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ABSTRACT

This experiment explored how incorporating the importance of task strategy use and positive achievement beliefs into cognitive modeling affected self-efficacy and skill acquisition. Students deficient in division skills received cognitive modeling of division solution strategies and practice opportunities. For one group of students the cognitive modeling stressed the importance of using task strategies, for a second group it emphasized the importance of positive achievement beliefs, students in a third condition received modeled importance of both task strategy use and positive achievement beliefs, and those in a fourth condition received cognitive modeling alone. Modeling the importance of using task strategies enhanced students' motivation and skill development, but modeling the importance of both task strategies and achievement beliefs led to the highest self-efficacy. Implications for teaching are discussed. (Author)

Modeled Importance of Learning Strategies and Children's Achievement Behaviors

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Abstract

This experiment explored how incorporating the importance of task strategy use and positive achievement beliefs into cognitive modeling affected self-efficacy and skill acquisition. Students deficient in division skills received cognitive modeling of division solution strategies and practice opportunities. For one group of students the cognitive modeling stressed the importance of using task strategies, for a second group it emphasized the importance of positive achievement beliefs, students in a third condition received modeled importance of both task strategy use and positive achievement beliefs, and those in a fourth condition received cognitive modeling alone. Modeling the importance of using task strategies enhanced students' motivation and skill development, but modeling the importance of both task strategies and achievement beliefs led to the highest self-efficacy. Implications for teaching are discussed.

Modeled Importance of Learning Strategies and Children's Achievement Behaviors

According to Bandura's social learning theory, different psychological procedures change behavior in part by creating and strengthening a sense of <u>self-efficacy</u> (Bandura, 1977, 1981, 1982). Self-efficacy refers to personal judgments of one's performance capabilities in specific situations that may contain ambiguous, unpredictable, and stressful features. Self-efficacy is hypothesized to influence choice of activities, effort expended, perseverance, and task accomplishments. People acquire information about their self-efficacy in given situations through self-performances, socially comparative vicarious (observational) means, forms of persuasion, and physiological indexes.

Although self-efficacy originally was employed to help explain coping behaviors in fearful situations, its role has been extended to other contexts including cognitive-skill acquisition (Schunk, 1981, 1982, 1983). This latter research has shown that educational practices (e.g., goal setting, reward contingencies, feedback) are important contextual influences on self-efficacy (Schunk, in press). In turn, self-efficacy affects skill development.

One common educational practice is modeling. There is much evidence that modeling is an effective means of teaching skills, general rules, and problem-solving strategies (Bandura, 1971; Rosenthal & Bandura, 1978; Rosenthal & Zimmerman, 1978; Zimmerman & Rosenthal, 1974). Modeling also is a vicarious source of efficacy information (Bandura, 1977, 1981, 1982). Observers may experience higher self-efficacy from observing a model perform a task because modeling implicitly conveys that they are capable enough to successfully perform the same sequence of actions (Schunk, in press). This vicarious sense of efficacy is substantiated later as observers work at the task and experience some success.

In a study exploring the effects of modeling on self-efficacy during cognitive-skill acquisition (Schunk, 1981), children (M = 9.8 years) deficient in division skills received either cognitive modeling of division operations or didactic instruction, along with practice opportunities, over three sessions. During cognitive modeling, children observed adult models verbalize aloud cognitive operations as they solved division problems contained on explanatory pages. In the didactic treatment, children studied the same explanatory pages on their own. These pages included explanations of the solution strategies and step-by-step examples of their application.

Although cognitive modeling led to higher division skill, both treatments enhanced division self-efficacy equally well. This latter finding seemed surprising in light of the hypothesized benefits of modeling on self-efficacy. Schunk (1981) suggested that didactic subjects may have been overly swayed by their modest training successes while remaining largely uninformed of the extent of their deficiencies.

The effects of cognitive modeling on self-efficacy might have been greater had the importance of using the division solution strategies been stressed to subjects; that is, how consistent strategy use could benefit their performance on different tasks. Research shows that merely modeling task-solution strategies may not have much effect on children's performances (Borkowski, Levers, & Gruenenfelder, 1976; Kramer & Engle, 1981), but that consistent and effective strategy use is enhanced by conveying strategy importance (Kennedy & Miller, 1976). It also has been suggested that strategy importance can be transmitted through modeling (Borkowski et al., 1976).

