THE USE OF READING GUIDES AS A TEACHING METHOD FOR MATHEMATICS WORD PROBLEM COMPREHENSION

THESIS

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Abstract

The purpose of this study was to investigate the use of reading guides as a teaching method for word problem comprehension. Attitudes toward mathematics were also examined. A quasi-experimental, nonrandomized, pretest-posttest, treatment group design was used for the investigation. The sample consisted of 40 students (two classes) taught by the same instructor and was equated in terms of mathematics levels, ages, and IQ scores. One treatment group used reading guides to comprehend mathematics word problems. The other treatment group utilized a "general approach" to comprehend the same set of problems.

The students were pretested on a word problem comprehension test based on word problems used in the study. Each form consisted of five sets of fifteen statements sequenced in the literal, interpretive, and applied orders. Attitudes toward mathematics were also pretested on the mathematics section of the Estes Attitude Scales (Secondary Form).

The instructor presented twenty-one word problems throughout the investigation. One treatment group received instruction using reading guides designed by the researcher. The other treatment group received instruction using a general approach to solving the same set of problems. Upon completion of the eight week treatment period, students were posttested.

A one-tailed t test for independent means was used to analyze the data at a .05 level of significance. The results indicated that overall mean posttest scores were not significantly different between the reading guide and general approach groups for word problem comprehension. This was also the case when the scores were analyzed in terms of sex differences. Analysis of posttest scores for the attitude toward mathematics inventory revealed a significant gain in attitude for those students who were instructed using reading guides. Recommendations for classroom use of reading guides as well as suggestions for future research were given.

Table of Contents

Table of Contents (Continued)

List of Tables

Chapter I

Statement of the Problem

Purpose

The purpose of this study was to investigate the effectiveness of using reading guides as a method of teaching comprehension of word problems in mathematics. Attitudes toward mathematics were also investigated.

A nonrandomized, pretest-posttest, treatment group design was used for the investigation. One treatment group used reading guides while the other treatment group used a "general approach" to comprehend mathematics word problems.

Need for the Study

Content teachers are becoming increasingly aware of the reading skills students need in order to work effectively. The fact that teachers want to know more about the teaching of reading and the skills that can be incorporated into a content lesson is demonstrated in part by the increased number

of studies and reports on reading in various education journals. For example, the December 1980 edition of the Arithmetic Teacher reported on the topic of mathematics and language and the problems therein.

Each content area uses terms that are unique to that area and are often unfamiliar to the student. The student is also confronted with the problem of multiple meanings in which the same term can assume an entirely different denotation depending upon the subject area in which it is used.

It is important that students master the vocabulary terms in a course of study because these terms are used in conjunction with the concepts to be learned. Not knowing the key content terms hinders one's ability to comprehend the content passage (Burmeister, 1976).

The literature reveals a method of systematically guiding a student's comprehension of word problems in mathematics. Durrell (1956) predicted the value of reading guides to facilitate attentive reading. Herber (1978) has suggested that the use of three level reading guides, including the literal, interpretive, and applied levels, would facilitate

comprehension of content area materials.

Riley (1979) found that significant gains were made in the ability to solve mathematics word problems related to the mathematics textbook through the use of three level reading guides.

The literature reveals several studies investigating the relationship between attitudes and mathematics. Lerch (1961) has stressed the importance of experience on students' attitude toward mathematics and the willingness to perform mathematical tasks. He suggests "... that teachers at all grade levels should be aware of their pupils' attitude toward the subject and strive to use teaching methods that will help facilitate favorable attitudes toward mathematics."

The literature suggests that reading instruction can improve understanding of mathematics. Reading guides might be a viable method of bringing about such improvement. This study sought primarily to investigate the usefulness of reading guides as a teaching technique for comprehension of mathematics word problems.

Definition of Terms

The definitions of certain terms important to this study are as follows:

Reading Guides. Reading guides are defined as sets of statements that guide students' understanding of content area material by simulating the comprehension process (Herber, 1978).

Comprehension. Comprehension is theoretically defined as the understanding of the facts, numerical expressions, and mathematical concepts that are related to specific word problems. Comprehension is operationally defined as the student's score on a researcher-constructed comprehension test which requires the student to choose from among alternatives, the facts, numerical expressions, and mathematical concepts that can be used to solve specific problems (Riley, 1979).

Attitude Toward Mathematics. Attitude toward mathematics is theoretically defined as an individual's response toward various aspects of mathematics (Riley, 1979). Attitude toward mathematics is operationally defined as the student's score on the Estes Attitude Scales (Secondary Form).

Word Problem. A word problem is defined as a problem that asks a question in the English language that requires a numerical answer.

Summary

Little research has been conducted using reading guides as a teaching technique for comprehension of mathematics word problems. This study investigated the usefulness of reading guides, sequenced in the literal, interpretive, applied order, as a teaching method for comprehension of mathematics word problems with seventh grade students.

