Modeling and Attributional Effects on Children's Achievement: A Self-Efficacy Analysis

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Article:

Children showing low arithmetic achievement received either modeling of division operations or didactic instruction, followed by a practice period. During practice, half of the children in each instructional treatment received effort attribution for success and difficulty. Both instructional treatments enhanced division persistence, accuracy, and perceived efficacy, but cognitive modeling produced greater gains in accuracy. In the context of competency development, effort attribution had no significant effect either on perceived efficacy or on arithmetic performance. Perceived efficacy was an accurate predictor of arithmetic performance across levels of task difficulty and modes of treatment. The treatment combining modeling with effort attribution produced the highest congruence between efficacy judgment and performance.

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The theory of self-efficacy postulates that different modes of influence change behavior in part by creating and strengthening self-percepts of efficacy (Bandura, 1977, in press). Perceived self-efficacy is concerned with judgments of one's capability to perform given activities. In this view, perceived self-efficacy affects behavioral functioning by influencing people's choice of activities, effort expenditure, and persistence in the face of difficulties. The higher the perceived efficacy, the greater is the sustained involvement in the activities and subsequent achievement.

Achievement behavior has been analyzed historically in terms of level of aspiration and outcome expectations. Although these different concepts involve an expectancy element, they differ in important ways from the concept of self-efficacy. Level of aspiration is concerned with the goals people set for themselves (Lewin, 1935; Lewin, Dembo, Festinger, & Sears, 1944). Aspirations differ from judgments of what one can do in the here and now. Outcome expectations refer to subjective estimates that a given behavior will lead to certain outcomes (Rotter, 1954; Rotter, Chance, & Phares, 1972). Self-percepts of efficacy are concerned with judgments of one's capability to produce a given pattern of behavior.

Results of a series of studies designed to alter phobic behavior provide support for self-efficacy theory (Bandura & Adams, 1977; Bandura, Adams, & Beyer, 1977; Bandura, Adams, Hardy, & Howells, 1980). Self-efficacy is enhanced by information conveyed through such different treatment modalities as actual performance, modeling, and systematic desensitization. Self-percepts of efficacy predict not only level of behavioral change resulting from different treatments but also variations in coping behavior by persons receiving the same type of treatment and even specific performance attainments by individuals on different tasks.

Because self-efficacy is postulated to have motivational effects, it seems especially relevant to children's achievement behavior. Children who have a strong sense of efficacy in a given subject matter would be expected to exhibit strong achievement strivings. In contrast, children who perceive themselves as inefficacious should tend to shun achievement tasks or to engage in them halfheartedly and to give up readily in the face of obstacles. It follows from this theory that experiences designed to raise self-efficacy should also enhance persistence and skillful performance.

The purpose of this study was to test hypotheses from self-efficacy theory in the area of children's arithmetic achievement. First, the theory predicts that providing subjects with modeling, guided performance, corrective feedback, and self-directed mastery will foster development of' skills and self-efficacy (Bandura, 1977). One group of children therefore received cognitive modeling of problem-solving strategies with guided participation (Bandura, 1976; Meichenbaum, 1977). In this approach, children observed adult models verbalize aloud the cognitive operations they were using as they engaged in arithmetic problem-solving activities. The children then practiced applying what they had learned with corrective modeling of any constituent operations they failed to grasp. The comparison approach involved didactic instruction. Children received the same explanatory material, the same amount of practice applying the knowledge they had gained, and the same feedback of' accuracy, but they did not receive any modeling of cognitive operations. Although it was expected that didactic instruction would also raise skills and self-efficacy, there is evidence to suggest that with young children, providing explanatory principles with exemplary modeling is more effective in developing cognitive skills than is providing explanatory principles alone (Rosenthal & Zimmerman, 1978).

The second set of hypotheses concerned the effects on achievement of effort attribution for success and difficulty provided during the process of competency development. According to attribution theory, ascribing past achievement outcomes to effort is hypothesized to have motivational effects. To the extent that children come to believe that increased effort produces success, they should persist longer in the face of difficulties and thereby increase the level of their performance (Weiner, 1977, 1979; Weiner et al., 1971). Attribution training programs in the area of achievement behavior often concentrate on changing children's causal ascriptions of failure from lack of ability to lack of effort. Results of such studies generally show that attributing failure to a lack of effort increases persistence (Andrews & Debus, 1978; Chapin & Dyck, 1976; Dweck, 1975).

Self-efficacy theory predicts that active engagement in activities promotes development of skills and self-efficacy (Bandura, in press). Viewed from this perspective, effort attribution can affect self-efficacy and the development of skills to the extent that it results in more active efforts. But such efforts require minimal skills to start with. In the present context, effort attribution may have different effects in the two instructional treatments. If children can apply operations more readily through modeling, then effort attribution could lead to more active engagement with further skill and self-efficacy gains. On the other hand, if skills develop slower with didactic instruction, the validity of' effort attribution especially for difficulty—may be mitigated in favor of other factors, such as task difficulty. Developmental evidence indicates an increasing ability to integrate information from several sources in arriving at causal attribution (Guttentag & Longfellow, 1977).

