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A comparison of strategy instruction and sequential instruction of verbal math problems

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A COMPARISON OF STRATEGY INSTRUCTION
AND SEQUENTIAL INSTRUCTION OF
VERBAL MATH PROBLEMS

by
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ABSTRACT

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Thesis Advisor: Dr. Stanley Urban
Learning Disabilities

This research study was conducted to test the effectiveness of strategy instruction and sequencing practice problems in teaching fourth grade students to identify the correct algorithm for solving one-step multiplication and division problems. Forty-eight students were assigned to one of three experimental groups: strategy-plus-sequence, strategy only, or sequence only. The results indicated that students in the strategy only group and the strategy-plus-sequence group scored significantly higher than did students in the sequence only group. Findings indicated that strategy teaching was more effective than sequencing problem type. Implications for instructional design are discussed.

MINI-ABSTRACT

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This research study was conducted to test the effectiveness of strategy instruction and sequencing practice problems in teaching fourth grade students to identify the correct algorithm for solving one-step multiplication and division problems. It was concluded that strategy instruction was effective in improving the performance of the students.

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Chapter One
The Problem

Need

Problem-solving instruction has traditionally been a part of the mathematics curriculum in US public schools. Unfortunately, the development of these skills has not progressed to a sufficient level in children as seen on standardized test results. Also, these skills taught in schools have not transferred well to real life problem-solving situations.

There are several reasons for this situation. First, basal arithmetic programs may be contributing to the problems students experience in solving word problems. After reviewing elementary mathematics curricula, Silbert, Carnine, and Stein (1981) reported major concerns about the lack of allowance for practice and review, inappropriate sequencing of problems, and an absence of strategy teaching and step-by-step procedures for problem-solving. A review of the literature has shown that only "scant attention" is directed toward word-problem-solving skills (Cawley, Miller, and School, 1987). It has also been found that the curricula often emphasizes rote development of computational skills (Cawley et al. 1978, 1979a, 1979b; Cawley and Goodman, 1968, 1969).

In the 1980's, the National Council of the Teachers of Mathematics (NCTM) presented a challenge to educators asking them to focus on two goals for the decade. These goals included the "Back to the Basics" movement, focusing on basic math concepts, and the promotion of problem-solving skills. In 1989, the NCTM issued a set of standards to be used as a guideline for mathematics curriculum development and evaluation. These standards which included both elementary and secondary mathematics stressed the area of problem-solving. The standards emphasize problem-solving as a process and suggest that routine and non-routine problems be included in classroom instruction to help students understand the importance and necessity of problem-solving skills. They also suggest that children should have many opportunities to analyze problem situations, select appropriate strategies, test the strategies, and check the reasonableness of the answer. Also, existing research suggests that when presenting instruction in problem-solving, consideration must be given to sequencing, providing adequate practice, cognitive strategies, direct instruction, and techniques to promote generalization (Darch, Carnine, and Gersten, 1984; Fleischner and O'Loughlin, 1985; Jones, Krouse, Feorene, and Saferstein, 1985; Montague and Bos, 1986). This study is necessary to help find an effective means of instruction for problem-solving in math. The purpose of education is to prepare children for the future so that they may lead productive and independent lives as adults. Since problem-solving skills, especially those in math, are central to everyday life, a strong background in these skills is essential for successful living. It is our responsibility as educators to provide that background in an effective way.

Purpose

In response to this research, this study seeks to find if the use of a strategy-plus sequence of teaching problem-solving in math will improve the mathematical performance of children as opposed to the traditional approach to problem-solving. A strategy approach can be described as teaching a set of instructions to guide students when solving word problems. A strategy plus sequence approach involves not only the use of instructional strategies, but also involves sequencing problems according to type as opposed to teaching all problem types simultaneously.

Hypothesis

Students who participate in a strategy approach program and students who participate in a strategy plus sequence program for teaching word problems in math will produce higher gains on a posttest and follow-up test than students who participate in a traditional program.