Chapter II

Review of the Literature

Purpose

The purpose of this study was to investigate the use of reading guides as a method for teaching comprehension of mathematics word problems at the seventh grade level. A secondary purpose was to investigate attitudes toward mathematics. This investigation dealt with three areas of research and the literature surveyed will be divided into the following categories accordingly:

Reading skills in mathematics

Reading guides as a teaching technique in mathematics

Attitude toward mathematics

Reading Skills in Mathematics

The literature reviewed in this section will deal with specific reading skills used in mathematics instruction. The concentration will center on vocabulary, language, and procedures for problem solving.

Several studies analyzed the importance of

vocabulary instruction on problem solving ability. Vanderlinde (1964) compared the problem solving ability of sixth graders who received instruction in quantitative vocabulary with the problem solving ability of students who did not receive vocabulary instruction. Students receiving such instruction scored significantly higher on a test of problem solving ability than those who did not.

Henney (1971) investigated the effect of teaching vocabulary as well as other reading skills upon the problem solving ability of fourth grade students. Two groups roughly equivalent in IQ, reading and mathematics achievement were involved in the study. The experimental group was given instruction in recognizing and understanding vocabulary as well as other reading skills. A control group was allowed to use any method. Both groups received other mathematics and reading instruction during the school day. No significant difference in problem solving among the two groups was found. However, the girls in the experimental group were favored in their performance on the problem solving test. The investigator concluded that computational ability and the ability to apply appropriate reading skills

are needed to solve problems since a significant relationship between both abilities was indicated.

In another study, Linville (1976) investigated the vocabulary difficulty of word problems. The effects of "hard" versus "easy" vocabulary and "hard" versus "easy" syntax of statements intended to present mathematical situations had a significant effect on student's success in solving the problem.

Gilmary (1967) investigated the effect of remediation of both reading and arithmetic skills on arithmetic computational ability. Some students of unspecified ages and ability who were enrolled in a summer school program received remediation in arithmetic and reading. A significant difference was found favoring the reading/arithmetic group in computational ability.

Another area that appears in the literature is the relationship between language and mathematics. Moffett and Wagner (1976) describe the link in this manner:

> Language is not a subject like history, science, geography or social studies because it comprises all of these. It is a symbol system. It is the medium into which these other subjects are cast... The real kinship is between English and math,

> because both are symbol systems by means of which we encode experience, math being a special notation that purifies and extends ordinary language... (p. 15)

Knight and Hargis (1977) contend that children's language development is likely to affect their mathematics learning. For example, mastery of the grammar of one-to-one correspondence leads to the concept of "manyness." Another set of patterns occurs in noun phrases that "contain the fundamental language vehicle for presenting arithmetic concepts" (p. 425). They point out that an understanding of the syntax of comparative construction is essential to coping with arithmetic problems.

Hargis (1976) in a previous study found that a significant number of "normal" children do not have adequate language mastery for success in mathematics. Earp and Tanner (1980) conclude that students' success in mathematics seems inextricably interwoven with their level of language sophistication.

Another facet of the literature focuses on oral language in mathematics. Heddens and Smith (1964) contended that mathematical terms are not nearly as likely to be part of children's oral language. The end result is that mathematical

vocabulary is much less sophisticated. Reading in mathematics is likely to be greatly improved when children speak the related oral language. A further observation made by researchers from visiting elementary classrooms is that seldom is there extensive discourse in which mathematics is "talked." The suggestion is that much more oral language be used in mathematics classes. More time in the discussion of ideas is recommended.

In yet another area, the literature points to specific procedures for reading and solving word problems. Earle (1976) describes a step by step procedure which would require teacher and students to "talk" through numerous examples focusing on the major ideas given in the problem. He also proposed that the use of the cloze procedure and reading guides may help to facilitate the comprehension of word problems.

Call and Wiggin (1966) attempted to determine the effect on tenth graders' ability to solve algebra problems if they were instructed in getting meaning from context. Students were assigned to an experimental group and a control group based on

intelligence tests and aptitude tests obtained from school records. The experimental group received no such instruction. The results indicated that the experimental group did significantly better than the control group on a problem solving test.

Earp (1970) reported that the nature of verbal arithmetic material requires adjustment of rate, varied eye movement, and rereading. Arithmetic is seldom read for one purpose alone. He contends that "a single reading of a word problem is never enough." (p. 529)

Faulk and Landry (1961) investigated the effect of a systematic approach on achievement in problem solving in sixth grade arithmetic. Two groups of students and teachers were involved in the study. The control group was instructed using the technique for problem solving described in the teacher's edition of their math textbook. The experimental group was given instruction using a systematic reading approach to learning vocabulary. They concluded that the systematic approach was as effective as the textbook approach. The systematic approach seemed slightly superior, although not

statistically significant.

(Bassler, Beers, and Richardson, 1975) examined the "step method" and "translation method" as problem solving strategies among a group of ninth grade students. One group was given instruction in a step by step method of problem solving which concentrated on the main ideas and facts given in each problem. The second group was given instruction in problem solving by converting the English statements into mathematical statements before finding a solution. The results favored the "step method" on an equation criterion test but there was no significant difference between the means of the groups on a solution criterion test. A significant difference was found between the posttest scores and retention test scores as measured by the problem solving achievement of the two groups.

In conclusion, several reading skills are apparent to mathematics instruction. The concerned teacher should employ as many reading strategies as necessary to foster success in mathematics.