One purpose of the present study was to determine the effects of incorporating the importance of task strategy use into cognitive modeling on self-efficacy and skillful performance. Students with division-skill deficiencies received cognitive modeling of division solution strategies and practice opportunities over sessions, similar to the Schunk (1981) study. Included in the cognitive modeling for some subjects was information that consistent use of division solution strategies had benefited other students' performances, which was designed to convey the importance of strategy use. The solution strategies emphasized were: (a) proper application of division operations (steps), and (b) careful computations (multiplication and subtraction); both of these strategies were strongly related to the development of division skills and self-efficacy in a previous study (Schunk & Gunn, 1984).

It was hypothesized that incorporating strategy importance into cognitive modeling would promote students' self-efficacy and skill development more than cognitive modeling alone. It was felt that conveying strategy importance would facilitate subsequent strategy utilization as students solved problems during training (Kennedy & Miller, 1976), which was expected to result in greater task success and higher self-efficacy (Schunk, in press). There is evidence that modeled importance promotes strategy generalization (Borkowski et al., 1976; Kramer & Engle, 1981), which was important in the present study because division requires generalized application of solution strategies to different types of problems. From a self-efficacy perspective, conveying strategy importance by stressing that strategy use benefited other students is a form of social comparative information. Such information can motivate students and result in a high initial sense of self-efficacy for performing well because subjects are apt to believe that if other students could employ the strategies they can as well (Bandura, 1981; Schunk, in press). This initial sense of self-efficacy is apt to be validated as students solve problems during training.

A second purpose of this study was to investigate whether incorporating the importance of positive achievement beliefs into cognitive modeling increased self-efficacy and skill development. This focus was important because research shows that the typically poor performances of low achievers stem in part from negative achievement beliefs (Diener & Dweck, 1978). Compared with mastery-oriented subjects, learned-helpless students are more likely to ascribe failures to low ability and are less apt to believe that low effort causes failure (Diener & Dweck, 1978). Other research shows that students' self-efficacy bears a strong, positive relationship to subsequent skillful performance, that stressing ability and effort promotes self-efficacy and skills, and that ability attributions (i.e., perceiving that ability causes task success) enhance performance expectancies on future tasks (Fontaine, 1974; McMahan, 1973; Schunk, 1982, 1983; Schunk & Gunn, 1984).

Although modeling can be used to portray positive achievement beliefs, their effects on self-efficacy may depend on subsequent performance outcomes. Zimmerman and Ringle (1981) exposed children to an adult model who unsuccessfully attempted to solve a wire puzzle problem for either a high (5 min) or low (30 sec) time period and who verbalized either statements of confidence or pessimism, after which children attempted an insolvable puzzle. Compared with children's self-efficacy for solving the puzzle prior to their attempting it, only children in the confident/low persistence group did not judge self-efficacy lower after their own unsuccessful efforts. Children in the confident/high persistence group apparently discounted the confidence statements, perhaps because they concluded that the model lacked skills or that the task was difficult.

In the present study, the cognitive modeling presented to some subjects stressed the importance of the following achievement beliefs: self-efficacy for performing well, ability and effort attributions. As before, importance was conveyed with information that these beliefs had benefited other students. Incorporating the importance of positive achievement beliefs into cognitive modeling was not expected to increase self-efficacy or skills more than cognitive modeling alone. Although stressing the importance of positive achievement beliefs with social comparative information might result in a high initial sense of self-efficacy for performing well, in the absence of modeled strategy importance these students were not expected to utilize task strategies as well during training. To the extent that they encountered some difficulty solving problems their actual task performances would not substantiate their initially high self-efficacy.

