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ABSTRACT

This study explored how task strategies and attributions for success during cognitive skill acquisition influenced self-efficacy and skillful performance. Fifty children aged 9 to 10 who lacked division skills received instruction and practice opportunities. Task strategies were assessed by recording children's verbalizations while they solved problems. Ability attributions exerted the strongest influence on changes in self-efficacy, and improvements in division skill largely depended on self-efficacy and effective strategy use during the training program. Future research should explore the relationship between strategy use and self-efficacy during various phases of skill acquisition. Implications for teaching are discussed. (Author/MS)

# Strategy and Attributional Effects on Children's Self-Efficacy and Skills



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## Abstract

This study explored how task strategies and attributions for success during cognitive skill acquisition influenced self-efficacy and skillful performance. Children who lacked division skills received instruction and practice opportunities. Task strategies were assessed by recording children's verbalizations while they solved problems. Ability attributions exerted the strongest influence on changes in self-efficacy, and improvements in division skill largely depended on self-efficacy and effective strategy use during the training program. Future research should explore the relationship between strategy use and self-efficacy during various phases of skill acquisition. Implications for teaching are discussed.

Strategy and Attributional Effects

on Children's Self-Efficacy and Skills

According to Bandura, 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 activity. Self-efficacy can influence choice of activities, effort expenditure, persistence, and task accomplishments (Bandura, 1977). People acquire information about their self-efficacy through their own performances, observations of others, forms of persuasion, and physiological indexes (e.g., heart rate).

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 learning (Schunk, 1984). This latter research has explored how students acquire information about their self-efficacy and has identified important influences on self-efficacy, such as rewards, goals, and social comparisons (Schunk, 1984). Self-efficacy has been shown to affect persistence and level of skill development (Schunk, 1981, 1984).

One theoretically important influence on self-efficacy is subjects' cognitive processing as they work at tasks (Bandura, 1977). Much cognitive skill acquisition requires that subjects comprehend task strategies, or systematic approaches involving procedural knowledge (Winne, in press). Self-efficacy is enhanced by personal knowledge that one possesses skills for coping with stressful situations (Bandura, 1977). Extending this thinking to cognitive skill learning, the belief that one understands and can effectively apply task strategies ought to result in higher self-efficacy (Corno & Mandinach, 1983; Winne, in press), which should be validated as students engage in the task and successfully apply task strategies. In contrast, students who encounter difficulties in cognitively processing task information may doubt their capabilities to acquire skills.

Although there is much evidence that effective use of task strategies promotes skill development (Dansereau, 1978; Diener & Dweck, 1978; Peterson, Swing, Braverman, & Buss, 1982; Resnick, 1981), there is little research on how task strategies influence self-efficacy. In a recent study (Locke, Zubritsky, & Lee, 1983), college students participated in a brainstorming task (uses for common objects) over trials, and some subjects were trained in the use of brainstorming strategies. The results showed that strategy use influenced self-efficacy and that post-training performance was influenced by self-efficacy and strategy use.

One purpose of the present study was to explore how task strategies affected self-efficacy and skill development in a cognitive skill learning context (mathematical division, among children. Based on the preceding considerations, it was predicted that greater use of effective task strategies (i.e., those oriented toward successful problem solutions) would positively influence self-efficacy and skill development. Higher self-efficacy also was expected to promote skills.

Within this context, this study explored how children's self-efficacy and skill development were affected by their attributions for task successes and how task strategies influenced attributions. Attributional theories postulate that individuals make causal ascriptions for the outcomes of their actions (Kelley & Michela, 1980). In school, students often attribute their successes and failures to ability, effort, task difficulty, and luck (Frieze, 1980; Weiner, 1979). Future expectancies of success and failure heavily depend on causal ascriptions (Weiner, 1979). For example, if one believes that the conditions surrounding a task will remain much the same, attributing prior successes to relatively stable causes, such as high ability or low task difficulty, should result in higher expectancies of future success (i.e., self-efficacy) than attributions to the more unstable causes of high effort or good luck (Fontaine, 1974; McMahan, 1973; Weiner, Nierenberg, & Goldstein, 1976).

Children often use ability and effort to explain successes (Frieze, 1980; Harari & Covington, 1981). Young children view effort as the prime cause of outcomes and ability-related terms as closely associated, but around Age 9 a distinct conception of ability begins to emerge (Nicholls, 1978). With development, ability attributions become increasingly important in explaining successes, whereas effort declines in importance (Harari & Covington, 1981; Nicholls, 1978). The perception of less effort required to succeed at a task should raise self-efficacy more than when greater effort is required (Bandura, 1977, 1981).