A third set of hypotheses tested in the present study concerned the relationship of self-efficacy to subsequent achievement. In a series of studies with adult phobics, Bandura and his colleagues (Bandura & Adams, 1977; Bandura, Adams, & Beyer, 1977) found that subjects accurately appraise their capabilities to perform given activities, as revealed by high agreement between self-efficacy judgment and subsequent performance at the level of individual tasks. Accurate appraisal is important, since misjudgments in either direction can have negative consequences. Persons who over-estimate their capabilities are apt to become demoralized through repeated task failure, whereas those who underestimate their capabilities may shun achievement contexts, thereby precluding opportunities for skill development.

Accuracy of self-percepts is affected by the validity of information on which they are based. Modeling seems ideally suited for this purpose because it focuses children's attention on problem-solving strategies and corrective operations. To the extent that the benefits of modeling are augmented by boosts in performance arising from the effects of effort attribution on task engagement, attribution should also lead to more accurate appraisal. Conversely, with the less explicit information provided by a didactic mode of treatment, effort attribution might offer no significant advantage in appraisal compared with no attribution.

In the present study, children who had experienced repeated failure at arithmetic received either a didactic or a cognitive-modeling treatment designed to increase their knowledge of arithmetic operations. For half of the children in each of these treatments, the experimenter periodically ascribed the children's successes to sustained effort and their difficulties to insufficient effort. The remaining children received the competency training without causal attribution for their performances. Arithmetic skill, persistence, and self-efficacy were measured before and after treatment.

It was hypothesized that compared with didactic instruction, cognitive modeling would result in higher arithmetic achievement, persistence, self-efficacy, and accuracy of self-appraisal. Effort attribution was expected to lead to higher achievement, persistence, self-efficacy, and accuracy of' self-appraisal in the modeling treatment but not in the didactic treatment.

Method

Subjects

The sample consisted of 56 children ranging in age from 9 years 2 months to 11 years 3 months, with a mean of 9 years 0 months. There were 33 males and 23 females. Although varied socioeconomic backgrounds were represented, children were predominantly middle-class.

Children were drawn from five elementary schools. As an initial screening procedure, teachers identified children who displayed low arithmetic achievement, persistence, and self-confidence. Those children were then administered the formal preassessment individually by an adult tester. Different adults administered the assessment and treatment procedures.

Pretreatment Assessment

Arithmetic performance test. The pretest consisted of 18 division problems graded in level of difficulty. They included 6 problems with one-digit divisors, 6 with two-digit divisors, 3 with three-digit divisors, and 3 with four-digit divisors. The latter two groups of' problems were included to test the generalized effects of' treatment, which included only problems with 1- and 2-digit divisors. Thus, the performance test contained 12 *training* problems and 6 *generalization* problems. The arithmetic tasks were also graded in difficulty within common divisor level by having progressively more digits in the dividends. The problems were presented individually in order of least-to-most difficult within common divisor level, except that four-digit divisor problems occurred in positions 6, 12, and 18. Since these were very difficult problems, they were interspersed with less taxing ones; had they been grouped at the end, cumulative fatigue might have exercised undue influence.

Each division problem was presented on a single page. Children were instructed to examine each problem and to place the page on a completed stack when they were through solving the problem or had chosen not to work it any longer. The tester recorded the time children spent with each problem.

Efficacy judgment. Children's pretest level of' efficacy was measured after the division performance test to insure familiarity with the different types of problems. The efficacy scale ranged from 10 to 100 in intervals of 10, with verbal descriptors occurring at the following points: 10 = not sure, 40 = maybe, 70 = pretty sure, 100 = real sure. At the outset, children were given practice with the efficacy assessment procedure by judging their capability to jump progressively longer distances. A wide variety of distances ranging from a few inches to several yards was included to insure that children understood both the scale direction and the general meaning of each of the l0 points. Following this practice, children were shown for 2 sec each 18 pairs of division problems in increasing level of difficulty. This brief exposure was sufficient to portray the nature of the tasks but too short to attempt any solutions. For each of the samples, children privately judged on separate efficacy scales their capability to solve that type of problem, according to the following directions:

> Circle the number on the line that matches how sure you are that you could work problems like those shown and get the right answers. Remember that the higher the number the more sure you are while the lower the number the less sure you are. Please be honest and mark how you really feel right now.

Each sample pair corresponded in form and difficulty to one problem on the preceding test. However, the problems in the efficacy set were not the same as those on the performance test. Since the self-efficacy measures tapped new applications of the cognitive skill, children had to rely on generalizable perceptions of their capabilities in making the judgments.