The cognitive modeling presented to some students in the present study incorporated both the importance of strategy use and that of positive achievement beliefs. An interesting question was how this combined treatment would compare with modeled strategy importance alone. Because modeling the importance of task strategies was predicted to strongly enhance students' problem solving during training, the addition of achievement beliefs was not expected to further promote skill development. At the same time, students whose cognitive modeling also included the importance of positive achievement beliefs were expected to experience a higher initial sense of self-efficacy for performing well, which should be validated by their subsequent training performance. Thus, it was hypothesized that incorporating the importance of both strategy use and achievement beliefs into cognitive modeling would result in the highest self-efficacy.

Method

Subjects

The sample included 40 students drawn from five classrooms. Ages ranged from 9 years 4 months to 11 years 8 months ($\underline{M}$ = 10.5 years). The 18 boys and 22 girls were predominantly middle class. Because this study focused on processes whereby skills and self-efficacy could be developed when they initially were lacking, teachers were shown the division skill test and identified students who they felt could not solve correctly more than about 25% of the problems. These students were administered the pretest individually by one of three female adult testers.

Pretest

Self-efficacy. Self-efficacy for solving division problems was measured following procedures of previous research (Schunk, 1981, 1982; Schunk & Gunn, 1984). The efficacy scale ranged from 10 to 100 in 10-unit intervals from high uncertainty (10), through intermediate values (50-60), to complete certitude (100). Students initially received practice by judging their certainty of successfully jumping progressively longer distances. In this concrete fashion, they learned the meaning of the scale's direction and the different numerical values.

Following this practice, students were shown 18 sample pairs of problems for about 2 sec each, which allowed assessment of problem difficulty but not actual solutions. The two problems constituting each pair were similar in form and difficulty, and corresponded to one problem on the ensuing skill test although they involved different numbers. Thus, students were judging their capability to solve different types of problems and not whether they could solve any particular problem. Students made their judgments privately by circling an efficacy value. They were advised to be honest and mark how they really felt. Scores were averaged across the 18 judgments.

Skill test. The skill test included 18 division problems ranging from one to three digits in the divisor and two to five digits in the dividend as follows: seven problems with one-digit divisors, eight with two-digit divisors, three with three-digit divisors (ranging from three to five digits in the dividend). All problems required "bringing down" numbers and most had remainders. Half of the 18 problems were similar to those students would solve during training whereas the other half were more complex to test for generalization. During training, for example, students brought down numbers once or twice per problem, but some test problems required bringing down three numbers.

The tester presented the problems one at a time and instructed students to examine each problem, indicate whether they wanted to try to solve it, and place each page on a completed stack when they finished solving the problem or chose not to work on it any longer. Students received no performance feedback. The measure of skill was the number of problems solved correctly.

Training Procedure

Following the pretest, students were assigned randomly within sex and classroom to one of four treatment conditions (ns = 10). All students received four, 40-min training sessions over consecutive school days, during which they individually worked on four training packets. The first two packets covered problems with one-digit divisors, whereas the latter two included two-digit divisors. Packets two and four required bringing down numbers. The format of each packet was identical. The first page explained the division solution strategies and provided exemplars that showed application of the strategies step-by-step. The second page contained a practice problem, and the next several pages included problems to solve. Sufficient problems were in each packet so that students could not finish it.

An adult female proctor escorted students individually to a large room where they were seated away from others to preclude visual and auditory contact. Each of the three proctors worked with approximately equal numbers of students in each experimental condition. At the start of each training session the proctor administered the appropriate treatment (described below) depending on the student's experimental assignment, after which the student worked the practice problem. The proctor then stressed the importance of careful work, and moved out of sight. Students solved problems alone during each training session and received no performance feedback on the accuracy of their solutions.

<u>Treatment Conditions</u>

<u>Cognitive modeling</u>. In this treatment, which was similar to the 10-min instruction phase of the Schunk (1981) study, students observed an adult model solve two division problems portrayed on the explanatory page of the training packet. The model verbalized aloud the division solution strategies and their application to problems as she arrived at the correct solutions. On completing the second problem, the model summarized the solution strategies verbally while referring to a sample problem. For example, the summary instructions given by the model during session two were as follows (problem was 173 divided by 4):

While solving problems, remember to follow the steps in the right order. In this problem, you'd first want to divide the 4 into 17, and then bring down the 3. So you might think to yourself, 'How many times does 4 go into 17?', and then after you figure that out you might think, 'Now I need to bring down the 3.' While solving problems, also remember to be careful when you multiply and subtract. In this problem, you'd need to multiply 4 by some number to get a number a little smaller than 17 and then subtract that number from 17. You might think, '4 times 3 is 12. Too small. 4 times 4 is 16. That's right. 17 take away 16 is 1.' So remember to follow the steps in the right order and be careful when you multiply and subtract.