In the present study, children received training in division operations over sessions. It was expected that use of effective task strategies would lead to successful problem-solving during training. Because task success is a prominent cue used in formulating ability attributions (Weiner, 1974), task strategies were expected to increase ability attributions. Task strategies also were expected to promote attributions to low task difficulty, because students who applied strategies more readily were expected to view the task as less taxing than those who encountered difficulties. It was predicted that effective task strategy use would relate negatively to luck attributions, and because the present subjects were old enough to have begun to differentiate ability from effort it was hypothesized that greater use of effective task strategies would result in lower effort attributions. Attributions of task success to high ability and low task difficulty were expected to enhance self-efficacy and skillful performance, whereas attributions to high effort and good luck were predicted to exert a negative effect on these outcomes (Fontaine, 1974; McMahan, 1973; Schunk, 1984; Weiner et al., 1976).

## Method

### Subjects

The sample included 50 children drawn from two elementary schools. Ages ranged from 9 years 3 months to 10 years 9 months ($M$ = 10.0 years). The 28 boys and 22 girls were predominantly middle class. Because this study focused on self-efficacy and skill development, children's teachers were shown the division skill test and identified children who they felt could not solve correctly more than about 25% of the problems. These children were administered the pretest individually by one of two female adult testers.

### Pretest

Self-efficacy. Children's self-efficacy for solving division problems correctly was measured following procedures of previous research (Schunk, 1981, in press). The efficacy scale ranged from 10 to 100 in 10-unit intervals from high uncertainty--10, to complete certitude--100. Children initially received practice by judging their certainty of successfully jumping progressively longer distances. In this concrete fashion, children learned the meaning of the scale's direction and the different numerical values.

Following this practice, children were shown 18 sample pairs of division 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 operations required, and corresponded to one problem on the ensuing skill test although they involved different numbers. Children were judging their capability to solve different types of problems and not whether they could solve any particular problem. Children made each judgment 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.

Division skill test. The skill test was given next and included 18 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). Problems required "bringing down" numbers with and without remainders. Half of the 18 problems were similar to those children would solve during training, whereas to assess generalization the other half were more complex. For example, during training children had to bring down numbers once or twice per problem, whereas some skill test problems required bringing down three numbers.

The tester presented the problems one at a time and instructed children 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. Children were given no performance feedback. The measure of skill was the number of problems solved correctly.

Training Procedure

Children received four, 40-min training sessions over consecutive school days, during which they worked on four training packets. The first two 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 and exemplified division operations with a step-by-step worked problem. The second page contained a practice problem, and the next several pages included problems to solve. Sufficient problems were in each packet so that children could not complete it.

An adult female proctor escorted children individually to a large room where they were seated away from others to preclude visual and auditory contact. Initially, the proctor reviewed the explanatory page by pointing to the operations while reading from the narrative. Children then worked the practice problem, after which the proctor stressed careful work and moved out of sight. Children solved problems alone and received no performance feedback on the accuracy of their solutions.

Task strategies were assessed by having children verbalize aloud while solving problems. Verbalizations were collected about 10 min into the fourth session. The proctor explained to each child that she wanted them to talk out loud because she was interested in knowing what children think about as they solve problems. To lessen potential evaluative concerns about verbalizing, she explained that children might think about many things, such as what numbers to use, how well they are doing, and what they will do at recess or after school.

After the proctor showed children the tape recorder, they were given a problem to solve, and were reminded to say aloud everything they were thinking about. If at any time children did not verbalize for about 10 sec the proctor reminded them of the instructions. Verbalizations were recorded for 20 min. The proctor supplied new problems as necessary.

The proctor remained silent during the taping except to inform children that their answers were correct and when giving them a new problem. If children were baffled about how to proceed, the proctor referred to the explanatory page and reviewed the troublesome operation. When children verbalized an incorrect operation (e.g., 28 times 2 is 48), the proctor initially remained silent to see if they would correct the error. If they did not, she advised them to check the appropriate step, and pointed out the error if children were still puzzled after checking their work.

Attributions

Children's attributions for their problem solving during training were measured the day following the last training session. Four scales were shown on a sheet of paper; each ranged in intervals of 10 from 0--not at all, to 100--a whole lot. The four scales were labeled "good at it" (i.e., ability), "worked hard" (effort), "easy problems" (task), and "lucky" (luck). Label order was counterbalanced across subjects.

