Modeled Importance of Task Strategies and Achievement Beliefs: Effect on Self-Efficacy and Skill Development

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Abstract:
This experiment explored how modeling the importance of task strategy use and positive achievement beliefs affected self-efficacy and skill acquisition. Students deficient in division skills participated in a training program that included instruction and practice opportunities. In the context of instruction, students observed a model demonstrate division solution strategies. For one group the model emphasized the importance of using task strategies, for a second group the model emphasized the importance of positive achievement beliefs. Students in a third group received modeled importance of task strategy use and positive achievement beliefs. Modeling the importance of using task strategies enhanced students' motivation and skill development, but emphasizing both task strategy use and achievement beliefs led to the highest self-efficacy. Implications for teaching are discussed.

Article:
According to Bandura's social learning theory, different psychological procedures change behavior in part by creating and strengthening perceived self-efficacy (Bandura, 1977, 1981, 1982), which refers to personal judgments of one's performance capabilities in a given area. Self-efficacy is hypothesized to influence choice of activities, effort expended, perseverance, and task accomplishments. People acquire information about their self-efficacy from their own performances, by observing others, through persuasion, and from 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, 1983). This latter research has shown that educational practices (e.g., goal setting, reward contingencies, feedback) are important influences on self-efficacy (Schunk, 1984). In turn, self-efficacy affects level of skill development.

One common educational practice is modeling. There is much evidence that modeling can help teach skills, general rules, and problem-solving strategies (Bandura, 1971; Rosenthal & Bandura, 1978; Rosenthal & Zimmerman, 1978; Zimmerman & Rosenthal, 1974). Modeling also is an observational 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, 1984). This sense of efficacy brought about by observation is substantiated later as observers successfully perform the task.

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 division solution strategies and step-by-step examples of their application.

Although cognitive modeling led to higher division skill, both treatments enhanced 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, if the model had emphasized that consistent strategy use could benefit children's performance on different tasks. Research shows that use of strategies, or cognitive plans leading to sequenced actions, improves performances on cognitive tasks, but that merely modeling task solution strategies may not have much effect on children's performances (Borkowski, Levers, & Gruenenfelder, 1976; Kramer & Engle, 1981). 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 how modeling the importance of task strategy use affects self-efficacy and skillful performance. Students low in division skills received cognitive modeling of division solution strategies and practice opportunities over sessions, similar to the Schunk (1981) study. For some subjects the model emphasized 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).

Incorporating strategy importance into cognitive modeling was expected to 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, 1984). There is evidence that modeled importance promotes strategy generalization (Borkowski et al., 1976; Kramer & Engle, 1981), which was important 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 lead students to become more motivated and result in a high initial sense of self-efficacy for performing well. Subjects are apt to believe that using the strategies will lead to success and that if other students could employ the strategies they can as well (Bandura, 1981; Schunk, 1984). 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 modeling the importance of positive achievement beliefs increases 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 influences subsequent skillfull performance, that stressing ability and effort promotes self-efficacy and skills, and that ability attributions (i.e., believing that high ability causes task success) enhance performance expectancies on future tasks (Fontaine, 1974; McMahan, 1973; Schunk, 1983, 1984).

Despite this evidence, the effects of modeled achievement beliefs on children's self-efficacy may depend on their 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 model emphasized to some subjects the importance of self-efficacy for performing well, ability and effort attributions; importance was conveyed with information that these beliefs had benefited other students. Although modeling the importance of positive achievement beliefs might result in high initial 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 maintain 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 who received the combined treatment (importance of strategy use plus positive achievement beliefs) were expected to experience higher self-efficacy for performing well, which should be validated by their subsequent training performance. Thus, the combined treatment was expected to 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 (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 low, 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; Schunk & Gunn, 1984). The efficacy scale ranged from 10 to 100 in 10-unit intervals from high uncertainty-10 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 rather than whether they could solve particular problems. Students privately recorded their judgments. 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, decide 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; small computational errors were discounted.[1]

Treatment Conditions

Following the pretest, students were assigned randomly within sex and class-room to one of four treatment conditions (N's=10): cognitive modeling, modeled importance of task strategies, modeled importance of achievement beliefs, modeled importance of task strategies and achievement beliefs. All students received four, 40-min training sessions over consecutive school days, during which they 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.

At the start of each training session, each student received the appropriate treatment depending on the student's experimental assignment.

Cognitive modeling. 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, `Pm 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.