Experimental Assignments

Since the study was aimed at children who exhibited gross deficits in arithmetic skills, children who solved at least four problems were eliminated. Those meeting this criterion were randomly assigned to one of four conditions of 12 subjects each (modeling—attribution, modeling—no attribution, didactic—attribution, didactic--no attribution) or to a nontreated control group of 8 subjects.

Training Sessions

On separate days, children received three 55-minute training sessions, each of which contained three phases. The first phase (10 minutes) provided instruction on division strategies. The second phase (35 minutes) provided children with opportunities to practice the strategies they had learned. During the third self-directed mastery phase (10 minutes), children solved problems on their own. Training was administered individually; trainer and child were seated side-by-side during the instruction and practice phases. The trainer moved out of the child's sight at the end of the practice phase and the child worked alone during the self-directed mastery phase.

Instructional Materials

Although different packets were used for each session, their format was identical. The first two pages of each packet explained the solution strategies and provided exemplars that showed application of the strategies step-by-step. The solution strategies were based on the distributive algorithm, which requires a separate division to arrive at each digit in the quotient and "bringing down" numbers one at a time from the dividend. On each of the next several pages was one division problem; children worked these pages one at a time during the practice phase and enough pages were included so that no child finished all of them. Children were informed of the correctness of their solutions; for small computational errors trainers asked children to check their work. Several self-directed mastery problems appeared on the last two pages.

Treatment Conditions

Treatments were distinguished by the mode of instruction given during the instruction phases, the format of' corrective feedback for conceptual errors occurring during the practice phases, and whether effort attribution was provided for successes and difficulties during the practice phases.

Cognitive-modeling treatment. During the instruction phase children observed an adult model solve division problems contained in the explanatory pages of the training packet and verbalize aloud the solution strategies used to arrive at the correct solutions. During the practice phase corrective modeling was provided when children encountered conceptual difficulties. On these occasions, the trainer modeled the relevant strategy while referring. to the appropriate explanatory page.

Didactic treatment. Children in this condition initially studied the same explanatory pages on their own, after which they worked the practice problems. When children experienced conceptual difficulty during practice, the trainer referred them to the relevant section of the explanatory pages and told them to review it. If children were still baffled after a referral, they were asked to read the section aloud.

This condition represented as complete a treatment as cognitive modeling except that modeling was not provided during instruction or practice. The explanatory pages were pilot tested to insure that the vocabulary was understandable by children low in arithmetic achievement.

Attribution treatment. For children assigned to the modeling- and didactic-attribution conditions, the trainer attributed their successes to high effort and their difficulties to low effort on the average of once every 5-6 minutes during the practice phase of each of the three training sessions. Children received each type of attribution about 20 times during training so as to make the effort attributions salient. To insure credibility, attributions were given when it seemed most appropriate. For example, success was attributed to high effort when children succeeded on a task after expending a great deal of effort ("You worked really hard on that one"). Conversely, difficulty was attributed to insufficient effort when children seemed less diligent in their efforts or after they had performed some operation carelessly ("You need to work harder"). Effort attribution was never verbalized in conjunction with corrective feedback to avoid confusing the two.

Posttreatment Assessment

The posttreatment assessment was conducted within a week after completion of training. The procedures were identical to those used in the pretreatment assessment except that efficacy judgments were collected before the division performance test. The self-efficacy scores obtained prior to this test provided the measure for testing their predictive value.

The division performance test was similar in form and difficulty to that used in the pretreatment assessment, but it included different problems. A parallel form was used to eliminate any possible effects due to increased familiarity with the problems. Both forms were administered to 13 fourth graders not participating in the study. Their scores on these alternate forms were highly correlated (r = .92).

Children's scores were obtained from the school district on the mathematical portion of the Metropolitan Achievement Tests (MAT; Durost, Bixler, Wrightstone, Prescott, & Balow, 1970) to determine whether mathematical ability was related to children's response to treatment. 'The MAT score obtained for each child, expressed as a percentile rank, represented a composite of three subtests that tapped mathematical computation, concepts, and problem solving. The MAT composite scores were low (M = 32.4, SD = 20.7), which supported the teachers' nominations.

Results

The self-efficacy scores were analyzed using a median split; judgments higher than 55, which indicated at least moderate assurance, were scored as efficacious, whereas those lower than 55 were scored as inefficacious. Persistence was defined as the number of seconds children worked each problem. Performance-test problems were scored as correct if children correctly applied the division operations at each solution stage or made a small computational error but otherwise used the correct operations.[1]

There were no reliable differences due to sex or experimenter on any of the pretreatment or posttreatment measures; the data were therefore pooled for subsequent analyses. Although there also were no reliable differences between treatment groups on any pretest measure, I decided to use pretest scores as predictors in the analyses of post-test measures to remove this extraneous variability from the posttest scores. Re-moving pretest variation from posttest scores in this fashion results in a more reliable score than using change scores (posttest minus pretest), which are often more unreliable than either of the component variables (Cohen & Cohen, 1975). The use of pretest scores necessitated demonstration of homogeneity of regression coefficients across treatment groups (Kerlinger & Pedhazur, 1973). Tests of slope differences for each variable 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 pre-post relationship pooled across the four treatments. These analyses found the assumption of homogeneity of variance across treatment groups to be tenable.

