' instruction of cognitive processes and children's ability to profit by memory instruction was demonstrated. Children of teachers high in cognitive suggestions were also better able to verbalize aspects of the training procedure and task performance than were children whose teachers did not emphasize cognitive processes. These findings are correlational, of course, but they do provide a strong basis for experimental efforts to manipulate teachers' use of cognitive strategies and processes in order to examine the direct effect of such instruction on children's memory skills.

Our work has been an initial effort to learn about how teachers attempt to influence memory in the classroom, to find out what teachers expect of children in the way of memory skills, and to explore the extent to which their efforts may shape children's learning styles. The findings yield a somewhat mixed picture. Although teachers were observed to teach some very appropriate and innovative strategies during lessons and seemed to use many of these in ways that were appropriate both developmentally and in terms of subject matter, they seldom provided rationales for strategy use or explicitly instructed metamemory or self-monitoring activities. Consideration of teachers' expectations for children suggests that teachers may hold some unrealistic views of the memory knowledge and capability that young children possess.

Our findings offer some justification for a greater emphasis on the teaching of cognitive processes to children in the classroom and also for a greater emphasis on teaching teachers about the development of memory and cognition during their training. Efforts in this direction by Howe (1984) and by E. D. Gagné (1985) should be further incorporated into teacher training, and developmental aspects of cognitive processing, in particular, should receive greater attention. Exposure to descriptions of memory development and of research efforts to facilitate memory and metacognitive skills may provide a conceptual framework upon which teachers can develop more realistic expectations, as well as grade-appropriate procedures for regulating classroom activity so as to encourage children's developing memory skills. Greater in-

struction in the development of memory and metacognitive skills and more extensive information about how to facilitate such development would be a useful addition to any teacher-training curriculum.

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REFERENCES

Biehler, R. F., & Snowman, J. (1982). *Psychology applied to teaching* (4th ed.). Boston: Houghton Mifflin.

Bjorklund, D. F., Ornstein, P. A., & Haig, J. R. (1977). Developmental differences in organization and recall: Training in the use of organizational techniques. *Developmental Psychology, 13,* 175–183.

Black, M. M., & Rollins, H. A., Jr. (1982). The effects of instructional variables on young children's organization and free recall. *Journal of Experimental Child Psychology, 33,* 1–19.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (Eds.). (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I. Cognitive domain.* New York: Longman.

Borkowski, J. G., Peck, V. A., Reid, M. K., & Kurtz, B. E. (1983). Impulsivity and strategy transfer: Metamemory as mediator. *Child Development, 54,* 459–473.

Bromage, B. K., & Mayer, R. E. (1981). Relationship between what is remembered and creative problem-solving performance in science learning. *Journal of Educational Psychology, 73,* 451–461.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. In J. H. Flavell & E. M. Markman (Eds.), *Handbook of child psychology: Vol. 3. Cognitive development* (pp. 77–166). New York: Wiley.

Brown, A. L., Campione, J. C., & Barclay, C. R. (1979). Training self-checking routines for estimating test readiness: Generalization from list learning to prose recall. *Child Development, 50,* 501–512.

Corno, L. (1980). Individual and class level effects of parent-assisted instruction in classroom memory support strategies. *Journal of Educational Psychology, 72,* 278–292.

Davis, G. A. (1983). *Educational psychology: Theory and practice.* Reading, MA: Addison-Wesley.

Dunkin, M. J., & Biddle, B. J. (1974). *The study of teaching.* New York: Holt, Rinehart & Winston.

Flavell, J. H. (1970). Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), *Advances in child development and behavior* (Vol. 5, pp. 181–211). New York: Academic.

Flavell, J. H., Beach, D. H., & Chinsky, J. M. (1966). Spontaneous verbal rehearsal in a memory task as a function of age. *Child Development, 37,* 283–299.

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. (1970). Developmental changes in memorization processes. *Cognitive Psychology, 1,* 324–340.