Reading Guides as a Teaching Technique in Mathematics

Researchers and teachers are discovering uses for reading guides in classrooms. Feeman (1973) reported that reading guides are powerful instruments that combine content with process and have the capability of diagnosis, review, guided study, motivation and enrichment.

Durrell (1956) predicted the value of reading guides to facilitate attentive reading. Herber (1978) has suggested that the use of three level reading guides would facilitate comprehension of content area materials.

Studies investigating the effect of reading guides on the understanding of mathematical materials are limited. Riley (Note 1) reported the use of three level guides with expository mathematics materials. No significant differences were found in ability to solve trigonometry problems for eleventh grade trigonometry students who received guides sequenced in the literal, interpretive, applied order and those who received guides in the literal, applied, interpretive order. A trend favoring the literal, applied, interpretive treatment was noted, however.

Riley (1979) investigated the effect of varying the sequence of three level reading guides on ninth graders' comprehension and understanding of the process of comprehending word problems in mathematics. Three treatment groups were formed: literal/interpretive/applied (LIA), literal/applied/interpretive (LAI), and literal/applied (LA). In choosing literal level statements necessary for solving specific problems, significant differences were found favoring the LA over the LAI treatment; the LAI treatment over the LIA treatment; the LA treatment over the LIA treatment. In choosing applied level statements necessary for solving specific problems, significant differences were also noted favoring the LIA group over the LA group; the LAI over the LA group and the LIA group over the LAI group. No significant differences were found among treatment groups when literal, interpretive, and applied were combined. All three treatment groups significantly improved choosing statements at the three levels that were useful in solving specific problems.

In yet another study, Riley (1979) investigated the effect of reading guides and a directed reading method on seventh graders' comprehension of word problems, problem solving ability, and attitude toward mathematics. The sequence of the three levels of comprehension were varied as in a previous study. LAI amd LIA reading guides produced significant gains in word problem comprehension.

In the area of problem solving, there were no statististically significant differences in problem solving ability for students who were instructed in the reading guide or directed reading treatment groups.

There were no statistically significant differences in attitude toward mathematics among students who received instruction in the four treatment groups. "Reading guides can be effective in facilitating students' learning in the content areas, including mathematics. Among LAI, LIA, or LA treatments, the most effective sequence for presenting guides in mathematics has not been clearly identified. However, a trend can be noted favoring the use of LAI or LIA guides in facilitating higher level comprehension processes." (Riley, 1979, p.33)

There are many unexplored areas for future re-

search in using reading guides for comprehension of mathematics word problems. For example, investigating the effectiveness of their use in the elementary grades, where exposure to verbal problems in mathematics initially occurs. Few, if any studies have dealt with the use of reading guides in this age group.

Attitude Toward Mathematics

A number of studies have investigated the relationship between attitude and mathematics. (Hodges, Downs, and Schwartz, 1975) investigated the effect of choice of instruction on attitude toward mathematics in primary grades. An unspecified number of primary grade children received instruction in a variety of "miniunits." The students were allowed to choose the units they desired for instruction. The results were successful as measured by standardized achievement tests. An unsigned opinion survey showed positive outcomes.

The formation of atitude toward mathematics becomes well defined by junior high school. Dutton (1956) found that many junior high students showed an extreme dislike for various aspects of mathematics. on the other hand, 8.7% enjoyed problems when they knew how to work them. Reasons for disliking problems were given as lack of understanding and difficulty

in doing problems.

Riley (1979) found that when students were asked to apply a Directed Reading method in reading word problems, a significant negative effect upon student's attitude toward mathematics was apparent. He speculated that this might have been due to the fact that students using this method had to supply the facts, numerical expressions, and mathematical concepts related to the problem. Furthermore, these negative attitudes may have been produced for those students in the DR group who did not know how to produce such information independently.

In another study, Aiken and Dreger (1961) investigated the relationship between the scores on mathematics attitude scales and the scores for another attitude or psychological trait. They found that if the correlation between the two was very low, it was accepted as support for the uniqueness of the two traits. This type of evidence reveals that the mathematics attitude scale measured attitude toward mathematics and not some other trait.

Estes (1978) concluded that attitudes toward mathematics are a measurable outcome of learning in mathematics.

In conclusion, attitudes toward mathematics appear to play a significant role in the learning of that subject matter. Teachers owe it to their students to measure attitudes in order to better plan for and evaluate their pupils' educational experiences.

Summary

The literature reveals some evidence that reading instruction in mathematics can encourage learning mathematics. Since there is a lack of operational definitions associated with problem solving, reading and other mathematical skills, it is difficult to interpret the research.

In addition, much of the research reviewed investigated the direct teaching of specific reading skills which yielded various results. The unique nature of reading in mathematics may require that future instruction be based on generalizable processes which can be adapted to several reading/math situations.

Investigations of reading guides as a teaching method have yielded favorable results when sequenced in literal/interpretive/applied and literal/applied/interpretive orders. Students were able to choose

statements which were useful in solving word problems thus facilitating comprehension of the problems. Furthermore, there are many areas where reading guides can be utilized in the classroom that have yet to be investigated.