Definition of Terms

problem-solving - The action or process used to determine the answer to a verbal mathematical problem or word problem.

strategy approach to problem-solving - Instructional method in which students learn a strategy that helps them engage in appropriate steps needed to recognize and successfully solve a word problem (Mercer, Cecil D., 1992).

strategy plus sequence approach to problem-solving - Students are instructed using a strategy approach (as defined above). In addition, students are taught to apply the strategy to one problem type at a time as opposed to a variety of problem types at once.

traditional approach to problem-solving - An instructional method that does not involve a strategy approach, but instead, involves demonstration of problem solution and guided practice.

Chapter Two
Reviewing the Literature

Various studies have identified the attributes of expert problem-solvers. These experts "organize their knowledge for quick retrieval from memory, create meaningful patterns in problem-solving, implement procedures for using knowledge expediently in problem-solving, and utilize self-monitoring skills to ensure effective performance" (Montague and Applegate, 1993). It seems only logical that researchers have found that learning disabled (LD) students and students who are poor problem-solvers display limited cognitive and metacognitive knowledge (Montague and Bos, 1991) and that gifted students frequently use metacognitive knowledge and problem-solving strategies to process information effectively (Montague and Applegate, 1993). Therefore, LD students and poor problem-solvers employ different thinking strategies than those of expert problem-solvers.

Montague, Bos, and Doucette conducted a study that interviewed LD, average-achieving, and gifted students about their knowledge and use of problem-solving strategies. After responding to open-ended questions, both average-achieving and gifted students expressed more knowledge and practice of strategies associated with problem representation than LD students (Montague, Bos, and Doucette, 1991). They therefore concluded that "students with learning disabilities lack knowledge of problem representation strategies and rely more on reading and computing strategies than other students" (Montague, Bos, and Doucette, 1991). It can be concluded from this study that LD students and poor problem-solvers lack specific problem representation strategies necessary to answer a problem correctly.

Although LD students are known to lack certain strategies necessary for problem-solving, research shows that they are capable of learning and applying these strategies if taught properly. In a study conducted by Case, Harris, and Graham (1992), instructing LD students in a task specific strategy proved effective in improving their performance in solving simple addition and subtraction word problems. The four, fifth and sixth grade students that participated in the study, were interviewed and assessed in order to find their current level of performance an to discuss the goal of instruction. The students were found to frequently perform the wrong operation or not complete all the necessary steps to solve the problem correctly.

The students were taught a self-regulated problem-solving strategy which consisted of the following steps: a) read the problem, b) look for important words, c) draw pictures to help tell what is happening, d) write down the math sentence, and e) write down the answer. The instructor and students discussed the importance of each step and also the importance of what they say to themselves as they use the strategy. The students then created a list of self-instructions such as "What do I have to find?" and "How can I solve this problem?" that could help them better understand the question and find important information. The instructor modeled the strategy and self-instructions and the students practiced until the strategy was mastered. The students were also instructed in the meaning and process of finding key words or phases in the type of addition and subtraction problems they completed, along with metacognitive and self-regulatory strategies. The strategy was first taught and applied to solving addition word problems until mastered before applying to subtraction problems.

On the addition posttest, the students answered correctly and wrote the correct equation for 95% of the problems as compared to 82% on the pretest (Case, Harris, and Graham, 1992). Three of the four students improved while the remaining student's score remained the same. Of the four problems missed on the posttest, only one occurred due to performing the wrong operation. More impressive gains were made for subtraction. The students answered correctly and wrote the correct equation for 82% of the subtraction problems as compared to only 30% on the pretest (Case, Harris, and Graham, 1992). Only 42% of the errors were due to performing the wrong operation. Although this study was limited in the number of subjects, the results of this study support the use of metacognitive and self-regulatory strategies in teaching problems solving to LD students.

Another method of teaching, direct instruction, has also shown to be effective in instruction in problem-solving. Jones, Krouse, Feorene, and Saferstein (1985) conducted a study to compare the effectiveness of two methods of direct instruction for teaching elementary students a strategy for discriminating between addition and subtraction story problems. It was hypothesized that instruction would be more efficient if the students were taught to use a strategy to solve four types of word problems sequentially than if instruction in the four types was given concurrently and without regard to problem type. The hypothesis tested was that sequential instruction in the four problem types would result in higher posttest achievement than concurrent instruction.

