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ABSTRACT

This study was designed to test preschoolers' thinking about strategies and the relationship between strategy selection and performance through the use of computer-presented puzzle tasks. A total of 61 children between the ages of 3 and 5 years were observed to see whether they used trial and error, model consultation, or a mixed strategy to solve animated puzzles. The children were divided into four groups, with each group receiving different levels of feedback before or during the testing by one of two teachers who had instructed them in the mechanics of computer-presented puzzles, and who were blind to the research hypothesis. It was found that the majority of children resorted to the trial and error method. Although a trial and error approach required more trials, it took a shorter period of time than the model consultation or mixed strategy. It appeared that the children were motivated to find the quickest solution to the puzzle rather than the most effective strategy. Contains 38 references. (MDM)

Strategies, Solutions, and Snoopy: Teacher-Child Dyads Solving Microcomputer Puzzles

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A strategy is a set of decision processes that determine what series of actions to take in solving a problem (Chi, 1978). The ability to access a model and gather information from it is a useful strategy used in puzzle-solving, particularly when customary cues such as the shapes of puzzle pieces are not available. Preschoolers however, do not spontaneously employ a model-consultation strategy and do not attend to relevant pictorial stimuli in a model. Research supports children under 5 years of age do not comprehend the strategic significance of looking at a model (Wertsch, McNamee, McLane & Budwig, 1980; Wertsch, Minick & Arns, 1984). Preschoolers often recognize a solution before they can produce it (Flavell, 1970; Olson, 1970). Research also indicates young children do not seem to have developed a strategic organization of examining a picture (Vurpillot, 1968; Day, 1975; Hale, 1979; Vurpillot & Ball, 1979). Young children have difficulty knowing what attributes to look for when scanning visual arrays and models.

Although age is highly correlated with pictorial attention strategies, information-selection strategies and recall of visual arrays, its acquisition is not always singularly marked by age and can depend on experimental conditions, knowledge about task stimuli and mediation (Olson, 1966; Belmont & Butterfield, 1977; Chi, 1978; Paris & Lindauer, 1982). Richards and Siegler's (1981) work demonstrated that 3 year-olds could adopt to systematic strategies in problem-solving with an encouragement to adopt analytic attitudes and exposure to similar tasks involving the same rule models. Vliestra (1978) found relevant observational behaviors of 3-5 year-olds improved significantly after strategy training involving verbal instructions, modeling, and fading using a pictorial task.

In the present study, a microcomputer-presented puzzle task provided an opportunity to examine whether preschoolers can employ a model-consultation strategy after receiving certain facilitating conditions of mediation: access of the puzzle model and analysis of the puzzle picture. Children's thinking about strategies and the relationship between strategy selection and performance were investigated empirically and within a Vygotskian theoretical framework.

Much of the early developmental cognitive research involved experimenters directing their subjects in an instructional approach with pointing, touching, naming, labeling, chunking, rehearsing, elaborating, applying rules and strategies (Belmont & Butterfield, 1977). Instructional intervention research, much of it set within anti-Piagetian hypotheses, sought to demonstrate that children's developmental limitations of conceptual operations could be altered with cognitive training. For example, Meichenbaum's (1977) research on cognitive behavior modification with impulsive children, involved training in sequential behaviors necessary to accomplish a task with the use of imagery and self-directed speech. Modeling, practice with feedback and cue highlighting appear to affect children's rate of strategy progress (Case, 1978). Klahr (1978) notes children's problem-solving behaviors have been characterized by empirical descriptions, global characteristics and procedural descriptions which all account for what develops but not how strategies develop. Much of cognitive strategy instruction research has generated performance models which may not account for the Vygotskian notions of dialectical negotiation and intersubjectivity.

From a metacognitive perspective, Brown & DeLoache (1978) note that children may not realize or know how to coordinate certain metacognitive operations like predicting, checking, monitoring an ongoing activity and reality testing. Siegler & Shipley (1987) question how much of a role explicit knowledge about one's capabilities or metacognition plays in children's strategy choices. Through the use of a computer simulation model of learning associations, Siegler et. al (1987) found that children chose the most rapid and effortless strategy as long as they could get the right answer. The amount of effort required, children's personal significance of the goal, a perception of the future benefits of a strategy and the level of motivation all play a role in strategic plans for action (Paris et al. 1982; Scardamalia & Bereiter, 1983). Furthermore, strategy development is related to one's experience, purposes and motivation within a social-cultural context (Paris et al. 1982). Stone (1986) criticizes current attempts at fostering strategic learning that merely involve technical training and declarative knowledge instruction and which consider the child an inactive, passive learner.