These summary instructions contained no new information over that previously modeled. Because the subjects possessed deficiencies in division despite much previous classroom instruction, it was felt that the modeled summary would help foster their understanding of solution strategies (Rosenthal & Zimmerman, 1978; Zimmerman & Rosenthal, 1974). Including modeled summary instructions in this treatment also served to disentangle their potential effects from those due to the modeled importance of strategy use, both of which were contained in the strategy importance treatment.

Modeled importance of task strategies. This treatment was identical to the cognitive modeling treatment except that after completing the second problem the model stated, "I've worked with a lot of students like you and I've found that those who do the best in division do certain things while working on problems." The model then introduced the summary with the phrase, "Students who do the best in division." In the above example, "Students who do the best in division follow the steps in the right order," replaced, "While solving problems remember to follow the steps in the right order," and, "Students who do the best in division also are careful when they multiply and subtract," replaced, "While solving problems, also remember to be careful when you multiply and subtract."

Modeled importance of achievement beliefs. This treatment included all components of the cognitive modeling treatment described above. Following the modeled summary, the adult conveyed the importance of positive achievement beliefs by verbalizing the following while pointing to a sample problem:

> Students who do the best in division think that they can solve problems, that they need to work hard, and that they're getting pretty good in division. In this problem, you might think at first, 'I can do this one.' As you're working on it you might think, 'I can finish it if I work hard,' and when you finish it you might think, 'I'm getting pretty good at this.' So remember to think that you can solve problems, you need to work hard, and you're getting pretty good in division.

Self-efficacy, effort and ability attributions were conveyed in the statements, "I can do this one" (self-efficacy), "I can finish it if I work hard" (effort attribution), and, "I'm getting pretty good at this" (ability attribution).

Modeled importance of task strategies + achievement beliefs (combined). Children assigned to this condition received both treatments. The adult modeled task-strategy importance followed by positive achievement beliefs, as described above.

Posttest

The posttest was administered 1 or 2 days after the last training session. The self-efficacy and skill-test instruments and procedures were identical to those of the pretest except that a parallel form of the skill test was used to eliminate possible problem familiarity. For any given student, the same tester administered the pretest and posttest, had not served as the student's training model, and was blind to the student's treatment condition. All tests and materials were scored by a different adult who was unaware of students' experimental assignments.

Results

Means and standard deviations of all measures are shown by experimental condition in Table 1. Preliminary analyses revealed no significant differences on any measure due to tester, classroom, or sex of student, nor any significant interactions. The data were pooled across these variables. There also were no significant between-condition differences on the pretest measures. Each posttest measure was analyzed with analysis of covariance (ANCOVA) using the appropriate pretest measure as the covariate. The four experimental conditions constituted the treatment factor.

Insert Table 1 about here

The use of ANCOVA necessitated demonstration of slope homogeneity across treatment groups (Kerlinger & Pedhazur, 1973). Tests of slope differences for each measure were made by comparing a linear model that allowed separate slopes for the four treatment groups against one that had only one slope parameter for estimating the pretest-posttest relationship pooled across the four treatments. These analyses found the assumption of homogeneity of slopes across treatments to be tenable.

Self-Efficacy

ANCOVA yielded a significant between-condition difference on the posttest self-efficacy measure, $F(3, 35) = 18.57$, $p < .001$. Post-hoc analyses using the Newman-Keuls test (Kirk, 1968) showed that the strategies + beliefs (combined) treatment led to higher self-efficacy than the cognitive modeling ($p < .01$), achievement beliefs ($p < .01$), and task strategies treatments ($p < .05$). Students in the task strategies condition judged self-efficacy higher than both achievement beliefs and cognitive modeling subjects ($ps < .05$). The latter two conditions did not differ significantly.