Gagné, E. D. (1985). *The cognitive psychology of school learning.* Boston: Little, Brown.

Gagné, R. M. (1977). *The conditions of learning* (3rd ed.). New York: Holt, Rinehart & Winston.

Gagné, R. M., & White, R. T. (1978). Memory structures and learning outcomes. *Review of Educational Research, 48,* 187–222.

Ghatala, E. S., Levin, J. R., Pressley, M., & Lodico, M. G. (1985). Training cognitive-strategy monitoring in children. *American Education Research Journal, 22,* 199–215.

Goetz, E. T., & Chatman, S. P. (1985). Coverage of cognitive psychology in educational psychology textbooks. *Educational Psychologist, 20,* 41–46.

Guilford, J. P. (1967). *The nature of human intelligence.* New York: McGraw-Hill.

Hagen, J. W., Jongeward, R. H., Jr., & Kail, R. V., Jr. (1975). Cognitive perspectives on the development of memory. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 10, pp. 57–101). New York: Academic.

Hagen, J. H., & Stanovich, K. G. (1977). Memory: Strategies of acquisition. In R. V. Kail, Jr. & J. W. Hagen (Eds.), *Perspectives on the development of memory and cognition* (pp. 89–111). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Hakstian, A. R., & Cattell, R. B. (1978). Higher-stratum ability structures on a basis of twenty primary abilities. *Journal of Educational Psychology, 70,* 657–669.

Higbee, K. L. (1979). Recent research on visual mnemonics: Historical roots and educational fruits. *Review of Educational Research, 49,* 611–629.

Howe, M. J. A. (1984). *A teacher's guide to the psychology of learning.* Oxford, England: Basil Blackwell.

Hyman, R. T. (1975). *School administrator's handbook of teacher supervision and evaluation methods.* Englewood Cliffs, NJ: Prentice-Hall.

Kail, R. V., Jr., & Hagen, J. W. (Eds.). (1977). *Perspectives on the development of memory and cognition.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Keeney, J. J., Cannizzo, S. R., & Flavell, J. H. (1967). Spontaneous and induced verbal rehearsal in a recall task. *Child Development, 38,* 953–965.

Kellas, G., McCauley, C., & McFarland, C. E., Jr. (1975). Developmental aspects of storage and retrieval. *Journal of Experimental Child Psychology, 19,* 51–62.

Kennedy, B. A., & Miller, D. S. (1976). Persistent use of verbal rehearsal as a function of information about its value. *Child Development, 47,* 566–569.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. (1975). An interview study of children's knowledge about memory. *Monographs of the Society for Research in Child Development, 40*(1, Serial No. 159).

Leal, L., Crays, N., & Moely, B. E. (1985). Training children to use a self-monitoring study strategy in preparation for recall: Maintenance and generalization effects. *Child Development 56,* 643–653.

Lodico, M. G., Ghatala, E. S., Levin, J. R., Pressley, M., & Bell, J. A. (1983). The effects of strategy-monitoring training on children's selection of effective memory strategies. *Journal of Experimental Child Psychology, 35,* 263–277.

Mishra, S. P., & Elkhanjari, A. A. (1983). Interactive effects of instructional style and learner characteristics on academic achievement. *Journal of Instructional Psychology, 10,* 192–199.

Moely, B. E. (1977). Organizational factors in the development of memory. In R. V. Kail, Jr. & J. W. Hagen (Eds.), *Perspectives on the development of memory and cognition* (pp. 203–236). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Moely, B. E., Olson, F. A., Halwes, T. G., & Flavell, J. H. (1969). Production deficiency in young children's clustered recall. *Developmental Psychology, 1,* 26–34.

Mullally, L. (1977). Educational cognitive style: Implications for instruction. *Theory into Practice, 16,* 238–242.