According to Vygotsky, higher order mental functions, like strategy thinking, are culturally mediated in dialogues of problem-solving whereby children have the opportunity to reconstruct inadequate strategies and reformulate new skills with adult assistance. Children's active coinvestigation of cognitive strategies is supported in collaborative learning contexts that enhance the development of children's own cognitive strategies (Vygotsky, 1981; Scardamalia et al. 1983). Vygotsky's theory (1978) emphasizes that tutor and tutee respond to each other, negotiating strategy significance withi the child's current level of understanding but leading to higher internal levels of thinking and children's self-regulation.

METHOD

Subjects

Sixty-one children, 34 girls and 27 boys, enrolled in a university child care and research center participated in the study. The children's ages ranged from 3.6 to 5.6 years with a mean age of 4.6 years and came from five different day care classes: 56% were in full-day care and 44% were in half-day care. Children were from middle-class, highly-educated families of diverse ethnicities. All children had received prior computer experiences through the center's microcomputer-integrated curriculum.

Teachers were both female, early childhood graduate students. Each teacher served as a tutor in each of the four experimental treatments and were blind to the research hypotheses. Children were randomly assigned to treatments, teacher and turn-taking order.

Experimental Setting and Materials

Training and testing were conducted in two research rooms, each equipped with a videotape recorder, a wall-mounted video camera, a ceiling-suspended microphone, an Apple II+ microcomputer and color monitor. Responses were made via the keyboard using highlighted keys. The software, Peanuts Picture Puzzlers (Random House/McGraw Hill, 1984), was novel to the children.

Criteria for Task Selection

A puzzle task was chosen for its problem-solving nature including memory components, visual attributes, spatial relations, and task familiarity. Pictures were colorfully detailed with friendly cartoon-like characters in familiar contexts of play and animated upon puzzle completion. Siegler et al. (1987) state that although unfamiliar Piagetian tasks have been used to provide indexes of children's basic reasoning, a more balanced and less artificial view of children's thought processes may be revealed with familiar tasks. Furthermore, the use of meaningful tasks has been thought to encourage the development of appropriate strategies (Smirnova, 1987).

The task had to be both entertaining, interactive and challenging in order to measure the strategy mediation and its effects. Children were first exposed to an easy 4-piece warm-up puzzle and then exposed to a more difficult puzzle. Pilot work indicated that 4-year-olds could easily solve a 4-piece puzzle. During a segment of the pilot study an 8-piece puzzle was tested and did not prove effective in teaching the model-consultation strategy. The 8-piece puzzle was too easy for most children and its design encouraged a part-fit strategy. A more difficult 16-piece puzzle with pieces of equal shape and size was more effective in investigating the mediation and acquisition of the model-consultation strategy (see Figure 1). Brown & Palincsar (1986) suggest that children should be presented with a view that not only conflicts with their own, but is also one they can take seriously.

Research Design

Two dimensions of instruction; its timing of model-consultation or "access mediation" and its informativeness or "analysis mediation" were investigated in a randomized pretest-posttest factorial design. Access mediation involved teacher suggestions for accessing or looking back at the model. These suggestions occurred either prior to problem-solving or during problem-solving; "prior access" versus "during access". Analysis mediation involved "analysis" versus "no analysis" of the puzzle model. In analysis, the teacher gave a pictorial analysis including perceptual features of objects and their spatial relations using indexing. The combination of these dimensions resulted in four treatment groups: "prior access/no analysis", "prior access/prior analysis", during access/no analysis", and "during access/analysis" (see Table 1). Two posttests, one immediately after instruction and another, one week later were designed to determine whether these factors were related to children's short and long term independent performance. By facilitating preschoolers' sensitivity to the information in the context of the experimental task, the "during access/analysis" treatment was designed to elicit the model-consultation behavior.

Procedures

Teacher Training. Teachers received training and practice in the application of the pretests, treatments and posttests. Teacher training included instruction and role-playing with the researcher, a review of the scripts, and video-taped scenes from piloting. Intervention guidelines and techniques for responding to children's learning efforts were provided in a manual.

Instruction and Interventions. Teachers' behaviors during treatment were guided by scripts that described and illustrated the behaviors appropriate for each treatment. The scripts are derived primarily from the work of Wood, Bruner & Ross (1976), Vygotsky (1978), Wood, Wood & Middleton (1978), Wertsch et al. (1980) and took over two years to develop. Teacher behaviors drawn from these sources were used to define four treatments. Treatment validity was then established through confirmation of these behaviors.