Skill

ANCOVA applied to the posttest skill measure yielded a significant treatment effect, $F(3, 35) = 8.34$, $p < .01$. The task strategies and combined conditions did not differ, but each outperformed the cognitive modeling and achievement beliefs groups ($ps < .01$). The latter two conditions did not differ significantly in division skill.

Training Progress

To determine whether treatments differentially affected students' motivation during training, the number of problems that children completed was analyzed with ANOVA. A significant between-condition difference was obtained, $F(3, 36) = 20.07$, $p < .001$. The combined and task strategies conditions did not differ but each completed more problems than the achievement beliefs and cognitive modeling conditions (ps $< .01$). More rapid problem solving was not attained at the expense of accuracy because a similar pattern of results was found using the proportion of problems solved correctly (i.e., percentage of problems completed that were solved correctly). The cognitive modeling and achievement beliefs conditions did not differ significantly either in rate or accuracy of problem solving.

Correlational Analyses

Product-moment correlations were computed among training progress (number of problems completed), posttest self-efficacy and posttest skill to explore the theoretical relationships between variables. Correlations initially were computed separately within each experimental condition. Because there were no significant between-condition differences in the correlations of any measures, correlations were averaged across conditions using an r to z transformation (Edwards, 1976).

The more problems that children completed during training, the higher was their self-efficacy, $r(38) = .52$, $p < .01$, and their division skill, $r(38) = .65$, $p < .01$. A similar pattern of results emerged using the proportion of problems solved correctly as the measure of training progress. Self-efficacy bore a strong relationship to subsequent skillful performance, $r(38) = .74$, $p < .01$.

Discussion

The present study demonstrates that incorporating the importance of task strategy use into cognitive modeling enhances rate of problem solving, skills and self-efficacy. These effects cannot be due to providing task strategies or modeling their application to problems because the cognitive modeling treatment included these features. One explanation for these findings is that stressing the importance of strategy use can enhance students' understanding of strategies, which promotes subsequent utilization and generalization (Borkowski et al., 1976; Kennedy & Miller, 1976; Kramer & Engle, 1981). In the present study, strategy importance was conveyed with social comparative information that consistent strategy use had benefited other students. In the self-efficacy view, such information can enhance students' motivation and convey a sense of self-efficacy for performing well, because students are apt to believe that if others could employ the strategies they can as well (Bandura, 1981; Schunk, in press). This initial sense of self-efficacy is substantiated later as students work at the task and experience some success.

These results must be qualified because strategy importance was conveyed with social comparative information. Future research needs to investigate whether similar effects are obtained from other ways of conveying importance. For example, as students work at a task their problem-solving progress could be linked with consistent strategy use through teacher verbal feedback (e.g., "You're doing well because you're following the steps in the right order").

Incorporating the importance of positive achievement beliefs into cognitive modeling led to no benefits over those obtained from cognitive modeling alone. The rationale for including achievement beliefs was based on evidence that low achievers typically lack self-efficacy for performing well and do not stress effort or ability as causes of success (Diener & Dweck, 1978; Schunk, in press; Schunk & Gunn, 1984). Although stressing the importance of positive achievement beliefs may have created a high initial sense of self-efficacy for performing well, in the absence of modeled strategy importance these students did not utilize task strategies as well during training. Thus, any vicarious increase in self-efficacy was negated by the difficulties students encountered during their subsequent performances. These results are similar to those of Zimmerman and Ringle (1981), who found that children lowered their self-efficacy judgments after they observed a persistent but confident model fail to solve a puzzle and then failed to solve the puzzle themselves.

Incorporating the importance of both task strategies and positive achievement beliefs into cognitive modeling led to the highest self-efficacy. This combined treatment presented the most complete set of cognitive influences on achievement, because it included modeling the importance of task **strategy** use to aid problem solving and of positive achievement beliefs to convey that students were capable of succeeding at the task. The latter modeling likely created a high initial sense of self-efficacy for performing well (Bandura, 1981; Schunk, in press). As students then worked at the task their problem solving was aided because they also had received modeled task strategy importance. Thus, students' initial self-efficacy should have been substantiated by their performance successes during training. This interpretation is only suggestive, however, because self-efficacy was not assessed immediately following the modeling. Future research that includes such a measure would increase our understanding of how modeling affects self-efficacy.