The tester explained that this paper showed four things that can help children work problems. The tester described the scale and each attribution, and provided examples of how hypothetical children might mark each scale. Children were advised to think about their work during the four training sessions and mark how much they thought each factor helped them solve problems. They were told that their marks did not have to add to a certain number (e.g., 100). Children privately recorded their ratings.

Posttest

The posttest was administered the next day. The self-efficacy and division skill instruments and procedures were similar to those of the pretest except that a parallel form of the skill test was used to eliminate possible problem familiarity. For any given child, the same tester administered the pretest, attributional assessment, and posttest, and had not served as the child's training proctor. All materials were scored by a third adult.

Task Strategies

Verbalizations were transcribed verbatim and each statement was classified by an adult unfamiliar with the purpose of the study. Where a statement was followed immediately by its answer (e.g., "How much is 4 times 5? 20."), the entire sequence was classified as one statement. The breakdown of this classification was as follows: task strategies--94.4%, miscellaneous statements--5.6%. The latter statements included achievement beliefs that primarily reflected attributions (e.g., "I'm lousy at this," and, "That wasn't too hard"), and irrelevant statements (e.g., "Have you seen E.T.?"). Miscellaneous statements were not included in the data analyses.

Task strategies were classified further as effective or ineffective by the same scorer. This categorization was checked by the authors;

agreement was 94.6%. Where disagreement occurred, the statement was discarded.

Effective task strategies. These strategies were oriented toward problem solution and if properly followed would lead to a correct answer. Two distinct types were found: application and computation. Application strategies referred to properly applying steps in the division algorithm to the problem at hand. For example, in the problem 4109 divided by 16: "First I have to divide 16 into 41," and, "Now bring down the 0." Computation strategies involved accurate multiplication and subtraction: "16 times 2 is 32," "41 take away 32 is 9? Yes." Data initially were analyzed using separate application and computation categories. These categories were merged because they yielded similar patterns of results.

Ineffective task strategies. Ineffective strategies were task-oriented but if followed would lead to an inaccurate solution. Examples of ineffective application strategies were: "Divide 41 into 16," and, "No numbers to bring down" (when there were). Ineffective computations included, "16 times 2 is 38," and, "41 take away 32 is 11."

## Results

Table 1 portrays means, standard deviations, and intercorrelations of all experimental measures. Data were analyzed using hierarchical multiple regression (Kerlinger & Pedhazur, 1973). Variables were added to each regression equation in predetermined steps based on the following temporal order: pretest efficacy, pretest skill, effective task strategies, attributions (as a group), and posttest efficacy. No causal reciprocity was assumed between the attributional variables (Covington & Omelich, 1979). These results should be viewed with some caution. When multiple regression is employed with a small total sample size and a large number of predictors the regression coefficients can be unstable from one sample to another, especially when independent variables are intercorrelated (Kerlinger & Pedhazur, 1973).

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Insert Table 1 about here

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## Pretest Skill

This variable was regressed on pretest self-efficacy with a non-significant result. Pretest efficacy accounted for 3% of the variation in skill, which suggests that when skills are low factors other than self-efficacy (e.g., mathematical ability) might be better predictors.

## Task Strategies

Pretest self-efficacy and skill were entered as predictors, and pretest skill accounted for 8% of the variation in use of effective task strategies, $F(1, 47) = 4.44$, $p < .05$. The contribution of pretest efficacy (3%) was not significant.

## Attributions

Ability. This measure was regressed on pretest self-efficacy, pretest skill, and task strategies. These three predictors jointly accounted for 6% of the variation, but none of the individual contributions were statistically significant.

Effort. The same three predictors jointly accounted for 6% of the variation in effort attributions. As before, the individual contributions were not statistically significant.

Task difficulty. The joint contribution of the four predictors was 9%, but none of the predictors accounted for a significant portion of the variability.

Luck. A significant effect was obtained for pretest skill (9%), $F(1, 46) = 4.49$, $p < .05$. This effect was in a negative direction. Jointly, the predictors accounted for 12% of the variation in luck attributions.

Posttest Self-Efficacy

Seven predictors jointly accounted for 56% of the variation in posttest efficacy. Two predictors accounted for significant increments in the explained variability ($df = 1, 42$): ability attributions ($R^2 = .43$, $F = 40.57$, $p < .001$), and luck attributions ($R^2 = .07$, $F = 6.46$, $p < .05$). The effect due to luck attributions was in a negative direction.