The "during access/analysis" or optimal mediational treatment, outlined teachers' usage of individually tailored feedback responsive to children's active collaboration and interactive learning. The "during access/no analysis" treatment offered only access mediation. It was hypothesized that when children direct their mental activities only on observable behavior such as the look-back suggestions, their behavior would merely reflect the motor action of accessing a model without an understanding of how the model access aids their search. The "prior access/analysis" was predicted to be ineffective in enhancing the model-consultation strategy because the access and pictorial analysis did not occur in the context of problem-solving or within a shared definition of task components. Furthermore, the large dosage of mediation prior to problem-solving taxed young children's very limited short-term memory span (Rohwer & Dempster, 1978). The "prior access/no analysis" treatment served as a control condition to test whether children's self-regulated model-consultation could improve with practice only.

Sessions. Children were trained and tested individually in three 15 to 20 minute sessions. The first session included instructions of the program manipulanda and a pretest. From an initial sample of 75 children, pretesting eliminated 9 children who exceeded the criterion of 2 look-backs (mean = 7.5 look-backs, range = 4-13) and 5 children who were inattentive to the task. Two days later in the second session, 61 children received one of four treatments and an immediate posttest. One week later in the third session, children received a delayed posttest.

Measures

Three measures are often used in model-consultation studies to assess children's self-regulated behavior. One measure is the child's correct placement of pieces without adult mediation or self-regulated piece placement. However, when first learned, higher order strategies may not always lead immediately to correct placements and alternative problem-solving strategies may do as well. A better, and more direct measure of strategy acquisition is whether a child actually consults the model. Nevertheless, a child might access the model and not use the information it provides. A third measure of strategy acquisition is thus whether a look-back is followed by a correct placement. Several other measures provide useful indications of the children's willingness to engage in the task. If for example, some groups take more time to complete the puzzle, or make more attempts to place pieces, these differences would have to be taken into account when evaluating children's puzzle-solving behavior and the process of self-regulated strategy acquisition.

Treatment Homogeneity and Validation

A category coding scheme was developed from the script to analyze and validate the videotaped tutoring sessions (see Table 2). Treatment validation measures were designed to confirm that the groups actually received the scripted treatments. The investigator coded all of the tutoring sessions including both teacher and child behaviors. A female graduate student, who was blind to the research hypotheses, and the researcher independently coded a random selection of 40% of the total sample. Overall agreement percentages between the coder and researcher was .99.

Children's Learning Behaviors

Children's learning behaviors during treatment and posttests were calculated from videotapes and included: self-regulated piece placements, children with self-regulated look-backs, children with piece retrieval after self-regulated look-backs, trials of piece insertion, test time, and strategy type. The overall interobserver agreement between two coders for posttest measures was .99 and .91 for the post hoc measure of individual strategy differences.

Coding Individual Strategy Differences

The coding of individual strategy differences was established by viewing videotapes from a macro to micro sequence. The global viewing revealed three types of strategy users: trial and error, mixed strategy, and model-consultation.

Trial and error users never used the model-consultation strategy; used impulsive guessing; often took less time than other strategy users; had many tries and gave verbal evidence of a trial and error approach (e.g. "Tell me when I'm finished". "I keep hitting this key then that key, that's how I do it". "Oh I'm tired of hitting this"). Nonverbal indicators of trial and error type included children's rhythmical body rocking, synchronized with key press action and accompanied with motor-like sounds. A trial and error strategy permitted children to place pieces without receiving adult assistance.

The mixed strategy approach children did not consistently use the model-consultation strategy. The pattern of mixed strategy user change involved a period of variable performance in which higher level but mainly lower level strategies were used. Many of these children looked once at the model in the early stage of puzzle-solving, most often before the sixth piece placement, then abandoned the strategy to a trial and error approach which required less adult assistance; was easier and sometimes quicker.

The model-consultation users accessed the model, especially when having difficulty, evidenced by several incorrect selections and then returned to the model. This was often accompanied by verbalizations (e.g., "Let me see"). The model-consultation users were often effective in retrieving pieces after a look-back and employed the strategy throughout the puzzle-solving.

RESULTS

To explore children's self-regulation of the model-consultation strategy and their use of alternative strategies, a series of analyses were performed. First, analyses of variance (ANOVA) were performed on the measures of self-regulated piece placements, trials and test time to examine for differences in treatments. Second, intercorrelations between self-regulated piece placements, trials, test time and self-regulated look-backs were investigated. Third, a three-way chi-square analysis was performed to examine for individual strategy differences. Fourth, strategy types were then examined in relation to self-regulated piece placements, trials and test time using ANOVA. Fifth, proportions of time with trials and with self-regulated piece placements were investigated in relation to strategy types using ANOVA.