Chapter III

The Research Design

The purpose of this study was to determine the effects of reading guides on comprehension of mathematics word problems and attitude toward mathematics.

Questions

1. Do reading guides make a significant difference in the comprehension of mathematics word problems?

2. Do reading guides make a significant difference in the comprehension of mathematics word problems in boys?

3. Do reading guides make a significant difference in the comprehension of mathematics word problems in girls?

4. Do reading guides make a significant difference in attitude toward mathematics?

Methodology

Subjects

The subjects in this study were seventh grade students attending a suburban school in a predominantly middle to upper middle class school district.

A total of 40 students participated in this study during the regular meeting of their mathematics class. There were 24 males and 16 females. The two classes were equated in terms of the available IQ scores and mathematics level.

The mathematics level data were taken from the May, 1981 total math scores on the Stanford Achievement Tests, Intermediate II, Form A.

The two classes were randomly assigned to the treatment groups. The period eight group was designated as the first treatment group and was instructed using a general approach to solve selected math word problems. The first treatment group will be referred to as the general approach group or GA group for the duration of this report. The period six class was the second treatment group and was instructed using reading guides as an alternative method in solving the same set of word problems (see Appendix A). This group will be referred to as the reading guide group or the RG group throughout this report.

Instruments

Twenty-one math word problems were selected by the investigator from a variety of textbooks. One of the two forms of the researcher-constructed comprehension test (A and B) was administered before the treatment period as a pretest and the alternate form was administered at the end of the study as a posttest. The investigator constructed Form A and Form B based on word problems that were similar to those used in the study (see Appendix B).

Each form consisted of five word problems each containing three literal, three interpretive, and three apllied level statements assigned according to the consensus of the researcher and two faculty members of the reading staff from the State University of New York, College at Brockport. The subjects responded to the literal, interpretive, and applied level items as they would on a reading guide.

The mathematics section of the Estes Attitude Scales (Secondary Form) was administered to all subjects of the study as a pretest and again during the last week of the study as a posttest. The inventory consisted of fifteen statements measuring students' feelings toward the subject of mathematics. The

student could make five possible responses to each statement ranging from "strongly agree" to "strongly disagree," and assign a numerical value of one to five. The higher the score received by the student, the more positive his or her attitude was judged to be.

Procedure

The data were collected during an eight week period. There were two treatment groups in this study. One group received a general approach (GA) to solving mathematics word problems. The second group received reading guides (RG) as a technique to solving mathematics word problems.

Twenty-one word problems were selected, and reading guides were written for these twenty-one word problems by the researcher.

The GA group was presented the word problems and worked through the following format:

1. Reading and visualizing the problem as a whole
2. Reexamining the problem to identify what was asked to be found
3. Rereading the problem, noting the information given
4. Analyzing the problem and noting the relationship of information given to what was to be found

5. Translating the relationship into mathematical terms

6. Performing the necessary computation

7. Examining the solution, labeling and checking for accuracy (Earle, 1976).

Some of the problems in the GA group were worked through together as a class until the subjects were familiar with the procedure. The remainder of the problems were written on the board and the students worked through the steps independently. Each lesson was followed with a discussion of the problem.

The RG group completed the reading guides and then compared its responses in small group discussion. The students' performances in small group discussion were evaluated through a discussion led by the instructor on the specific statements that should have been checked at each level of the reading guide (see Appendix A).

Analysis of Data

A one-tailed *t* test was used to test the hypotheses at the .05 level of confidence. Posttest scores of the students who were instructed in the general approach to solving mathematics word problems were compared

with posttest scores of students who used reading guides. The reading guide group mean gain score and the GA mean gain score were analyzed in terms of sex differences. Posttest scores of the attitude scales for students in both groups were also compared.

Summary

A quasi-experimental, nonrandomized, alternative method group, pretest-posttest design was used for this study. The sample consisted of 40 students (two classes) taught by the same mathematics teacher. The two classes were equated in terms of age, mathematics level, and IQ score. During the eight week treatment period, the GA group worked on twenty-one mathematics word problems in a step-by-step method. The RG group worked the same problems using three level reading guides. A *t* test was used to analyze the data.

Chapter IV

Analysis of Data

The purpose of this investigation was to assess reading guides as a method for teaching comprehension of mathematics word problems.

Findings and Interpretations

The following hypotheses were tested:

1. There is no significant difference between posttest mean scores on a researcher-constructed test of word problem comprehension for students who receive instruction in the RG and GA groups.

2. There is no significant difference between posttest mean scores on a researcher-constructed test of word problem comprehension for boys who receive instruction in the RG and GA groups.

3. There is no significant difference between posttest mean scores on a researcher-constructed test of word problem comprehension for girls who receive instruction in the RG and GA groups.

4. There is no significant difference between posttest mean scores on an inventory of attitude toward mathematics for students who receive instruction in the RG and GA groups.

The first question was to determine whether a significant difference existed between the posttest scores of the RG and GA groups on the word problem comprehension test. A one-tailed t test for independent means was used to test the hypothesis at the .05 level of significance. Table 1 provides the data from this statistical analysis.