The posttest measures (accuracy, persistence, self-efficacy) were analyzed using multiple-regression procedures (Kerlinger & Pedhazur, 1973). The appropriate pretest score was entered first in each of these analyses to derive a clearer picture of the influence of other factors. To check for intergroup differences, three categorical variables were introduced as predictors for each measure (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). These three variables were instructional treatment (modeling—didactic), attribution within modeling (yes—no), and attribution within didactic (yes—no).

The decision to use multiple regression was based on the idea that factors other than treatment might account for some variation in the posttest measures. For each of the three measures, T felt that treatments, the appropriate pretest score, and the MAT score would account for some of the posttest variability; in addition, self-efficacy theory predicts that persistence should be influenced by self-efficacy and that accuracy should be influenced by both self-efficacy and persistence. The use of multiple regression in the present context, with a small total sample size and a large number of predictors, is not without problems. In such instances the regression coefficients tend to be unstable from one sample to another, especially when the independent variables are intercorrelated (Kerlinger & Pedhazur, 1973). Although the present use of multiple regression seems justified, the reader should bear in mind this caution. As a safeguard, adjusted R^2 results are also reported.

Pre- and posttreatment means are shown by condition in Table 1. The measures are classified according to whether the problems resembled those presented during training (training problems) or whether they required skill application to problems more complex than those presented during training (generalization problems). As the results of these two problem classes followed a similar pattern, only the results for training problems will be reported to simplify the discussion. Posttest scores were pooled across the four treatments and compared with pretest scores using the *t* test for correlated scores (Winer, 1971) to assess the overall effects of treatment. All differences were positive and reliable: $t(47) = 11.64$, $p < .01$, for division accuracy; $t(47) = 5.95$, $p < .01$, for persistence; and $t(47) = 7.68$, $p < .01$, for self-efficacy. As expected, therefore, children who received treatment judged them-selves more efficacious, persisted longer, and solved more problems. In contrast, the controls showed no reliable differences except for less persistence, $t(7) = —2.98$, $p < .03$.

Table 1
Pre- and Posttest Achievement-Outcome Means and Standard Deviations by Problem Class and Experimental Condition

Problem class	Modeling–attribution *M*	Modeling–attribution *SD*	Modeling no attribution *M*	Modeling no attribution *SD*	Didactic–attribution *M*	Didactic–attribution *SD*	Didactic–no attribution *M*	Didactic–no attribution *SD*	Control *M*	Control *SD*
Accuracy[a]										
Training										
Pretest	2.2	1.6	2.7	2.5	2.4	1.7	2.3	1.4	1.6	1.6
Posttest	8.3	3.6	7.8	3.0	6.3	2.7	7.0	3.1	1.8	2.1
Generalization										
Pretest	.0	.0	.3	.6	.2	.3	.2	.5	.0	.0
Posttest	1.6	1.6	1.2	1.6	.3	.4	.5	.6	.0	.0
Persistence[b]										
Training										
Pretest	36.0	35.6	53.3	53.3	45.9	34.1	65.0	61.8	28.9	23.4
Posttest	99.7	53.3	79.5	41.6	100.1	57.8	97.0	56.6	13.6	10.6
Generalization										
Pretest	35.1	72.1	27.5	47.2	27.0	32.6	36.7	65.4	19.6	19.1
Posttest	102.2	116.7	59.9	81.0	47.8	64.2	73.3	101.1	5.0	3.9
Self-efficacy[c]										
Training										
Pretest	2.0	1.7	2.3	2.1	2.2	1.9	3.2	2.7	1.8	2.4
Posttest	7.5	4.7	7.2	5.0	7.4	4.2	6.3	4.4	2.8	4.1
Generalization										
Pretest	.0	.0	.3	.6	.0	.0	.0	.0	.5	.4
Posttest	.9	1.2	1.5	1.6	1.2	1.5	1.7	1.7	.0	.0

[a] Number of accurate solutions: maximum of 12 training, 6 generalization. [b] Average number of sec/problem.
[c] Number of efficacious judgments: maximum of 12 training, 6 generalization.

Self -Efficacy

The predictors entered to account for the variation in treatment subjects' ($N = 48$) posttest self-efficacy judgments were pretest self-efficacy, MAT score, and the three categorical variables. Only the effect due to pretest self-efficacy was reliable, $F(1, 42) = 8.77$, $p < .01$.. Although this effect indicates that the more efficacious children at the outset tended to remain so, pretest self-efficacy accounted for only 16% (14% adjusted) of the total variation in posttest self-efficacy; together, the five predictors accounted for only 22% (18% adjusted) of the total variation. Although it is clear that treatments did not differentially affect self-efficacy, it, is not clear what factor or factors were greater influences. Possibly some components of the training that cut across treatments, such as children's perceptions of their successes and difficulties, were more important than the components distinguishing the treatments.