Test time and Trials

Table 3 shows that treatments did not significantly affect the level of teacher assistance, the speed of problem-solving or motivation as indexed by the number of problem-solving efforts. Self-regulated piece placements, test time and effort were the same on the average for children regardless of mediation, however large standard deviations revealed differences within groups. The analyses indicate that the measures of self-regulated piece placement, test time, and trials were not sensitive measures of children's self-regulated model-consultation. Further analyses revealed interesting relationships among variables and particularly across strategy type users and treatments.

Relationships among variables

Pearson product-moment correlations among self-regulated piece placements and test time demonstrated that children who took more time to complete the puzzle had fewer self-regulated piece placements or received more adult assistance in the immediate and delayed posttests, -.50, $p < .001$ and -.63. $p <$

.001, respectively. Children who had fewer trials also took longer to complete the puzzle in both posttests, -.40, p < .000 and -.37, p < .001. However, children who took more test time, also had significantly more self-regulated look-backs in both posttests, .32, p < .01 and .67, p < .001 (see Table 4).

Types of Individual Strategy Differences

A three-way chi-square analyses was performed to examine for individual strategy differences within treatments. The results, displayed in Table 5 reveal that children exhibited significantly different approaches in their attempts at puzzle-solving. Significant main effects were revealed in the immediate posttest for access main effect, Chi (2,N = 61) = 9.78, p < .007 and for the interaction effect of "during access/analysis" versus all other treatments, Chi (2,N = 61) = 9.82, p < .007. On the delayed posttest, children in the "during access/analysis" treatment were more likely to be model-consultation and mixed strategy users whereas, children in the "prior access/no analysis" were all trial and error users. Chi-square analyses revealed significance for the access main effect, Chi (2,N = 61) = 12.10, p < .002, for the analysis main effect, Chi (2,N = 61) = 9.61, p < .008, and for the interaction effect, Chi (2,N = 61) = 13.78, p < .001.

Relationship Between Strategy and Performance

ANOVA's were conducted to test for differences in strategy types as related to self-regulated piece placements, test time and trials in two posttests (see Table 6). Significant differences were found for all measures in the immediate posttest: self-regulated piece placements, $F(2,58) = 3.6$, $p < .03$, test time, $F(2,58) = 5.88$, $p < .005$, and trials, $F = (2,58) = 3.44$, $p < .03$. The model-consultation strategy users had fewer self-regulated piece placements than the trial and error and mixed strategy users (M's = 8.4 versus 12.3 and 13.7 respectively). Test time was almost twice as long for the model-consultation users as it was for the trial and error and mixed strategy approach users (M's = 8.4 versus 4.5 and 4.79 respectively). They also had fewer trials than the trial and error and mixed strategy approach users (M's = 33.4 versus 56.0 and 49.4 respectively). Significant differences were found in the delayed posttest: self-regulated piece placements, $F(2,58) = 3.75$, $p < .03$, test time, $F(2,58) = 21.25$, $p <= .0001$, and trials, $F(2,58) = 3.96$, $p < .02$.

Proportions of Time with Measures and Strategy Types

To further investigate differences in strategy types, the proportion of time to variables was calculated. As depicted in Table 7, the proportion of time to trials resulted in the trial and error group having the largest average number of trials per minute for the immediate and delayed posttests (range = 4.61 - 18.10 and 4.31 - 17.01 respectively). Furthermore, the pattern and frequencies are similar over time. ANOVA's yielded larger differences over time, $F(2,58)) = 3.11$, $p < .05$, immediate posttest and $F(2,58) = 7.17$, $p < .001$, delayed posttest.

Secondly, differences in the proportion of time to self-regulated piece placements was examined in relation to strategy types. As indicated in Table 6, the composition of the proportions differ between strategy types and more so in the delayed posttest. Significant differences for self-regulated pieces placed per minute were found in the delayed posttest, $F(2,58) = 6.70$, $p < .002$. Children who took less time placing puzzle pieces without assistance also had more trials per minute. This analyses provides further evidence that children placed puzzle pieces quickly and without assistance by using a trial and error strategy. It also indicates that the strategy development can be viewed as an extended process that becomes more characteristic over time.

DISCUSSION

General Findings

Examining patterns of relationships among measures and over time indicated that children found different ways to solve puzzles. Significant differences were not found on the measures of self-regulated piece placements, test time, and trials of piece insertion, but were found when these same measures when correlated with each other. Significant differences were found for self-regulated piece placements, test time, and trials of piece insertion in relation to individual strategy differences and in proportion to time. Treatments differed significantly in the strategy approach employed by children.