One hundred and forty-two third grade students were administered a qualifying test. Twenty-nine students who failed to use the correct operation 25% of the time were selected for the study. The students were randomly assigned to either the sequential training group or the concurrent training group. Both groups were taught to use a generalizable strategy to solve four different problem types consisting of simple action problems, classification problems, complex action problems, and comparison problems. The sequential training group addressed one problem type at a time until each was mastered. The concurrent training group was taught to apply the strategy to all four problem types at one time. Training consisted of nine 15-minute training sessions. Alternate forms of a 24 item test were used for the pre- and posttests.

Before training, the mean pretest score of the sequential training group was significantly lower than that of the concurrent training group. Posttest results showed that only two students in the sequential training group failed to score higher on the posttest than on the pretest. In comparison, only four of the sixteen students in the concurrent training group scored higher on the posttest than on the pretest.

The results of this study demonstrate that training third grade students to solve four basic types of word problems in a sequence results in higher posttest scores than training students to solve an unsequenced variety of the same problems. These results suggest practical considerations for instructional design. When using direct instruction to teach students to solve word problems, sequenced instruction is more effective than concurrent instruction (Jones, Krouse, Feorene, and Saferstein, 1987).

A study performed by Fleischner, Nuzum, and Marzola (1987) produced similar results. An instructional program was designed to teach LD students to solve four types of mathematical story problems. The four problem types consisted of addition and subtraction problems, two-step problems, and problems with extraneous information. Instruction included features of models which have been shown to be successful in teaching LD students to solve mathematical story problems. Such models include direct instruction (Silbert, Carnine, and Stein, 1981), mastery learning (Bloom, 1984), and cognitive behavior modification (Meichenbaum, 1977; Hallahan and Sapona, 1983). Students were taught to identify the question of the story problem, determine what information was needed to solve the problem, recognize unneeded information, and determine when one or more mathematical operations were required to solve the problem.

The instructional plan included self-questioning techniques for highlighting relevant information, identifying the task-specific information, or evaluating the process. After students were taught how to solve each problem type separately, they were required to sort new problems into their appropriate categories by focusing on the discriminating features of each. It was hypothesized that students who were taught an instructional process for solving story problems would result in higher posttest scores than students who were given equal practice in solving story problems but were not taught a specific instructional procedure.

Sixty fifth and sixth grade LD students were chosen for the study. All had problem-solving scores discrepant from computation scores on standardized tests. The experimental group received problem-solving instruction twice a week in thirty minute sessions. Instruction continued until mastery had been reached for four problem types: addition, subtraction, two-step problems, and extraneous information. Instruction lasted for about six weeks. Students used prompt cards, practice worksheets, and calculators to solve problems. The control group used practice worksheets and calculators, but did not receive instruction in the process of solving story problems.

Results of the study showed that the experimental group answered more story problems correctly than did the control group. Scores for the control group improved significantly. According to Fleischner, Nuzum, and Marzola (1987), using direct instruction and proper sequencing to teach story problems enabled students to acquire problem-solving skills.

Wilson and Sindelar (1991) conducted a study similar to that of Fleischner, Nuzum, and Marzola (1987). The study compared the effectiveness of three procedures for teaching students with learning disabilities to identify the correct algorithm in solving addition and subtraction word problems. Participants were divided into three groups: strategy only, strategy plus sequence, and sequence only. All three groups received instruction in thirty minute sessions for three weeks. All groups used the same questions and number of questions for boardwork and seatwork activities.

The strategy only and the strategy plus sequence groups followed identical scripts during instructional lessons. Although both groups received the same strategy instruction, the sequence of instruction differed. The strategy plus sequence groups were presented with three lessons addressing each problem type one at a time. The strategy only group received a combination of all four problem types each day. The sequence only group practiced word problems in the same order as the strategy plus sequence, yet without the strategy instruction.

It was hypothesized that students in the strategy plus sequence group would score significantly higher on both the posttest and follow-up test than the other two groups. Results showed that students in the strategy plus sequence group scored significantly higher on both the posttest and the follow-up test than did students in the sequence only group. Yet on the posttest, the difference between the strategy plus sequence and the strategy only groups was not significant. On the follow-up test, the strategy plus sequence group scored significantly higher. This may have been due to the fact that a classroom aide continued to practice the strategy used in the weeks following the study. It appears that strategy instruction is the more effective variable in the study. Further research should be done to determine whether or not sequencing problems according to problem type affects student performance significantly.