Table 1

t Test of Differences of Posttest Scores on Word Problem Comprehension for the RG and GA Groups

Group	n	Mean	s.d.	derived t ratio
RG	21	16.38	3.09	.505
GA	19	15.89	2.84	

critical t (38), $p < .05 = 1.682$

The RG group's mean score was higher than the GA mean score but there was not a significant difference between the two groups on the posttest as the data in Table 1 illustrate.

Questions two and three sought to determine whether there was a significant difference between

the posttest scores of the RG and Ga groups on the comprehension test, specifically within the sexes. There were no significant differences between the mean scores of the boys in both groups, nor were there any significant differences between the girls in the two groups. Tables 2 and 3 illustrate these results.

Table 2

t Test of Differences of Posttest Scores on the Word Problem Comprehension Test for Boys

Group	n	Mean	s.d.	derived *t* ratio
RG	13	16.77	3.40	1.709
GA	11	14.55	2.54	

critical *t* (22), $p < .05 = 1.717$

Table 3

t Test of Differences of Posttest Scores on the Word Problem Comprehension Test for Girls

Group	n	Mean	s.d.	derived *t* ratio
RG	8	15.75	2.38	.282
GA	8	17.38	2.17	

critical *t* (14), $p < .05 = 1.761$

Question four compared the mean scores of the RG and GA groups on the attitude inventory for mathematics. There was a significant difference in attitude between the two groups. The mean raw score of the RG group was significantly higher than the mean raw score of the GA group. Table 4 provides the data for these results.

Table 4

t Test of Differences in Attitude Toward Mathematics for Each Treatment Group

Group	n	Mean	s.d.	derived *t* ratio
RG	21	45.43	3.05	1.72*
GA	19	43.63	3.38	

*critical *t* (38), $p < .05 = 1.686$

The findings of this study demonstrate that the use of reading guides did not produce significant gains in word problem comprehension among RG and GA groups in general, and specifically among the sexes.

The mean score for girls in the GA group was higher than the mean score for girls in the RG group, although no significant differences were found. However, the boys in the RG group and the total RG group scored higher than the GA group in mean raw scores.

A significant difference in attitude toward mathematics existed between the RG and GA groups. The RG group made a significant gain in attitude.

Summary

The purpose of this investigation was to assess the effectiveness of reading guides as a teaching technique for word problem comprehension in mathematics. Analysis of the data demonstrated that posttest scores for the RG and GA groups were not significantly different for word problem comprehension. However, the RG group made significant gains in attitude when compared with the GA group in attitude toward mathematics.

Chapter V

Conclusions and Implications

The intent of this investigation was to examine the use of reading guides as a teaching technique for comprehension of mathematics word problems.

Conclusions

The results of this study demonstrated that the overall comprehension mean scores for the RG and GA groups were not substantially different. This was also the case when the scores were compared for males and females within the two groups.

The mean posttest scores on the mathematics section of the Estes Attitude Scales (Secondary Form) produced a significant gain in attitude in the group that was instructed using reading guides. Perhaps this gain was due to the fact that in the RG group students were asked to support or reject facts, concepts, and numerical depictions that were presented. The small group discussion was a deviation from the traditional math lesson, an activity the students appeared to enjoy.

Implications for Further Research

Further investigations could be conducted in the following areas:

1. There does not seem to be an abundance of studies using reading guides as facilitators of word problem comprehension. Future research could examine the effect of reading guides with various grade levels, reading levels, and mathematical ability and achievement.

2. An investigation over a longer period of time could be undertaken. Perhaps the extension would yield significant results in word problem comprehension through the use of reading guides.

3. Several studies examined attitude toward mathematics. However, the research is limited in comparisons of reading guides and attitude toward mathematics. Future research might be conducted to investigate the use of reading guides with such variables as attitude toward learning, attitude toward mathematics combined with attitude toward reading, and self-concept as related to attitude toward mathematics.

Classroom Implications

1. The use of reading guides generated discussion

of word problems since students were asked to support or reject facts, concepts, and numerical depictions that were presented at the literal, interpretive, and applied levels of comprehension. The discussion served as a catalyst for the investigator who could then clarify concepts, procedures, and terms and eliminate misconceptions.

2. Since neither treatment was clearly superior to the other, classroom teachers might employ a combination of reading guides and the general approach method in their instruction. Reading guides might provide students with possible "answers" and it is the students' responsibility to either support or refute those answers. Once the student is able to provide such evidence, he is ready to write the answers himself. At this point the instructor might introduce the GA method where the student must exhibit independence in supplying the answers.

3. Classroom mathematics teachers might consider using reading guides as a method of fostering positive attitudes toward mathematics. It is felt that the divergence from the daily mathematics lesson utilizing small group discussion provided and enjoyable atmosphere, thus contributing to positive attitudes.

Summary

The mean posttest scores for the RG and GA groups in word problem comprehension were not significantly different although the RG group mean for boys and the total population were consistently higher. A significant difference was found in attitude toward mathematics.

Future research could examine the following areas:

1. The effect of reading guides using different grade and reading levels as well as mathematical ability and achievement.

2. A similar investigation conducted over a longer period of time.

3. The effect of reading guides on attitude toward learning, attitude toward mathematics combined with attitude toward reading, and self-concept related to attitude toward mathematics.