The relationships among these measures suggests that self-regulated piece placements as a measure of self-regulated model-consultation is task specific. Multiple measures examined in relation to each other and over time, may better serve researchers in their attempts towards understanding young children's self-regulation of a culturally-mediated strategy.

Children's acquisition of a model-consultation strategy is enhanced with "during access/analysis" mediation, not immediately but over a short period of time. Given the brevity of the 15-20 minute mediation, and working with a stranger, the improvements made by children in this study are educationally significant. The composition of children's behaviors differed markedly between groups and more so on the delayed posttest. A longer intervention time involving more mediational sessions might have resulted in more immediately significant findings.

Children's understanding of the strategic significance of looking and studying a model as a cue in puzzle-solving did not necessarily occur in an all or none fashion and instead passed through a transitional zone itself. Those children attempting to utilize the model-consultation strategy may not have fully grasped the concept.

In contrast, a large number of children who had not received optimal mediation were groping for some task solution and found out quickly that a trial and error approach would also allow one to finish the puzzle without teacher assistance. From a developmental viewpoint, Piaget (1976) claims a trial-and-error reasoning seems to characterize problem-solving of younger children. In this study, the majority of children were trial and error users. Although a trial and error approach required more trials, it took a shorter period of time. Some children employed a "quasi-systematic" strategy by pressing the piece selection key three times and then inserting the piece without checking back at the model. Olson (1966) found a similar behavior with three and four-year olds who employed a primitive search strategy in a model-consultation task with an electric bulb model. Children pressed the edge bulbs even though the search was independent of the models made available.

The abandonment of old strategies poses an alternative analysis technique for developmental psychologists who might typically view only the development of new strategies (Kuhn & Phelps, 1982). The "during access/analysis" group showed the greatest decrease in the use of the trial and error strategy. The pattern of their behaviors over time suggests a gradual acquisition the model-consultation strategy. The majority of children in all other treatments were trial and error users in both posttests. The poor performance demonstrated by the "prior access/no analysis" or control group, suggests that improvement cannot be explained solely as a function of practice.

Perhaps the mixed strategy approach users were those children who had rudimentary ideas about the strategic significance of looking and studying a model but abandoned the model-consultation strategy because it took longer and was more difficult to employ.

In the present study, trial and error and mixed-strategy users often commented about when and what was going to animate after the puzzle was completed. A trial and error strategy accomplished that objective the fastest. Children may have been more motivated to make the characters animate than acquiring a strategy for puzzle-solving. Although the animation served as a motivational lure for children's attention to the puzzle-solving, it also served as a motivation to complete the puzzle, one way or another. Schabule (1989), investigating children's problem-solving exploration, found that children's objectives did not always match the experimenter's goals. In Schauble's study, elementary-aged children tried to build the fastest car possible instead of complying with the researcher's request to estimate the differentiating factors of a computerized car's speed. Schauble concludes that all children are natural problem-solvers and often seek to find a solution rather than a strategy. Similarly, Kuhn et al. (1982) found children made attempts to replicate an experiment instead of complying with an experimenter's request to explore color change in a chemical experiment. Litowitz (1990) addresses the issue of children's resistance to mediation that stems from an adultocentric viewpoint and states that "the motivation cannot be mastery of the other's skill but to be the other by means of mastery of the skill" (1990, p. 139). Children in the "during access/analysis" treatment chose more often than other treatments to be more like the adult problem-solver on the interpsychological plane.

However, some children's statements reflected transitions towards their self-regulation on the intrapsychological plane. Perhaps the optimal mediation enabled the resulting model-consultation users to perceive the adult as attempting to negotiate an intersubjective situation definition (Wertsch, 1984) with them and not for them.

This research opened a window into children's thinking and apprenticeship in strategy usage in a microcomputer-presented problem-solving task. The integration of adult perceptual and spatial descriptions to children's specific actions during problem-solving with indexing, assessments and repetitions of the strategic significance of accessing the model, proved to be effective tools in luring and convincing children to continue with the task and strategy despite its initial difficulty, in structuring the activity and in enhancing children's later independent functioning.

Implications

This study demonstrated that teachers can adapt and extend children's learning via a computer. With the burgeoning use of microcomputers in early childhood classrooms, this study suggests that human tutors should be integrated with children's learning in microcomputer-based problem-solving activities. Computer settings can invite contexts for dialogue that can benefit children working with their parents as well.