Persistence

The same five predictors were entered in the same order as in the preceding analysis except that pretest persistence was substituted for pretest self-efficacy. In addition, posttest self-efficacy was entered last, since self-efficacy is hypothesized to influence task persistence.

Pretest persistence accounted for 22% (20% adjusted) and posttest self-efficacy accounted for 11% (10% adjusted) of the total variation in posttest persistence. These increments were statistically significant: for pretest persistence, $F(1, 41) = 13.82$, $p < .01$, and for posttest self-efficacy, $F(1, 41) = 7.04$, $p < .05$. Together, the six predictors ac-counted for 36% (31% adjusted) of the variation in posttest persistence. Again, these results speak for the importance of factors not assessed in the present study as influences on persistence.

Although the hypotheses that modeling and attribution within modeling would increase persistence were not supported, the expected relationship between self-efficacy and persistence was found; children who judged they could solve more problems subsequently persisted longer on the problems. But the heavy contribution of pretest persistence indicates that children who persisted longer on the pretest also did so on the posttest. This may be a reflection of work-rate preference; for example, some children may have chosen to work the problems slowly hoping to insure accuracy, whereas others may have been more concerned with completing the task more quickly.

Table 2
Regression Analysis of Hypothesized Predictors on Division Accuracy

Source	R^2 cum	R^2 adjusted	R^2 change	*df*	*F*
Self-efficacy	.2419	.2388	.2419	1	29.57**
Persistence	.4335	.4237	.1916	1	23.42**
Accuracy pretest	.5683	.5474	.1348	1	16.48**
Modeling–didactic	.6190	.5749	.0507	1	6.19*
MAT score	.6621	.5979	.0431	1	5.27*
Attribution (didactic)	.6726	.6072	.0105	1	1.28
Attribution (modeling)	.6729	.6074	.0003	1	.04
Residual	.3271	.3926	—	40	—

Note. cum = cumulative; MAT = Metropolitan Achievement Tests.
* $p < .05$. ** $p < .01$.

Accuracy

Seven predictors were entered in a regression equation to account for the variation in posttest accuracy: accuracy pretest score, MAT score, the three categorical variables as a group, and posttest self-efficacy and persistence as a group. Persistence and self-efficacy were entered, since self-efficacy theory predicts that both should influence achievement. Results are shown in Table 2.

Self-efficacy, persistence, pretest accuracy, the modeling—didactic variable, and the MAT score each accounted for a significant increment in the explained portion of' variability in posttest accuracy. In contrast, the contributions of the attribution variables were nonsignificant. Thus, children who judged themselves more efficacious and those who persisted longer also solved more problems. Consistent with prediction, modeling children outperformed didactic children. The significant contribution of pretest accuracy may seem puzzling, since children were selected on the basis of low accuracy; nonetheless, pretest accuracy scores ranged from 0 to 3. The contribution of the MAT score suggests that regardless of treatment, children with greater mathematical ability responded better to the training.

Path Analysis

The finding that the variability in posttest accuracy is a function of multiple influences is interesting in its own right, but it would be more meaningful to relate these data to a causal model. Such a model could then be tested using path analysis (Kerlinger & Pedhazur, 1973; Nie et al., 1975) to determine how well the model reproduces the original correlation matrix. Although path analysis cannot "prove" a theory to be correct, it is useful in rejecting causal models that demonstrate a poor fit to the original (full-model) correlations.

Table 3
Original and Reproduced Correlations for the Self-Efficacy Model (N = 48)

Variable	1	2	3	4
1. Treatment		.115	.018	.234
2. Self-efficacy	.115		.295	.565
3. Persistence	.034	.295		.438
4. Accuracy	.229	.565	.435	

Note. Original correlations are in the upper half of the table; reproduced correlations are in the lower half.

In its strictest form, self-efficacy theory postulates that treatments promote changes in behavior through changes in self-percepts of efficacy (Bandura, 1977). In this four-variable model, there are direct causal links between treatment and self-efficacy, self-efficacy and persistence, self-efficacy and accuracy, and persistence and accuracy. There are no direct paths from treatment to persistence or from treatment, to accuracy because treatment has no direct effect on these measures. Rather, treatment influences persistence through its effects on self-efficacy, and treatment also influences accuracy through its effects on self-efficacy, which in turn influences accuracy directly and indirectly through persistence.

To test this parsimonious model, the correlations between the four variables were computed and are shown in the top half of Table 3. Treatment is represented as a categorical variable (modeling—didactic). The attributional variable was dropped as it failed to show any effects in the preceding analyses. Self-efficacy, persistence, and accuracy are represented as change scores (posttest minus pretest) for training problems. Change scores were used to remove pretest variability without adding extra paths from pretest scores. This approach fits self-efficacy theory, which emphasizes behavioral change as a function of changes in self-efficacy and persistence. However, the reader should interpret these results with caution owing to the earlier warning about the unreliability of change scores (Cohen & Cohen, 1975).