In the research mentioned, each study used one or a combination of direct instruction, self-regulated strategies, and cognitive strategies. Therefore, it is difficult to determine which techniques employed were most effective. The research done in the area of direct instruction appears to show valuable results. Although these studies were described as using a direct instruction approach to teaching problem-solving, most included self-regulatory and cognitive strategies. Therefore, research supports using a process approach incorporating several similar teaching methods.

Chapter 3
Design of the Study

This study was designed to determine the most effective instructional approach to problem-solving: a strategy approach, a strategy plus sequence approach, a sequence only approach, or a traditional instruction approach.

Population

The sample population consisted of four heterogeneous fourth grade classrooms. The subjects who participated in the study were from a small suburban, grades 4-8 school in southern NJ. The sample included 48 regular education students from low-middle to upper middle class socioeconomic backgrounds. One Asian, 4 Black, 3 Hispanic, and 40 White children were included in the population. Twenty-six were males and 22 were females.

Method of the Sample Selection

The sample population was a convenience sample.

Procedures

Students were instructed in a regular education classroom setting consisting of 16 students in each of the three classes. Each lesson lasted approximately 40 minutes for all groups. A total of 15 lessons took place over a three week time period.

A total of 72 word problems were used on the pretest, posttest, and follow-up test. The problems were divided into two main types:

1) one-step multiplication problems

2) one-step division problems

The two problem types were equally represented in all materials.

The classes consisted of three groups receiving different means of instruction in problem-solving. The groups were divided as follows:

group A - strategy plus sequence group

group B - strategy only group

group C - sequence only group

Group A, the strategy plus sequence group, and group C, the sequence only group, received one type of boardwork problem each day. Group B, the strategy only group, and group D, the traditional instruction group, received a variety of the two problem types in no particular order. Groups A and B were both instructed using a step-by-step strategy to solve word problems. The same problems were used in all three groups.

The pretest was comprised of 24 word problems, including 12 of each of the two problem types. The posttest and follow-up tests contained equivalent forms of the pretest. The posttest was administered at the end of the three week instructional period. The follow-up test was administered two weeks after the posttest. On all three tests, students were marked correct if the correct algorithm was written. Computation errors were disregarded since such skills account for a small population of the variance in solving story problems (Muth, 1984).

Other than the pre-, post-, and follow-up tests, two types of materials were developed: boardwork and seatwork. Four boardwork problems were presented each day for all three groups. All word problems were taken from the Real Math textbook (1991) which is currently used in the classrooms of the subjects or they were teacher-made.

Each teaching session was divided into teacher directed boardwork and structured seatwork. The strategy groups, A and B, were taught a generalizable problem-solving strategy and instructed in the application of the strategy. Scripted lessons were developed in order to present comparable information to both strategy groups. Boardwork lasted for approximately 15 minutes. Structured seatwork consisted of the students independently applying the strategy on word problems. The teacher was available for questions and follow-up instruction during this time.

The sequence only group followed a similar schedule of boardwork and seatwork. The sequence only group was introduced to one problem type at a time. No strategy instruction was presented to this group. During boardwork the problems were introduced and shown the equation and solution of the problems. Seatwork consisted of guided practice.

Teacher training consisted of three, forty-minute sessions within two weeks of the study. The examiner and teachers reviewed the instructional scripts and/or strategies where necessary.

Because the sample population is a convenience sample, there are limitations to this study. Although the students were assigned to classrooms heterogeneously, levels of ability may differ among the three classes. Another limitation to this study is the difference of length of teaching experience. The length of teaching experience ranges from 4-18 years.

The purpose of this study is to determine whether or not strategy instruction in problem-solving will improve problem-solving skills in students. A secondary variable involved is whether or not sequencing problem type during instruction is a significant factor to student success. The analysis of the data will be discussed in Chapter 4 of this research paper.