There is much research needed on the role of teachers diagnosing, mediating and remediating children's problem-solving efforts in computer contexts. There may be value in testing and incorporating some of the ideas of this tutoring in naturalistic settings and for a longer period of time. It is recommended that future researchers might utilize a combination of quantitative and qualitative analysis to give both a rich and sophisticated account of what has taken place before, during and after mediation. Continued research is needed to address more subtle and affective teacher behaviors, such as laughter, motivation, rapport, the use of touch and body distance, tone and amount of questioning, and teacher control, which are coherently linked to specific research questions. The investigation of these behaviors may be the hidden agenda that needs further attention in understanding the mediational process and how it affects children's effective strategy choices.

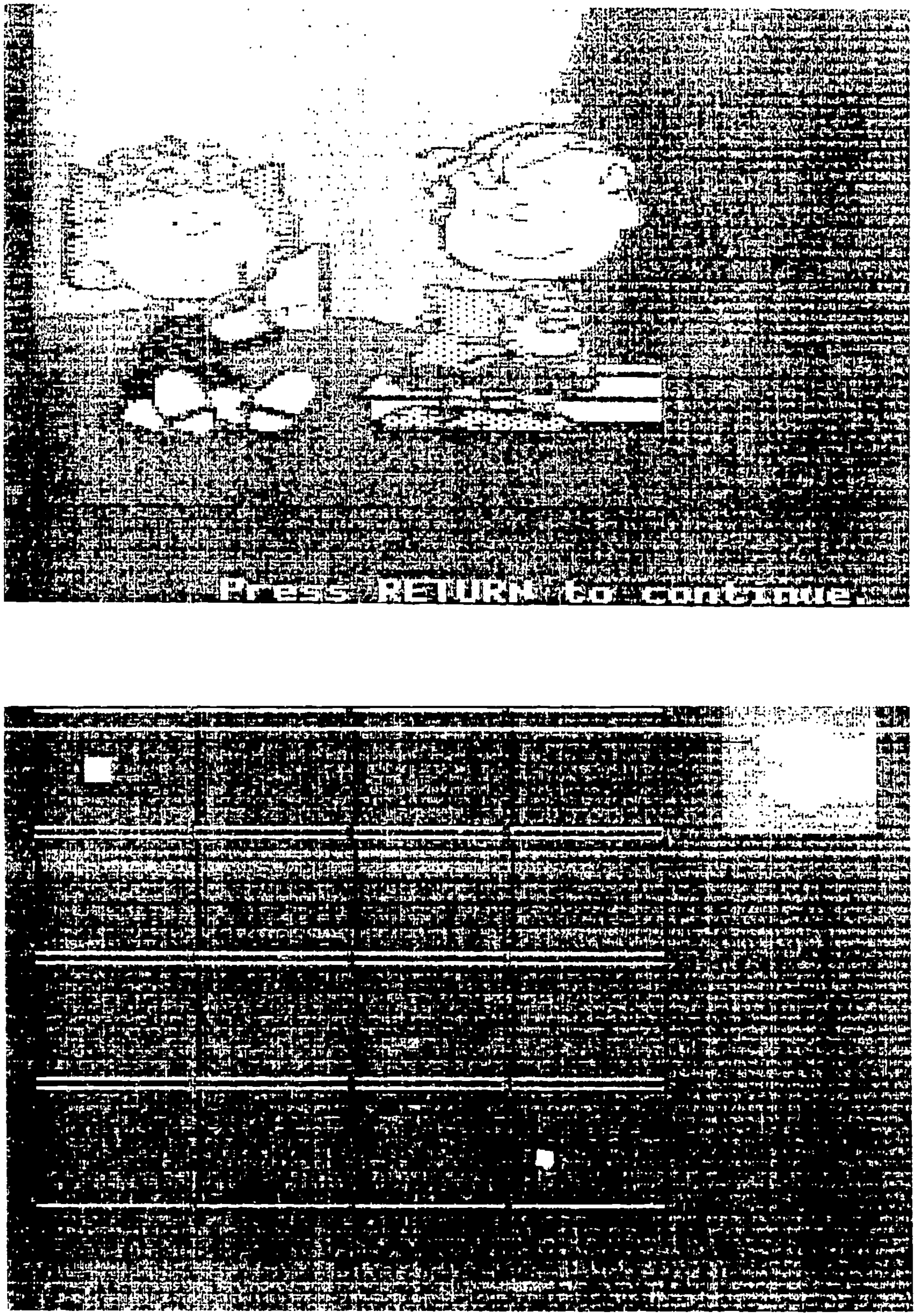

Figure 1. Example of experimental task

Table 1

Definitions and Examples of Teacher Behaviors and Treatment Components for Four Treatment Groups