In the classroom reading guides were valuable discussion tools in a subject matter that does not generally allow for a great deal of extended dialogue. The students appeared to look forward to the completion of the guides.

Although no significant differences were found between the RG and GA groups in word problem compre-

hension, students in the RG group appeared to be more attentive in their reading of the problems, concentrating on the useful facts and concepts which were either supported or refuted in the follow-up discussion.

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Appendix A

Reading Guide Group Activities

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Find the total cost of 3 cans of French fried onions at 38¢ each, 2 half-gallons of milk at 79¢ each, 2.5 pounds of bananas at 18¢ a pound, and a package of chocolate chips that costs 87¢.

Literal

____a. Three cans of onions cost 38¢.

____b. Chocolate chips cost 87¢.

____c. One half-gallon of milk costs 79¢.

Interpretive

____a. The words "total cost" usually suggest addition.

____b. There are sixteen ounces in a pound.

____c. Multiplication and addition are needed to solve the problem.

Applied

____a. $3 \times 38 = N$

____b. $38 + 79 + 18 + 87 = N$

____c. $2.5 \times .18 = N$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

In Phoenix, Arizona, the average amount of rain per year is 7.2 inches. In Omaha, Nebraska, an average of 27.56 inches of rain is received. In the average year, how much more rain is received in Omaha?

Literal

____a. The average of 27.56 inches of rain falls in Omaha.

____b. The average amount of rain per month in Phoenix is 7.2 inches.

____c. The problem asks us to find the average amount of rainfall in Omaha.

Interpretive

____a. There are 12 inches in a foot.

____b. The words "how much more" indicate subtraction.

____c. The word "average" usually suggests division.

Applied

____a. $27.56 - 7.2 = N$

____b. 27.56 divided by $7.2 = N$

____c. $27.56 - N = 7.2$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Bruce wants to buy an album that costs $5.53. If he has $1.68 in his bank and 75¢ in his pocket, how much more money does he need?

Literal

____a. Bruce wants to buy a record for $5.53.

____b. Bruce has $1.68 in his pocket.

____c. The problem asks us to find the amount still needed to buy the album.

Interpretive

____a. The words "how much more" often indicate subtraction.

____b. The amount of money Bruce has altogether is needed.

____c. Addition and subtraction are opposite operations.

Applied

____a. $1.68 - $.75 = N

____b. $.75 + $1.68 = N

____c. N = $5.53 - ($.75 + $1.68)

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

John's math test scores were 67, 90, 85, 76, 98, and 79. Find the mean of his set of test scores.

Literal

____a. John received 6 test scores.

____b. The problem asks us to find the mean score.

____c. John's highest test score was 98.

Interpretive

____a. The mean is the average of the scores.

____b. The word "set" indicates a group of scores.

____c. Addition and subtraction are opposite operations.

Applied

____a. 67 + 90 + 85 + 76 + 98 + 79 = n

____b. 79 + 98 + 76 + 85 + 90 + 67 divided by 6 = n

____c. 79 + 98 + 76 + 85 + 90 + 67 divided by n = 6

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

A copying machine in Barker Road Junior High School can copy 20,000 sheets of paper per hour. How many sheets of paper per minute is that?

Literal

____a. The machine can copy 20,000 sheets per minute.

____b. Barker Road Junior High School has a copying machine.

____c. The machine can copy 20,000 sheets per hour.

Interpretive

____a. There are 60 seconds in one minute.

____b. The word "per" often suggests division.

____c. There are 60 minutes in one hour.

Applied

____a. 20,000 x 60 = N

____b. 20,000 x N = 60

____c. 20,000 divided by 60 = N

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Marvin often babysits his four baby sisters. Marvin likes to take the girls to the store to buy them treats. If Marvin buys each girl a box of raisins and pays a total of $1.76, how much did each box of raisins cost?

Literal

____a. Marvin has four baby sisters.

____b. Marvin buys his sister's treats.

____c. The raisins cost a total of $1.76.

Interpretive

____a. The word "each" often suggests division.

____b. Addition and subtraction are inverse operations.

____c. The treats are expensive.

Applied

____a. $1.76 x 4 = N

____b. $1.76 divided by 4 = N

____c. 4 x N = $1.76

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

A man is building a room for his daughter's dollhouse. If each room is in the shape of a cube, and each side measures one foot, find the volume of the room.

Literal

____a. The problem asks us to find the volume of the room.

____b. A man is building a room for his daughter's dollhouse.

____c. Each side of the room measures one foot.

Interpretive

____a. 12 inches = one foot

____b. $V = s \times s \times s$

____c. A cube contains three dimensions.

Applied

____a. $V = 1 \times 1 \times 1$

____b. $V = 12 \times 12 \times 12$

____c. $V = 12^3$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Lee and Wendy used $3\frac{1}{2}$ yards of the same kind of cloth to make new pillows for their apartment. The cloth was a multi-colored stripe. If they needed 7/8 yard of cloth for each pillow, how many pillows could they make?