The results using this model reproduced the original correlation matrix except for the correlation between treatment and accuracy: reproduced $r = .05$; original r = .23. Since this discrepancy is not small (<.05), it is cause for rejection of this model (Kerlinger & Pedhazur, 1973). If the direct path between treatment and accuracy is added but the direct path between treatment and persistence remains deleted, the original correlations are reproduced, as shown in the bottom half of' Table 3. Thus, besides its indirect effects on accuracy through self-efficacy and persistence, treatment also has a direct effect. It does appear, however, that treatment effects on persistence operate through changes in self-efficacy. Again, the reader should note that this model is not proven but that it offers an acceptable fit to the data.

The suggestion of a direct link between treatment and accuracy is not incompatible with self-efficacy theory. In the present context, children were developing cognitive skills, and it is not unreasonable to assume that such skills could develop independently of changes in self-efficacy. In contrast, the snake-phobic research by Bandura and his colleagues (Bandura & Adams, 1977; Bandura et al., 1977) is more concerned with subjects developing confidence that they can perform behaviors presumably already established, such as walking up to and touching a snake. Since the present data indicate a strong relationship between self-efficacy and accuracy, the data support the idea that changes in accuracy depend largely on changes in self-efficacy.

Congruence Between Self-Efficacy and Accuracy

The above analyses were based on aggregated measures; the more problems children judged they could solve, the more they subsequently solved. To provide a more stringent test of' the relationship between self-percepts of efficacy and accuracy, the level of congruence between these two factors was calculated by comparing each posttest efficacy judgment with the subsequent accuracy score on the problem of comparable form and difficulty. Congruence was defined as children judging themselves capable of solving that type of problem and subsequently failing the exemplar. Self-efficacy judgments higher than 55 were defined as indicating efficacy. Separate congruence percentages were computed for training and generalization problems, although as before the results from the problem classes followed a similar pattern, so only the former will be discussed.

Two measures of' incongruence were computed to gain better insight into the effects of the treatments on children's appraisals of their arithmetic efficacy. The first was *overestimation,* defined as children judging they could solve a certain class of problem but subsequently failing to solve the exemplar. The second was *underestimation,* defined as children judging they could not solve a particular type of problem but subsequently solving the exemplar. Table 4 shows the mean posttest percentages by treatment. Comparison of' these percentages with pretest percentages by treatment condition revealed no significant changes for the modeling groups. However, didactic—attributional children showed less congruence on the posttest (70%) than on the pretest (90%), $t(11) = —3.24$, $p < .01$, and overestimated more on the posttest (19%) than on the pretest (4%), $t(11) = 2.73$, $p < .03$. Didactic—no attributional children also showed less posttest congruence (57%) than pretest congruence (76%), $t(11) = —2.22$, $p < .05$.[2]

Multiple regression procedures were applied to the posttest data using the appropriate pretest index and the three categorical variables as predictors. The percentages of the total variation in the posttest data accounted for by these predictors were 31% (25% adjusted) for congruence, 28% (22% adjusted) for overestimation, and 9% (1% adjusted) for underestimation.

The regression analyses supported the hypotheses that congruence would be significantly affected by both the instructional-treatment and attribution-within-modeling variables. Modeling children showed significantly higher congruence than didactic children, $F(1, 43) = 13.29$, $p < .01$, whereas modeling children receiving attribution showed higher congruence than those not receiving attribution, $F(1, 43) = 4.13$, $p < .05$. The respective percentages of the total variation in posttest congruence accounted for by these variables were 21% (17% adjusted) and 7% (6% adjusted). No significant differences were found due to the attribution-within-didactic variable. With regard to mismatches, didactic subjects overestimated significantly more than modeling children, $F(1, 43) = 5.02$, $p < .05$. This variable accounted for 8% (7% adjusted) of the overestimation variation. There were no significant attributional effects. Pretest overestimation accounted for 16% (13% adjusted) of the total variation in posttest overestimation, $P(1, 43) = 9.88$, $p < 01$. Thus, regardless of treatment condition, children who overestimated more on the pretest also did so on the posttest. In summary, the hypothesis that modeling children would appraise their capabilities more accurately than didactic children was supported; didactic children tended to overestimate. In the context of modeling, effort attribution fostered more accurate capability assessment.

Table 4

Percentage of Congruence and Incongruence Between Efficacy Judgment and Performance by Problem Class and Treatment Condition

Congruence index	Treatment condition: Modeling–attribution	Modeling–no attribution	Didactic–attribution	Didactic–no attribution
Training				
Congruent	84.7	76.4	70.2	56.9
Overestimated	4.2	9.0	19.4	18.8
Underestimated	11.1	14.6	10.4	24.3
Generalization				
Congruent	81.3	70.8	72.9	58.3
Overestimated	2.1	18.8	25.0	35.4
Underestimated	16.6	10.4	2.1	6.3

Discussion

The present, study demonstrates that treatment procedures providing problem-solving principles, practice in applying the principles, corrective feedback, and self-directed mastery were effective in developing skills and enhancing a sense of efficacy in children who had experienced profound failure in mathematics. In contrast, control children who did not have the benefit of the instructional treatment showed no significant changes in self-efficacy, remained unskilled at solving division tasks, and became less persistent at working problems.