Posttest Skill

Posttest skill was regressed on the preceding seven predictors, along with posttest efficacy. Each of the following accounted for a significant increment in variability ($df = 1, 41$): posttest efficacy, $R^2 = .17$, $F = 11.82$, $p < .01$; task strategies, $R^2 = .12$, $F = 8.81$, $p < .01$. Both effects were in a positive direction. The eight predictors jointly accounted for 43% of the variability.

Path Analysis

To further explore the theoretical relationships between variables, path analysis was applied to the data (Kenny, 1979; Kerlinger & Pedhazur, 1973). For this analysis, self-efficacy and skill were represented as change scores (posttest minus pretest) to remove pretest variability without adding extra paths from pretest scores. Although change scores can be unreliable (Cohen & Cohen, 1983), their use fits with the self-efficacy model, which emphasizes behavioral improvement as a function of increases in self-efficacy (Bandura, 1977, 1982). The path model is shown in Figure 1, where numbers refer to standardized regression coefficients (beta weights).

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Insert Figure 1 about here

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Consistent with prediction, greater use of effective task strategies positively influenced attributions of success to high ability and low task difficulty, and related negatively to effort and luck attributions. Ability attributions exerted the largest direct effect on changes in self-efficacy, which is consistent with prior research showing that ability attributions for prior successes strongly influence performance expectancies (Fontaine, 1974; McMahan, 1973; Weiner et al., 1976). Consistent with prediction, negative effects of effort and luck attributions on self-efficacy were obtained. The direct effects of task strategies and attributions to low task difficulty on self-efficacy were small; the latter was in the opposite direction than predicted.

The largest direct influence on changes in division skill was due to effective task strategies, and changes in skill also were affected strongly by variations in self-efficacy. Unexpectedly, effort attributions bore a positive relationship to changes in skill. Figure 1 shows that ability and task attributions, while influencing skill changes in the predicted direction, exerted only moderate direct influences. Attributions to luck did not directly affect changes in skill.

## Discussion

The present study shows that effective task strategies and attributions for task success have important effects on achievement outcomes. Greater use of effective task strategies bore a positive relationship to ability and task difficulty attributions and a negative relationship to effort and luck attributions. Although task strategies did not have a large direct effect on changes in self-efficacy, variations in strategy use exerted the strongest direct influence on skill improvement.

An explanation for these findings is as follows. Students who believe that they can effectively employ task strategies ought to experience higher self-efficacy than those who doubt their capabilities to cognitively process task information. This sense of efficacy is validated when students employ strategies while working on the task and observe their successes in solving problems. Successful problem solving is a prominent cue used to formulate ability attributions, and also is associated with perceptions of lower task difficulty (Weiner, 1974). Problem-solving facility should lead students to place less emphasis on effort and luck as causes of success.

Effective use of task strategies had a much greater effect on skill development than on changes in self-efficacy. These results differ from those of Locke et al. (1983), who found roughly comparable effects of task strategy use on both self-efficacy and performance. One important difference between the present study and that of Locke et al. (1983) is that attributions were not assessed in the latter study. Attributions are hypothesized to exert important effects on changes in self-efficacy (Bandura, 1977; Schunk, 1984). In the present study, it seems highly likely that, in addition to their direct effect, task strategies also influenced self-efficacy indirectly through attributions. For example, successful problem-solving can foster student beliefs of high task ability, and ability attributions exert strong effects on achievement expectancies (Fontaine, 1974; Frieze, 1980; McMahan, 1973; Weiner, 1979; Weiner et al., 1976).

The negative influence of effort attributions on self-efficacy is consistent with developmental evidence showing that ability attributions become increasingly important in explaining success, whereas effort as a causal factor declines in importance (Harari & Covington, 1981; Nicholls, 1978). Success attained with less perceived effort should promote self-efficacy more than when greater effort is required (Bandura, 1981).

Path analysis showed that task ease attributions exerted a small negative effect on changes in self-efficacy. This latter finding seems to contradict the idea that attributions of success to task ease enhance expectancies of future success (McMahan, 1973; Weiner et al., 1976); however, such a positive influence should be obtained only when subjects judge expectancies on the same or similar tasks (Weiner, 1983). When expectancy judgments are made on tasks of greater difficulty, the relationship of task-ease attributions to future expectancies becomes problematic. In the present study, half of children's posttest self-efficacy judgments were on types of problems more complex than those solved during training.