Literal

____a. Lee and Wendy were making pillows for their apartment.

____b. Each pillow called for 7/8 yard of cloth.

____c. The cloth was a multi-colored stripe.

Interpretive

____a. The word "each" often suggests division.

____b. There are three feet in a yard.

____c. a x b = b x a

Applied

____a. $3\frac{1}{2}$ divided by 7/8 = N

____b. N divided by $3\frac{1}{2}$ = 7/8

____c. N x 7/8 = $3\frac{1}{2}$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Al Martelli pays $27 a month for life insurance. Laura Benson pays $16.39. How much more does Al pay than Laura?

Literal

____a. The problem asks how much more Al pays for life insurance than Laura.

____b. Al pays $27 a month for insurance.

____c. Laura pays $16.39 per year for insurance.

Interpretive

____a. There are 12 months in a year.

____b. The words "how much more" often suggest subtraction.

____c. Addition is commutative. $a + b = b + a$

Applied

____a. $27 + 16.39 =$ ____

____b. $27 - 16.39 =$ ____

____c. ____ $- 16.39 = 27$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

The Scali family is going on a 5-day trip. At the start of the trip, the odometer showed 23538.8 miles. After 3 days, it showed 24333.2 miles. In this time, they used 40 gallons of gasoline. What was their rate of gas consumption to the nearest 0.1 mile per gallon?

Literal

____a. The odometer read 23538.8 miles at the beginning of the trip.

____b. Forty gallons of gas were used in three days.

____c. The trip will last five days.

Interpretive

____a. There are four quarts in a gallon of gas.

____b. The word "rate" often suggests division.

____c. There are 1,760 yards in a mile.

Applied

____a. 24333.2 - 23538.8 = N

____b. 2433.2 divided by 40 = N

____c. (24333.2 - 2358.8) divided by 40 = N

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

A man is building a fence around his circular garden. If the radius measures 7 feet, find the distance around the garden.

Literal

____a. The problem asks us to find the circumference of the garden.

____b. A man is building a fence.

____c. The radius measures 7 feet.

Interpretive

____a. C = 2 x x r

____b. There are 12 inches in a foot.

____c. = 3.14

Applied

____a. 2 x 3.14 x 7 = N

____b. 3.14 divided by (2 x 7) = N

____c. N divided by 3.14 = (2 x 7)

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

One day six players of the Southridge High School football team failed to appear for practice. If this represented .08 of the squad, how many players were there on the squad?

Literal

____a. The problem asks us to find the total number of football players.

____b. Southridge High football players practice daily.

____c. .08 of the football team failed to show up for practice one day.

Interpretive

____a. "how many" often suggests multiplication

____b. multiplication and division are opposite operations

____c. The word "of" often indicates multiplication.

Applied

____a. $.08 \times n = 6$

____b. 6 divided by $.08 = n$

____c. $.08 \times 6 = n$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

How much change should Anne receive from a $10 bill if she bought 6 pairs of socks at $1.00 per pair and 3 handkerchiefs for which she paid $3.00?

Literal

____a. Anne bought 6 pairs of socks.

____b. Anne bought some things at the store.

____c. Anne had a $10 bill to spend.

Interpretive

____a. The word "per" often suggests multiplication.

____b. Handkerchiefs cost $1.00 each.

____c. "How much change" often suggests subtraction.

Applied

____a. $6 + 3 =$ ____

____b. $10 - (6 + 3) =$ ____

____c. $(6 + 3) -$ ____ $= 10$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

The perimeter of a rectangular garden is 48 inches. Find the perimeter of the garden in feet.

Literal

____a. The problem asks us to find the perimeter of a rectangular garden.

____b. The perimeter is 48 inches.

____c. The garden is rectangular in shape.

Interpretive

____a. There are 12 inches in a foot.

____b. Perimeter = 2(l+w)

____c. 1 inch = 1/12 foot

Applied

____a. 2 x 48 = n

____b. 48 divided by 12 = n

____c. 48 x 12 = n

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

How many boxes are needed to package 100 pounds of rice that sells for 23 cents per pound if each box is to contain two pounds of rice?

Literal

____a. Rice costs 23 cents per pound.

____b. Each box of rice contains two pounds.

____c. Rice is packaged in boxes.

Interpretive

____a. There are 16 ounces in a pound.

____b. The word "each" often suggests division.

____c. Division and multiplication are inverse operations.

Applied

____a. 100 divided by 2 = ____

____b. ____ divided by 2 = 100

____c. 100 divided by 23 = ____

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

How many boxes are needed to package 100 pounds of rice that sells for 23 cents per pound if each box is to contain two pounds of rice?

Literal

____a. Rice costs 23 cents per pound.

____b. Each box of rice contains two pounds.

____c. Rice is packaged in boxes.

Interpretive

____a. There are 16 ounces in a pound.

____b. The word "each" often suggests division.

____c. Division and multiplication are inverse operations.

Applied

____a. 100 divided by 2 = ____

____b. ____ divided by 2 = 100

____c. 100 divided by 23 = ____

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

The sum of two whole numbers is 11. One of the numbers is even. One of the numbers is greater than 9. What are the two numbers?