As hypothesized, cognitive modeling was more effective than didactic instruction in promoting skill development. This difference was found despite many similarities between the two treatments. Both provided children with instruction on division principles, the opportunity to practice applying the principles to problems, corrective feedback, and self-directed mastery. The major difference between the two treatments was that children in the modeling condition observed division strategies modeled with different exemplars during periods of instruction and feedback.

The hypotheses of greater gains in self-efficacy and persistence as a result of modeling did not receive support. This may have been due to the intertreatment similarities noted above. Providing children with instruction and opportunities to practice, both of' which produce success experiences, should lead to heightened self-efficacy and persistence. The additional benefits of modeling did not contribute to gains on these measures. This is not to say that treatment was un-important. Compared with no treatment, it promoted significant gains in self-efficacy, persistence, and accuracy. More important, however, path analysis showed that omitting the direct effect of treatment on accuracy was untenable. A more reasonable statement is that treatment differences exert their effects directly on changes in skills and indirectly through changes in self-efficacy. This assumes, of course, that the treatments are meaningful; to teach children division, treatments should provide instruction, opportunities to practice, and feedback. Once these minimal criteria are met, variables such as self-efficacy and persistence may be more important predictors of skill changes.

These considerations actually support predictions from self-efficacy theory. Children with higher percepts of self-efficacy subsequently persisted longer and achieved more success on arithmetic tasks than their less efficacious and persistent counterparts. But other results indicate that factors other than self-efficacy and persistence can predict children's achievements. For example, children who persisted longer on pretest problems also persisted longer on posttest problems, which suggests that children who preferred to work rapidly may have become discouraged by the difficulty of' the test problems and therefore gave up more readily than more meticulous children. Also, pre-test accuracy and MAT score predicted posttest accuracy. An important consideration in the present research, which employed a classroom subject as the training task, is that children enter with some level of competence, so it is not unreasonable to expect that such entry-level competence would in part predict subsequent performance.

The hypothesis that attributing successes and difficulties to effort should influence self-efficacy, persistence, and skill accomplishment for modeling children failed to receive support. Since the modeling treatment provided children with valid information concerning their arithmetic competence, any effects of persuasive effort attribution may have been overridden. This interpretation is consistent with evidence report by Chapin and Dyck (1976) that the effects of effort attribution depend on the performance context in which it occurs. These investigators found that when children learn they can succeed despite repeated failure, they show high persistence regardless of whether their successes and failures were attributed to how much effort they exerted.

It is also conceivable that both modeling and didactic children altered perceptions of their capabilities as a result of effort attribution during training but that the effects dissipated quickly because many of' the problems they encountered were difficult. If expending more effort were often followed by difficulty on tasks, the causal ascriptions may have rapidly lost their impact. This idea is supported by recent research conducted within the attributional framework. Information that effort expenditure can affect outcomes is expected to be maximally effective for tasks perceived as intermediate in difficulty (Kukla, 1972b; Weiner, Heckhausen, Meyer, & Cook, 1972). Effort in-formation should have less effect on performance when subjects perceive the tasks as either very easy or very difficult, since in the former case high effort should not be necessary for success, whereas in the latter instance even high effort may not insure success. If modeling children perceived the division tasks as difficult even though they demonstrated greater skill than didactic children, the ineffectiveness of effort attribution is not surprising. Division is generally regarded by educational practitioners as a difficult subject for children to master, and especially so for low achievers.

A related line of evidence suggests that effort information is differentially valued depending on whether it leads to success or failure. According to the self-worth theory of achievement behavior (Beery, 1975; Covington & Beery, 1976), individuals view personal worth as highly dependent on their ability and believe that one's performance is a direct reflection of one's ability. Seen from this perspective, failure after the expenditure of high effort is threatening to self-worth, since this implies a lack of ability. In support of this theory, Covington and Omelich (1979b) found that when students failed at a task, they preferred being viewed as expending less rather than more effort. In contrast, high effort that leads to success should not threaten personal worth, since success at all but easy tasks requires a combination of' ability and effort (Kelley, 1971). Support for this latter contention has also been found (Covington & Omelich, 1979c). These considerations raise the question of how much effort modeling children actually expanded in response to the attribution. From the self-worth viewpoint, modeling children may have been reluctant to expend great effort on such difficult tasks, since resulting failure would discount a lack of effort as the cause and imply a lack of ability. Future research should address children's perceptions of the usefulness of effort attribution as it is being provided with an ongoing task.