The present study supports the idea that, although self-efficacy is influenced by task performances, it is not a mere reflection of them (Schunk, 1984). Greater use of effective task strategies bore a small but positive relationship to subsequent efficacy judgments. Performing a task well does not guarantee that people will view themselves as highly capable, because self-efficacy is partially independent of cognitive skills (Bandura, 1984). The effects of task outcomes on self-efficacy depend on how they are cognitively appraised (Schunk, in press). This study also supports the notion that perceptions of capabilities affect subsequent skillful performance (Covington & Omelich, 1979; Schunk, 1981). Personal expectations for success are viewed as important influences on behavior by a variety of theoretical approaches (Bandura, 1981; Covington & Omelich, 1979; Kukla, 1972; Schunk, 1984; Weiner, 1979).

It is interesting that the largest direct attributional effect on changes in skill was found for effort. It is possible that this effect was mediated by some variable not assessed such as persistence. Children who stressed effort as a cause of success may have persisted longer on the posttest and thereby solved more problems. This explanation is only suggestive because persistence was not assessed; however, prior research has shown that greater persistence during cognitive skill learning promotes skillful performance (Schunk, 1981).

The present study used verbalizations as data, which has been questioned (Nisbett & Wilson, 1977). According to Ericsson and Simon (1980), however, verbalizing does not affect underlying cognitive processes when the information to be verbalized is already being attended to, such as when subjects talk aloud while performing a task. Further, when information to be verbalized is not in verbal form, performance may be slowed down and verbalizations may be incomplete, but the structure of the task performance remains largely unaffected. Given these considerations, it appears unlikely that the present verbalizing altered children's cognitive processes.

Future research might sample verbalizations during various phases of cognitive skill acquisition. Early in the course of learning subjects might use a high proportion of ineffective task strategies, but later on should employ correct strategies more often. Collecting efficacy judgments as well at various points during skill acquisition could determine how well changes in self-efficacy correspond to skill improvement and predict effective strategy use.

The results of this study have implications for teaching. Although teachers instruct students in problem-solving strategies, it is important that students systematically employ strategies while working at tasks. One means of promoting such use is to emphasize strategy importance; that is, that consistent use of strategies can benefit students' performances on different tasks (Kennedy & Miller, 1976). Research shows that conveying strategy importance to students improves their motivation, self-efficacy and mathematical skill development (Schunk & Gunn, in press). In this latter study, importance was conveyed with information that consistent strategy use helped other students solve problems. It also is possible for teachers to convey importance through verbal feedback that links students' problem-solving progress with strategy use (e.g., "You're doing well because you're following the steps in the right order").

The present findings are consistent with the idea that ability attributions exert stronger effects on performance expectancies than do effort attributions once children begin to form distinct conceptions of ability and effort (Harari & Covington, 1981; Nicholls, 1978). Research also demonstrates that attributional feedback linking children's learning with attributions can have important effects (Schunk, 1984). For example, teacher verbal feedback that attributes students' successes to their abilities (e.g., "You're good at this") leads to higher motivation, self-efficacy and skill development than feedback linking successes to effort (e.g., "You've been working hard") (Schunk, 1984). When children learn a task readily, ability feedback for their early successes promotes achievement outcomes better than ability feedback for later successes (Schunk, in press). Teachers who judiciously deliver attributional feedback during classroom learning activities may help to develop students' skills and self-efficacy for applying them.

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Table 1

Means, Standard Deviations, and Intercorrelations of Experimental Measures

| Measure | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | M | SD |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-Pretest Efficacy[a] | .16 | .18 | .18 | .10 | .17 | -.16 | .21 | .07 | 30.2 | 15.3 |
| 2-Pretest Skill[b] | | | .18 | -.17 | .24 | -.32* | .25 | .35* | 1.1 | 1.3 |
| 3-Task Strategies[c] | | | .14 | -.14 | .22 | -.15 | .17 | .35* | 84.4 | 13.4 |
| 4-Ability[d] | | | | .29* | .70** | -.18 | .67** | .45** | 75.3 | 24.1 |
| 5-Effort[d] | | | | | .38** | .11 | .05 | .29* | 88.9 | 17.0 |
| 6-Task Ease[d] | | | | | | .09 | .38** | .49** | 70.8 | 18.5 |
| 7-Luck[d] | | | | | | | -.42** | -.16 | 32.2 | 28.7 |
| 8-Posttest Efficacy[a] | | | | | | | | .37** | 71.0 | 20.6 |
| 9-Posttest Skill[b] | | | | | | | | | 7.1 | 3.9 |