Descriptive Definitions	Treatments: Prior Access No Analy	Prior Access Analy	During Access No Analy	During Access Analy
*** Look-back:** Teacher suggestion that child look at model; verbal only (e.g. "Looking at the whole picture will help you remember where the pieces in the puzzle belong").	X	X		
***Contingent Look-back:** Teacher suggestion that child look at model contingent on child's error. Implicit or explicit utterances of model or actual demonstration (e.g. "Do you remember what you do when you want to see where the next puzzle piece belongs?" This is a good time to look at the model".			X	X
****Picture Analysis:** Global analysis describing picture puzzle, including characters' physical characteristics, clothing, objects; descriptions of shape, space, color, line, size (e.g. "Freida has red, curly hair." "There are white, fluffy clouds at the top of the picture").		X		
Contingent Picture Analysis: Statements describing a segment of the picture puzzle in which child is having difficulty.				X
Indexing: Pointing at model with global analysis.		X		X
Contingent Indexing: Pointing to model or picture segment during picture analysis.				X

Descriptive Definitions	Treatments: Prior Access		Treatments: During Access	
	No Analy	Analy	No Analy	Analy
Spatial References: Statements referencing puzzle piece location in model and computer cursor in puzzle space of the dissected puzzle (e.g. "We're looking for this part of the picture". "Where is the space with the small white box?" "Where was the last piece?").				X
+Reflective Assessments: Statements focusing child's attention to the functional significance of actions, suggesting appropriate means used in reaching goal. Used with successful piece placement, to partially completed puzzle and to completed puzzle (e.g."Now the cloud is exactly in the same place in both the puzzle and the picture".)				X
Positive Reinforcements Statements which reinforce child's success of each piece placement (e.g."Good").	X	X	X	X
++Assistance: Teacher assisted piece placement with implicit or explicit utterances or demonstration (e.g. "What do you think about this one?" "Let's try this one".	X	X	X	X

<u>Note.</u> Analy = Analysis

* These codes and definitions were adapted for the purposes of this study from Wood et al. 1978; Wertsch et al. 1980.

** This code and definition was adapted for the purposes of this study from Moss, 1983; Brookes, 1986.

\+ This code and definition was adapted for the purposes of this study from Wertsch et al. 1987.

++ This code and definition was adapted for the purposes of this study from Emihovich, Miller & Claire, 1985.

Table 2

Means, Standard Deviations, and F-ratios for Teacher Behaviors Assessed During Treatment

Measure	Prior Access No Analy (n=14)	Prior Access Analy (n=17)	During Access No Analy (n=15)	During Access Analy (n=15)	Access	Analy	Access x Analy
Look-Back	[a].21 (.58)	.82 (1.59)	6.67 (3.84)	9.13 (3.20)	120.75***	5.10**	1.88
Picture Analy	.21 (.43)	19.50 (1.77)	.67 (1.59)	24.00 (14.0)	1.98	136.96***	1.22
Index	.14 (.36)	.94 (.24)	.46 (.52)	1.00 (.00)	4.64**	60.31***	2.37
Spatial Ref	.85 (1.61)	.82 (1.28)	1.87 (2.20)	7.60 (2.61)	63.02***	30.70***	32.18***
Reflect Assess	.00 (.00)	.00 (.00)	.20 (.56)	4.67 (5.19)	14.65***	11.04**	11.30***
Pos Reinf	12.29 (3.56)	11.94 (3.91)	12.73 (2.05)	12.00 (4.27)	.07	.34	.04
Assist	4.64 (3.83)	3.47 (3.10)	2.93 (2.76)	3.00 (3.14)	1.65	.46	.56

Note. Analy = Analysis; Ref = Reference; Reflect Assess = Reflective Assessments; Pos Reinf = Positive Reinforcements; Assist = Assistance.

[a] Means and standard deviations in parentheses; ANOVA, df = 1 for access, 1 for analysis, 1 for access x analysis, df = 57 within.

** $p < .01$.
*** $p < .001$

Table 3

Means, Standard Deviations, F-ratios and Chi-square Values of Children's Behaviors Assessed in Immediate Posttest

Measure	Prior Access No Analy (n=14)	Prior Access Analy (n=17)	During Access No Analy (n=15)	During Access Analy (n=15)	Access	Analy	Access x Analy
Immediate Posttest							
SR Piece	[a]12.50 (3.10)	12.00 (4.11)	12.47 (5.00)	12.40 (3.72)	.04	.12	.14
Test Time	4.36 (2.17)	4.35 (2.26)	4.87 (2.07)	6.0 (3.52)	2.17	1.54	.00
Trials	55.43 (20.5)	54.88 (22.3)	50.13 (18.2)	50.00 (18.7)	1.23	.00	.00
Delayed Posttest							
SR Piece	13.50 (1.74)	12.76 (3.15)	12.47 (3.76)	12.60 (2.88)	1.69	.00	.13
Test Time	3.9 (1.73)	5.7 (4.78)	5.6 (2.85)	6.2 (3.63)	.01	.00	.03
Trials	53.07 (22.4)	53.59 (17.6)	49.00 (17.9)	48.27 (16.1)	.01	.82	2.69

Note. Analy = Analysis; SR Piece = Self-regulated piece placement.