Training Procedure

At the start of each training session, an adult female proctor escorted each student individually to a large room. Students were seated away from others to preclude visual and auditory contact. Each of three proctors worked with approximately equal numbers of students in each of the four experimental conditions to eliminate confounding models with treatments. The format of each session was identical. The proctor administered the appropriate treatment to each student (described above), after which the student worked the practice problem. The proc-tor then stressed the importance of careful work and moved out of sight. Students solved problems alone during the sessions and received no performance feedback on the accuracy of their solutions.

Posttest

The posttest was administered 1 or 2 days after the last training session. The self-efficacy and skill tests 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 students 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.

TABLE 1

Means (and Standard Deviations)

		Experimental Condition			
Measure	Phase	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.

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.

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. Separate analyses conducted on the set of 9 problems similar to those covered during training and the set of 9 more complex problems yielded identical patterns of results.

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. Separate analyses on the problems similar to those covered during training and those more complex revealed comparable results.

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, $r(38) = p < .01$.

DISCUSSION

The present study demonstrates that incorporating task strategy importance 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 task strategy importance 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, the model conveyed strategy importance with social comparative information that consistent strategy use had benefited other students. In the self-efficacy view, such information can lead students to become more motivated and convey a sense of self-efficacy for performing well, because students are apt to believe that using the strategies results in success and that if others could employ the strategies they can as well (Bandura, 1981; Schunk, 1984). This initial high self-efficacy if substantiated later as students successfully perform the task.

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").

Stressing the importance of positive achievement beliefs led to no benefits over those obtained from cognitive modeling alone. Although positive achievement beliefs may have created a high initial sense of self-efficacy for performing well, in the absence of task strategy importance these students did not utilize strategies as well during training. Thus, any 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.

Modeling the importance of both task strategies and positive achievement beliefs led to the highest self-efficacy. This combined treatment presented the most complete set of cognitive influences on achievement, because it included modeled strategy importance to aid problem solving and modeled achievement beliefs to convey that students were capable of successfully using the strategies. Collectively, these two forms of modeling likely created a high initial sense of self-efficacy for performing well (Bandura, 1981; Schunk, 1984), which should have been substantiated by their performance successes. This interpretation is only suggestive, 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. For example, research should investigate the stability over time of changes in self-efficacy brought about by modeling and how stability is affected by students' subsequent successes and failures.

The benefits of the combined treatment on self-efficacy must be viewed cautiously because the achievement beliefs were both modeled and emphasized. Unlike the effects of modeled task strategy importance, which were experimentally disentangled from those of presenting the task strategies themselves, it was not possible to incorporate the achievement beliefs into cognitive modeling. The model was an adult whose purported function was to instruct students in division operations, so it would have seemed awkward for the model to verbalize achievement beliefs (e.g., "I'm getting pretty good at this") during cognitive modeling. Students might 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 them-selves 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. To fully explore how the present modeling variables affect self-efficacy, research would need to be designed so that the effects of cognitive modeling, strategy importance, and achievement beliefs could be assessed independently and in combination with one another.

This study supports the idea that, although self-efficacy is influenced by prior accomplishments, it is not merely a reflection of them (Schunk, 1984). 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, both on types of problems similar to those solved during training and on types that were more complex. These findings are not surprising. 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, 1984). In addition to these influences, modeling is hypothesized to be an important 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). Previous research applying the self-efficacy model to children's cognitive skill learning shows that self-efficacy influences level of skillful performance (Schunk, 1981; Schunk & Gunn, 1984). Personal expectations for success are viewed as important influences on achievement by a variety of theoretical approaches (Bandura, 1981; Kukla, 1972; Moulton, 1974; Schunk, 1984; Weiner, 1979.)

This study has practical implications. Classroom teachers routinely model problem-solving operations. Although such modeling may convey to students that they are capable enough to learn skills, emphasizing strategy use further aids self-efficacy and skill acquisition. Social comparative information that strategy use benefited other students may be especially influential among students in the pre-sent 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, 1984).

Although the results on the effects of modeling achievement beliefs must be viewed cautiously, they suggest that such modeling should be supplemented with emphasis on task strategy use 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 model achievement beliefs need to insure that students comprehend how to use task solution strategies and that their use will benefit task performance.

Notes:

1This scoring method reflects children's division skills more accurately than one requiring perfect accuracy, by which children who correctly apply division operations but make a small error in subtraction are penalized as much as children who fail to work the problem. Skill data using the perfect accuracy scoring method were analyzed and yielded similar results to those reported.

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