Chapter 4
Analysis of the Data

Problem-solving in mathematics is an important skill for students to learn and probably the most difficult. Many teaching approaches have been used to teach problem-solving in math, and many studies have attempted to determine which approach is most effective. This study attempted to determine which factor of a strategy instruction approach was most responsible for improving mathematical performance of students in problem-solving.

A pretest consisting of 24 one-step multiplication and division problems was administered to three groups of students. The students were instructed in one of the following groups: strategy-plus-sequence, strategy only, or sequence only. A comparable posttest was administered to each group at the end of the three week instruction period. The mean of the pretests, posttests, and follow-up tests was calculated, along with the pretest/posttest differences and percentages of problems solved correctly. The results of this study can be found in Table One.

<u>Results</u>

The data was analyzed to determine if the type of instruction (strategy-plus-sequence, strategy only, sequence only) affected the number of problems solved correctly. The answer was considered correct if the correct mathematical operation was chosen to find the answer. Table 1 contains the means of the pretests, posttests, and follow-up tests, the percentage of problems correct, and the difference between the pretest and posttest scores.

Table 1

Test Data

	Pretest	Posttest	Difference	Follow-up
Group A Strategy-Plus-Sequence	m= 19.75	m= 21.75	+2.00	m= 21.88
	%= 82	%= 90	%= 8	%= 91
Group B Strategy Only	m= 19.31	m= 22.50	+3.19	21.75
	%= 80	%= 93	%= 13	%= 90
Group C Sequence	m= 19.13	m= 20.13	+1.00	m= 20.94

The analysis of the data indicated similar pretest results among the three groups, yet significantly different posttest results. The pretest scores of the three groups ranged from 19.13 to 19.75. The highest pretest mean of 19.75 was earned by group A, the strategy-plus-sequence group. The strategy only group, group B, had a mean score of 19.31, and the sequence only group had a mean of 19.13. All three groups scored within one percentage point on the pretest.

Posttest scores for the three groups yielded significantly different results. The posttest means of the three groups ranged from 20.13 to 22.50. The posttest means of the three groups were within 10 percentage points of each other, a larger range as compared to the range of the pretest scores.

More important than range of scores are the differences between the pretest and posttest scores for each group. Although the mean of these groups increased after instruction, pretest/posttest differences show a significant difference among group performance. The group showing the most improvement was group B, the strategy only group. The pretest/posttest difference for this group was 3.19, an increase of about 13 percentage points. The strategy-plus-sequence group, group A, had a pretest/posttest difference of 2.00, an increase of about eight percentage points. Group C, the sequence only group, showed the least improvement. The pretest/posttest difference for group C was 1.00, an increase of about four percentage points.

Analysis of individual scores for the groups yielded a similar pattern of results as posttest scores and pretest/posttest differences. Group B, the strategy only group, showed the most improvement. The group consisted of 12 students that improved their scores on the posttest, one student that showed no change, and three subjects that decreased in score. The twelve students that improved their scores in group B, increased their score by 2-9 more correctly solved problems on the posttest. The three students that decreased in score did so only by 1-3 incorrect responses.

Group A, the strategy-plus-sequence group, showed significant improvement on the posttest, yet not to the extent of group B. The group consisted of 12 students that improved on the posttest, two students that showed no change, and two students that decreased in score. The 12 students that improved their scores, did so by an increase of 1-5 more correctly solved problems. The two students that decreased in score, did so only by 1-2 incorrect problems.

The sequence only group, group C, showed the least amount of improvement on the posttest. Of the 16 students, 10 showed improvement, one showed no change, and five showed a decrease in score. The 10 students who showed improvement, did so by an increase of 1-4 correctly solved problems. The five that showed a decrease, did so by 1-3 incorrect responses.

Results of the follow-up test showed different results. The strategy-plus-sequence and the sequence only groups increased their scores. The strategy-plus-sequence group increased its score by 0.13, while the sequence only group increased its score by 0.81.

The strategy only group which showed the most improvement on the posttest, decreased its score by 0.75 on the follow-up test. These results were inconsistent with the pattern of posttest results.

Summary

In summary, the strategy only group yielded the most significant results with the highest increase of mean on posttest results. The strategy-plus-sequence group also showed improvement, yet not to the extent that the strategy only group improved. The sequence only group showed the least amount of improvement on the posttest. On the follow-up test, the sequence only group showed the most improvement followed by the strategy-plus-sequence group. The mean score of the strategy only group decreased on the follow-up test.