[a] Mean and standard deviation in parentheses. F-ratios; ANOVA, df = 1 for access, 1 for analysis, 1 for access x analysis, df = 57 within.

Table 4

Intercorrelations Among Four Variables, Immediate Posttest

Variables	1	2	3	4
1. SR Piece	-	-.50***	.54***	-.06
2. Test Time	-	-	-.40***	.32**
3. Trials	-	-	-	-.13
4. SR Look	-	-	-	-

Intercorrelations Among Four Variables, Delayed Posttest

Variables	1	2	3	4
1. SR Piece	-	-.63***	.40***	-.16
2. Test Time	-	-	-.37***	.67***
3. Trials	-	-	-	-.24*
4. SR Look	-	-	-	-

Note. SR Piece = self-regulated piece placement; SR Look = self-regulated look-back.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 5

Means, Standard Deviations, and Chi-square Values of Children's Individual Strategy Differences

Measure	Prior Access No Analy (n=14)	Prior Access Analy (n=17)	During Access No Analy (n=15)	During Access Analy (n=15)	Access	Analy	Access x Analy
Immediate Posttest							
Strategy Types:					9.78**	5.15	9.82**
Trial Error	[a]13 (92.9)	14 (82.4)	8 (53.3)	7 (46.7)			
Mixed	1 (7.1)	2 (11.8)	7 (46.7)	4 (26.7)			
Model-Consult	0 (0)	1 (5.9)	0 (0)	4 (26.7)			
Delayed Posttest							
Strategy Types:					12.10**	9.61**	13.78***
Trial Error	14 (100)	11 (64.7)	9 (60)	3 (20)			
Mixed	0 (0)	5 (29.4)	2 (13.3)	7 (46.7)			
Model-Consult	0 (0)	1 (5.9)	4 (26.7)	5 (33.3)			

Note. Analy = Analysis; Model-Consult = model-consultation.
[a] Number of cases in each group; proportions in parentheses.
Chi-square, df = 2, N = 61.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 6

Means, Standard Deviations, F-ratios of Self-regulated Piece Placements, Test Time and Trials by Strategy Differences

Measure	Trial & Error (n = 42)	Mixed (n = 14)	Model (n = 5)	F
Immediate Posttest				
SR Piece	[a]12.33 (3.58)	13.71 (3.62)	8.40 (5.94)	3.60*
Test Time	4.50 (2.38)	4.79 (1.53)	8.40 (4.28)	5.88**
Trials	56.02 (19.76)	49.35 (18.70)	33.40 (9.34)	3.45*
Delayed Posttest	(n = 37)	(n = 14)	(n = 10)	
SR Piece	13.03 (2.82)	13.79 (2.57)	10.70 (3.13)	3.75*
Test Time	4.24 (1.99)	4.79 (2.48)	10.50 (4.69)	21.25***
Trials	55.49 (18.99)	48.14 (17.20)	38.60 (8.96)	3.96*

Note. SR Piece = Self-regulated piece placement. Model = model-consultation.

[a] Mean and standard deviation in parentheses. df = 2,58.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 7

Means, Standard Deviations, F-ratios of Proportion of Time for Trials and Self-regulated Piece Placements by Individual Strategy Differences

Measure	Trial & Error (n = 42)	Mixed (n = 14)	Model (n = 5)	F
Immediate Posttest				
Trials per Minute	[a]18.10 (14.40)	12.33 (8.56)	4.61 (2.26)	3.11*
SR Piece per Minute	4.03 (3.46)	3.40 (1.93)	1.32 (1.30)	1.82
Delayed Posttest	(n = 37)	(n = 14)	(n = 10)	
Trials per Minute	17.01 (11.39)	12.45 (6.64)	4.31 (1.87)	7.17***
SR Piece per Minute	3.97 (2.21)	3.84 (2.31)	1.29 (.92)	6.70**

Note. SR Piece = Self-regulated Piece Placement. Model = model-consultation.

[a] Mean and standard deviation in parentheses. df = 2,58.

* $p < .05$.

** $p < .01$.

*** $p < .001$

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