Ornstein, P. A. (Ed.). (1978). *Memory development in children.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Ornstein, P. A., Naus, M. J., & Liberty, C. (1975). Rehearsal and organizational processes in children's memory. *Child Development, 46,* 818–830.

Ornstein, P. A., Naus, M. J., & Stone, B. P. (1977). Rehearsal training and developmental differences in memory. *Developmental Psychology, 13,* 15–24.

O'Sullivan, J. T., & Pressley, M. (1984). Completeness of instruction and strategy transfer. *Journal of Experimental Child Psychology, 38,* 275–288.

Pellegrino, J. W., & Glaser, R. (1979). Cognitive correlates and components in the analysis of individual differences. In R. J. Sternberg & D. K. Detterman (Eds.), *Human intelligence: Perspectives on its theory and measurement* (pp. 61–88). Norwood, NJ: Ablex.

Pellegrino, J. W., Posnansky, C., & Vesonder, G. T. (1977). Developmental changes in free recall: The interaction of task structure and age. *Journal of Experimental Child Psychology, 24,* 86–96.

Powell, M. (1979). Variable teaching behaviors: The importance of considering context in understanding teaching. *Educational Research Quarterly, 4,* 36–42.

Pressley, M., Borkowski, J. G., & O'Sullivan, J. T. (1984). Memory strategy instruction is made of this: Metamemory and durable strategy use. *Educational Psychologist, 19,* 94–107.

Pressley, M., Heisel, B. E., McCormick, C. B., & Nakamura, G. V. (1982). Memory strategy instruction with children. In C. J. Brainerd & M. Pressley (Eds.), *Verbal processes in children: Progress in cognitive development research* (pp. 125–159). New York: Springer-Verlag.

Pressley, M., & Levin, J. R. (Eds.). (1983a). *Cognitive strategy research: Educational applications.* New York: Springer-Verlag.

Pressley, M., & Levin, J. R. (Eds.). (1983b). *Cognitive strategy research: Psychological foundations.* New York: Springer-Verlag.

Pressley, M., Levin, J. R., & Bryant, S. L. (1983). Memory strategy instruction during adolescence: When is explicit instruction needed? In M. Pressley & J. R. Levin (Eds.), *Cognitive strategy research: Psychological foundations* (pp. 25–49). New York: Springer-Verlag.

Ringel, B. A., & Springer, C. J. (1980). On knowing how well one is remembering: The persistence of strategy use during transfer. *Journal of Experimental Child Psychology, 29,* 322–333.

Rogoff, B., & Wertsch, J. V. (Eds.). (1984). *New directions for child development: No. 23. Children's learning in the "zone of proximal development."* San Francisco: Jossey-Bass.

Seddon, G. M. (1978). The properties of Bloom's taxonomy of educational objectives for the cognitive domain. *Review of Educational Research, 48,* 303–323.

Simon, A., & Boyer, E. G. (Eds.). (1974). *Mirrors for behavior III: An anthology of observation instruments.* Wyncote, PA: Communication Materials Center.

Snow, R. E. (1978). Theory and method for research on aptitude processes. *Intelligence, 2,* 225–278.

Stallings, J. A. (1977). *Learning to look: A handbook on classroom observation and teaching models.* Belmont, CA: Wadsworth.

Sternberg, R. J. (1980). Factor theories of intelligence are all right almost. *Educational Researcher, 9,* 6–13, 18.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence.* New York: Cambridge University Press.

Wang, M. C. (1980). Adaptive instruction: Building on diversity. *Theory into Practice, 19,* 122–128.

Wertsch, J. V., McNamee, C. D., McLane, J. B., & Budwig, N. A. (1980). The adult-child dyad as a problem-solving system. *Child Development, 51,* 1215–1221.

Wittrock, M. C. (1978, March). *The art of memory and a model of generative learning.* Paper presented at the annual meeting of the American Educational Research Association, Toronto.

Wittrock, M. C. (1979). The cognitive movement in instruction. *Educational Researcher, 8,* 5–11.