Conclusions, discussion, and implications for further study will be discussed in chapter five of this study.

Chapter 5
Summary and Conclusion

Introduction

This research study was conducted to study the effectiveness of strategy teaching and sequencing practice problems in teaching fourth grade students to identify the correct algorithm for solving one-step multiplication and division word problems. Forty-eight students were assigned to one of three groups: strategy-plus-sequence, strategy only, or sequence only. The strategy groups were trained to use a direct instruction strategy, as found in Appendix D, to solve word problems. The strategy-plus-sequence group and the sequence only group addressed only multiplication problems for the first seven training sessions, and addressed only division problems for the remaining sessions. The sequence only group received no strategy instruction. The groups were pretested prior to the training sessions and posttested at the conclusion of the training period of three weeks. A follow-up test was administered to the groups two weeks after the posttest.

Summary and Conclusion

The analysis of the data indicated measurable differences among the performances of the groups on both the posttest and follow-up test. Students in the strategy only group scored higher than both the strategy-plus-sequence and sequence only groups on the posttest. The strategy-plus-sequence group scored higher than the sequence only group. Since both strategy groups showed measurable improvement on the posttest, it can be concluded that the strategy variable had the most effect on performance. On the follow-up test, the sequence only group showed the most improvement followed by the strategy-plus-sequence group. The strategy only group showed a decrease in performance on the follow-up test. Because the two sequence groups showed continued performance on the follow-up test, this may suggest that sequencing word problems may be an effective variable in the long term. The data indicated the superiority of a strategy approach to problem-solving in math, regardless of whether or not the problems were taught in a sequenced fashion.

Discussion

The results of this study were similar to the results of the studies conducted by Fleischner, Nuzum, and Marzola (1987) and Jones, Krouse, Feorene, and Saferstein (1985) as described in chapter 2 of this study. All three studies concluded that using direct instruction to teach problem-solving is effective. The studies by Fleischner, Nuzum, and Marzola and Jones, Krouse, Feorene, and Saferstein also concluded that sequencing was a significant variable, while the follow-up test results of this study only suggest this conclusion. The results of this study also yielded similar results to a study by Wilson and Sindelar (1991), which is also described in chapter 2. Both studies concluded that strategy instruction was the significant variable in the research. The Wilson and Sindelar study also suggested that sequencing may be an effective variable, but that more research in that area is necessary.

Several factors may have contributed to differences among group performance. Poorer performance among students in the sequence only group may have been related to instructional time. The teacher of this group reported that instructional time usually lasted about 30, as compared to the 40 minutes of the other groups that participated in the study. The teacher described it as difficult to spend much time demonstrating the problem solutions without the use of a strategy. She also noted that the students worked quickly while doing independent work. Therefore, difference in instructional time may have contributed to the lack of progress for this group, although the teacher felt that a lack of structure was more responsible.

Background and experience may have also contributed to differences in performance among groups. Regular practice of word problems and previous strategy instruction may have contributed to the superior performance of the strategy only group. The teacher of this group had previously taught the group a strategy for solving word problems, yet not specifically for multiplication and division word problems. Although the strategy was not identical to the strategy taught in this study, the students may have transferred similar skills to the new strategy. Solving of word problems is practiced regularly in the classroom of this group. It should also be noted that the teacher of this group had the most teaching experience, 19 years, as compared to the 10 years and four years of the other two teachers involved in the study.

Implications for instructional design include the use of a direct instruction strategy to teach problem-solving of word problems. Features such as teaching steps in the translation process, providing checking and correction procedures, and providing scripted lessons for teachers have been shown to improve student performance of solving word problems. The results of this study also indicate that strategy teaching may be enhanced in the long term when the problems are sequenced according to problem type or mathematical operation.

Several variables should be considered for further research in teaching verbal math problem-solving skills. Since significant improvement was shown as a result of strategy instruction after 15 training sessions, the effects of extended training time periods should be investigated. Although the use of a strategy proved to be the more effective variable in this study, follow-up test results suggested that sequential training may prove to be more effective over extended periods of time.