The benefits of the combined treatment on self-efficacy must be viewed cautiously because the achievement beliefs component included both modeling the beliefs and stressing their importance. Unlike the modeled importance of task strategies, the effects of which were experimentally disentangled from those of presenting the task strategies themselves, it was not possible to include positive achievement beliefs in the cognitive modeling treatment. Because the model was an adult whose purported function was to instruct students in division operations, it would have seemed awkward for the model to verbalize achievement beliefs (e.g., "I'm getting pretty good at this") during cognitive modeling. Had the model done so, students may have questioned the model's competence.

Future research could disentangle the potential effects of modeling the importance of positive achievement beliefs from those of presenting the beliefs themselves by utilizing a peer model (possibly on videotape) who received instruction from an adult and then verbalized positive achievement beliefs while solving problems. The importance of positive achievement beliefs might be conveyed to subjects by the adult with a modeled summary much the same as in the present study.

This study supports the previous finding that, although self-efficacy is influenced by prior accomplishments, it is not merely a reflection of them (Schunk, 1981, 1982). The task strategies and strategies + beliefs conditions did not differ in their rates or accuracy of problem solving during training, but students in the latter condition subsequently judged self-efficacy higher. Efficacy appraisal is an inferential process that involves weighting the relative contributions of many factors, such as self-perceptions of ability, effort expended, task difficulty, amount of external aid received, situational circumstances under which the performances occurred, and temporal pattern of successes and failures (Bandura, 1981, 1982; Schunk, in press). In addition to these influences, modeling is hypothesized to be an important vicarious source of efficacy information (Bandura, 1977, 1982).

This study also supports the idea that capability self-perceptions bear an important relationship to subsequent performance (Covington & Omelich, 1979; Schunk, 1981). Personal expectations for success are viewed as important influences on achievement by a variety of theoretical approaches (Bandura, 1981; Kukla, 1972; Moulton, 1974; Schunk, in press; Weiner, 1979).

This study has practical implications. Classroom teachers routinely model problem-solving operations. Although such modeling may convey to students a vicarious sense of efficacy for success, stressing strategy importance further aids self-efficacy and skill acquisition. Stressing importance with social comparative information that strategy use benefited other students may be especially influential among students in the present age range (9-12), who utilize social comparative information to help form self-evaluations of capabilities and become motivated from knowledge of other students' accomplishments (Schunk, in press).

Although the present results on the effects of positive achievement beliefs must be viewed cautiously, they suggest that such modeling should be supplemented with emphasis on consistent use of task strategies to promote self-efficacy and skills. Modeled achievement beliefs should retain their validity only if students' subsequent performances substantiate them. Especially with low achievers, teachers who incorporate positive achievement beliefs into their modeled demonstrations need to insure that students comprehend task solution strategies and that their use will benefit task performance.

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Table 1

Means (and Standard Deviations)

Measure	Phase	Experimental Condition: Cognitive Modeling	Task Strategies	Achievement Beliefs	Strategies + Beliefs
Self-Efficacy[a]	Pretest	35.7 (12.2)	33.8 (11.2)	29.6 (8.9)	31.4 (7.9)
	Posttest	50.7 (14.1)	69.7 (10.1)	55.3 (15.3)	85.2 (8.0)
Skill[b]	Pretest	1.8 (1.6)	1.9 (2.5)	1.8 (1.4)	2.1 (1.7)
	Posttest	5.4 (2.6)	9.6 (4.0)	4.9 (2.2)	10.5 (3.0)
Training Progress[c]	---	29.1 (8.2)	48.3 (9.1)	25.2 (9.8)	45.3 (8.6)

Note. N = 40, ns = 10.

[a]Average judgment per problem; range of scale: 10 (low) - 100.

[b]Number of correct solutions on 18 problems.

[c]Number of problems completed.