These findings suggest the need for caution in the use of effort attribution to correct cognitive deficiencies. Not only do the conditions under which attribution is effective need further clarification, but its use may involve risks where failures reflect basic deficits. Teachers who mistakenly attribute children's failure to insufficient effort, especially after children have worked hard at problems, might demoralize children who lack the requisite cognitive skills to succeed. The prediction from self-efficacy theory is that effort attribution is most likely to be motivating for children who possess the skills so that increased effort would likely bring success.

Data analyses revealed a close relationship between efficacy judgment and division performance at the level of individual tasks. This relationship is interesting considering the inferential nature of the judgmental task. Children were making a generalized judgment as to whether they were sufficiently skillful to solve a class of problems of a given type and level of' difficulty. In other words, they were judging a general capability and not their capability to solve a specific problem.

The expected differences in congruence favoring modeling over the didactic treatment cannot stem from differential behavior sources of efficacy because children in both treatments performed the same problems and had ample opportunities to observe their successes and difficulties. The congruence differences may have been due to a combination of beneficial factors that are associated with modeling procedures and that provide valid performance information, namely, that modeling focuses children's attention on the processes being taught, provides a concrete set of' observable operations tied to abstract principles, and provides specific information on the source and remedy for deficiencies. Without such valid indicators, didactic children may have been swayed by their modest training successes while remaining largely uninformed of the extent of their deficiencies. These same indicators may also help explain why modeling promoted problem accuracy.

The superiority of modeling in fostering accurate self-appraisal is supported by self-worth theory. Students who perceive themselves as low in ability may demonstrate self-serving biases in judging their capabilities (Beery, 1975; Covington & Omelich, 1979b). To lessen the sense of failure, students may judge their expectations so unrealistically high that failure does not necessarily implicate an ability deficit. Conversely, they may judge them unrealistically low, thereby guaranteeing success. During the posttest these self-serving tendencies may have been more pronounced among didactic children, who were undoubtedly more uncertain of their division capabilities. Modeling may help to reduce such tendencies by providing a more solid base on which to build task success and the accompanying self-perception of ability.

These considerations do not account for the finding that subjects receiving modeling and effort attribution were more likely to accurately appraise their capabilities than were children who received modeling alone. These two groups received the same amount of behavioral information during training and they did not differ in accuracy of division solutions.

It is possible that children in the modeling—attribution treatment benefited from the attribution by gaining a better under-standing of how effort can affect performance. Belief that heightened effort leads to success would occasionally be disconfirmed by failure on difficult tasks, despite the children's more concerted effort. As a result, children may have formed a more realistic picture of the limitations of effort in solving difficult problems than did modeling children for whom the limits of effort alone might have been less salient.

This interpretation is supported by Kukla's (1972a) contention that effort attribution is richer in informational content than no effort attribution. The latter condition leaves the subject numerous ways to construe the task. Thus behavioral differences between these two groups could be due not so much to the presence of effort attribution as to the differential amount of information each group receives. To circumvent this problem, Kukla (1972a) combined effort with ability attribution and compared this condition with a condition receiving only ability attribution. The results showed that effort attribution boosted performance only among high achievers; the performance of low achievers did not differ between the two conditions. To clarify the role of effort attribution in fostering accurate self-appraisal, future research should follow Kukla's suggestion.

The present research lends support to the idea that children's self-perceptions of their capabilities have an important effect on their subsequent achievements. Similar results have been obtained by Covington and Omelich (1979a) who, using adults as subjects, found that people's expectations of successful performance were one of the best predictors of how well they later performed. Although personal expectations for success are viewed as important influences on behavior by other contemporary theories of achievement behavior (Covington & Beery, 1976; Kukla, 1972b; Moulton, 1974), self-efficacy theory is concerned with casting achievement behavior in a broadly integrative theoretical framework by specifying the developmental influences on self-percepts of efficacy, the major sources of efficacy information, and the mechanisms through which self-referent thought affects behavioral, affective, and cognitive changes (Bandura, in press). The present study suggests that research investigating how children weigh and integrate efficacy-relevant information in forming efficacy judgments represents a worthwhile direction.

Notes:

[1] This scoring method provides a more sensitive measure of children's division capabilities than a more stringent method requiring perfect accuracy on all counts. By this latter method a child who performed the correct operations but who made a small error in subtraction and therefore arrived at an incorrect answer would be penalized as much as a child who failed to work the problem. Performance-test data were analyzed using both scoring methods. Their results were similar, so to avoid duplication the perfect-accuracy results are not reported.

[2] In a sense pretest congruence is not too meaningful because it is based on efficacy judgments collected after the performance test. Self-efficacy is therefore post-dictive and is undoubtedly influenced by test performance. This sequence was reversed in the posttest, where efficacy judgments were collected before the performance test; thus they provide a measure of prediction. It was felt, however, that some children might display systematic biases toward over- or underestimation in judging efficacy; therefore, pretest congruence was included in the analyses.

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