Also, variables such as instructional time, time on task, and previous training of students contributed to inconsistencies among training groups. Future studies should seek to better control these variables. Finally, future studies should consider the effectiveness of the teaching procedures with remedial and learning disabled students as well as regular education students.

This research contributes to the literature concerned with mathematical problem-solving skills of elementary students. It suggests that these students can be taught to solve multiplication and division problems accurately through the use of a strategy.

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APPENDICES

Appendix A

Problem-Solving Strategy

1. Read the problem at least two times.

2. Read what the question is asking and decide what the label for the answer will be.

3. If the problem deals with the same number again and again, multiply or divide.
   If the problem does not deal with the same number again and again, add or subtract.

4. Look at the information in the problem. Decide if the answer should be higher or lower than the numbers given in the problem.

5. If the answer should be higher, multiply or add.
   If the answer should be lower, divide or subtract.

6. Check to see if the answer makes sense.

Appendix B

Pretest

Read each problem carefullly. Solve each problem and be sure to show all of your work.

1. Vinnie eats 3 eggs each day. How many eggs will he eat in 15 days?
2. Sara walks 5 miles every day. How many days will it take her to walk 30 miles?
3. Erin sings 6 songs every show. How many shows will it be before he sings 24 songs?
4. Bob eats 3 eggs each day. How many days will it take him to eat 24 eggs?
5. Sara walks 7 miles every day. How many miles will she walk in 28 days?
6. Gary sings 8 songs every show. How many songs will he sing in 48 shows?
7. Dave has 4 bats in each pile. He has 36 piles. How many bats does he have in all?
8. Sue has 4 bats in each pile. She has 36 bats. How many piles does she have?
9. Matt earns $6 a day. How many days will it take him to earn $54?
10. There are 90 students in the school. There are 6 classes. Each has the same number of students. How many students are in each class?
11. Caitlin drove 75 miles in 5 days. How many miles did she drive each day?
12. Brian drove 36 miles each day. He drove for 4 days. How many miles did he drive in all?
13. Kaitlyn has 4 fish in a can. She has 28 cans. How many fish does she have?

14. Joe bought 125 packages of nails. Each package had 5 nails. How many nails did he buy?

15. Kelly has 110 marbles. She put them in 5 jars. How many marbles are in each jar?

16. 3 liters of milk cost $1.23. How much does milk cost per liter?

17. An 8 bottle carton of soda costs $1.76. How much is that per bottle?

18. Darren wants to buy 30 pencils. The pencils cost 6 cents each. How much money does he need to buy them?

19. Ray is saving to buy a baseball glove that costs $42. He saves $7 each week. How many weeks will it take to buy the glove?

20. Tonya rides her bike 3 kilometers every day. How far does she ride in 15 days?

21. Mike has 2 coins in each pocket. He has 6 pockets. How many coins does he have?

22. Darryl drove his moped 595 kilometers in 7 hours. How far did he drive each hour?

23. Nicole sold 16 boxes of candy. Each box cost $4. How much money did she collect?

24. A box of cereal has 2 cups of raisins per box. A case contains 24 boxes. How many cups of raisins are in a case?

14. Eric bought 8 packages of candy. Each package had 72 pieces. How many pieces of candy did he buy?

15. Kim has 99 baseball cards. She put them in 3 stacks. How many cards are in each stack?

16. 3 liters of juice cost $3.78. How much does juice cost per liter?

17. An 9-bottle carton of soda costs $4.23. How much is that per bottle?

18. Jim wants to buy 45 pens. The pens cost 9 cents each. How much money does he need to buy them?

19. John is saving to buy a catcher's mitt that costs $54. He saves $6 each week. How many weeks will it take to buy the catcher's mitt?

20. Nadine rides her bike 7 kilometers every day. How far does she ride in 14 days?

21. Frank has 3 coins in each bag. He has 9 bags. How many coins does he have?

22. Tom rode his motorcycle 630 kilometers in 9 hours. How far did he ride each hour?

23. Jennifer sold 21 boxes of fudge. Each box cost $3. How much money did she collect?

24. A box of cereal has 3 cups of marshmallows per box. A case contains 18 boxes. How many cups are in a case?