Note. $N = 50$

* $p < .05$

** $p < .01$

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

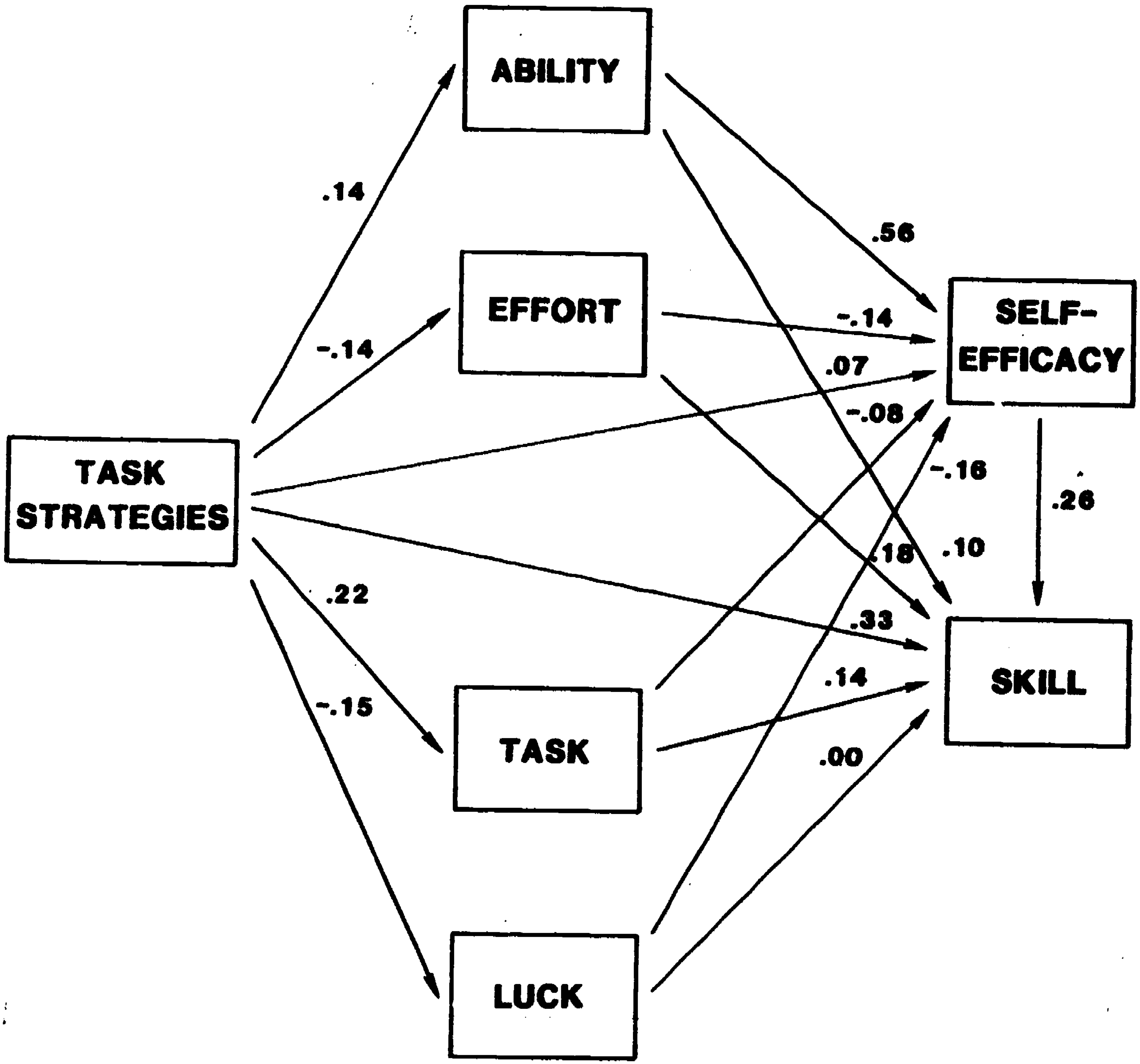
[b]Number of correct solutions on 18 problems.

[c]Percentage of all task strategies classified as effective.

[d]Range of scale: 0 (low) - 100.

## Figure Caption

Figure 1. Path model (numbers in parentheses are standardized regression coefficients).


ABILITY
EFFORT
TASK STRATEGIES
TASK
LUCK
SELF-EFFICACY
SKILL
.14
-.14
.22
-.15
.56
-.14
.07
-.08
-.16
.26
.18
.10
.33
.14
.00