Literal

____a. The two whole numbers added together equal 11.

____b. One of the numbers is even.

____c. One number is larger than 9.

Interpretive

____a. The word "sum" indicates addition.

____b. Addition and subtraction are opposite operations.

____c. An even number belongs to the set (2,4,6...)

Applied

____a. $a + b = 11$

____b. $11 - a = b$

____c. a is greater than 9

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

A department store had a sale on dresses. Each dress was discounted 20%. Mrs. Kline bought a dress which originally sold for $50.00. How much did she save on the dress?

Literal

____a. A department store had a 20% off sale on dresses.

____b. The problem asks us to find the discount on a $50 dress.

____c. Dresses were on sale.

Interpretive

____a. Discount = percent-off x original price

____b. Mrs. Kline saved 20% on her dress.

____c. Division is the opposite of multiplication.

Applied

____a. $50.00 divided by .20 = n

____b. .20 x n = 50

____c. 50 x .20 = n

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Jane rides her bike from home to school, averaging 10 miles per hour. The distance to school is 5 miles. On the return trip, she sometimes stops, and therefore averages 9 miles per hour. How long does the trip from home to school take?

Literal

____a. Jane averages 10 miles per hour on her bike.

____b. Jane stops at different places on her way home from school.

____c. Jane lives 5 miles from her school.

Interpretive

____a. There are 60 minutes in one hour.

____b. The word "average" often suggests division.

____c. It sometimes takes Jane longer to return home.

Applied

____a. $\frac{1}{2} \times 10 = 5$

____b. 10 miles per hour; 5 miles per $\frac{1}{2}$ hour

____c. $9 + 10 = N$

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

Lumber is transported by 25 trucks. Each truck carries the same load. The total load carried is 300 tons. How many tons are carried by each truck?

Literal

____a. Lumber is transported by trucks.

____b. 300 tons of lumber are carried by all of the trucks.

____c. 25 trucks are used for transporting lumber.

Interpretive

____a. The word "each" often suggests division.

____b. There are 2,000 pounds in a ton.

____c. Division is not commutative. $a/b \neq b/a$

Applied

____a. 300 divided by 25 = N

____b. 25 x N = 300

____c. N divided by 300 = 25

Directions: Read over the problem quickly. Check those statements which are useful in understanding the problem.

The shoe store is selling tennis shoes for $4.95 a pair. In the summer the shoes are on sale. How much would two pair cost?

Literal

____a. Tennis shoes cost $4.95 per pair.

____b. The problem asks us to find the cost of two pairs of shoes.

____c. Tennis shoes go on sale in the summer.

Interpretive

____a. Multiplication is associative (axb)xc=ax(bxc)

____b. Multiplication and division are opposite operations.

____c. The cost of the shoes must be doubled.

Applied

____a. $4.95 x 2 = N

____b. $4.95 divided by 2 = N

____c. N divided by 2 = $4.95

Appendix B

Word Problem Comprehension Pretest/Posttest

WORD PROBLEM COMPREHENSION TEST NAME_____

FORM A

Directions: Read over the problem quickly. Check those statements that are useful in understanding the problem. Refer to the problem and prior knowledge to verify your responses.

1. Mrs. Jessup keeps eight horses in each of her six stables. Each horse eats about 49 kilograms of food per week. About how much food do the horses eat in 12 weeks?

Facts (Literal Level)

____a. The problem asks us to find how much food the horses eat.

____b. Six stables each house eight horses.

____c. Each horse eats approximately the same amount of food per week.

Concepts (Interpretive Level)

____a. There are seven days in each week.

____b. One kilogram equals 2.2 pounds.

____c. The word "each" often suggests multiplication.

Possible Numerical Depictions (Applied Level)

____a. $49 \times 12 =$ ____

____b. $(49 \times 12) \times (8 \times 6) =$ ____

____c. $(49 \times 12) \times$ ____ $= (8 \times 6)$

2. Bill purchased two loaves of bread at 69¢ a loaf, a dozen eggs at 99¢, and a half pound of cheese at 98¢ per pound. He gave the clerk three one dollar bills as payment. How much change did he receive?

Facts (Literal Level)

____a. The dozen eggs cost 99¢.

____b. A pound of cheese costs 98¢.

____c. Bill gave the clerk three dollars.

Concepts (Interpretive Level)

____a. There are twelve eggs in one dozen.

____b. Addition is associative. $(a+b)+c = a+(b+c)$

____c. The words "change received" often indicate subtraction.

Possible Numerical Depictions

____a. $(2 \times 69) + 99 + \_\_\_\_ = 98/2$

____b. $69 + 99 + 98 = \_\_\_\_$

____c. $3 - (2 \times 6) + 99 + (98/2) = \_\_\_\_$

3. A store offers a 20% discount on all merchandise. If a customer pays $30 for a coat, what was the original price?

Facts (Literal Level)

____a. Coats are on sale at 20% of the original price.

____b. Coats are on sale.

____c. The customer paid the sale price of $30 for the coat.

Concepts (Interpretive Level)

____a. The customer pays 80% of the original price.

____b. discount = original price multiplied by the rate of discount.

____c. The customer received a good deal.

Possible Numerical Depictions (Applied Level)

____a. .20 x 30 = ____

____b. 30 x ____ = .20

____c. ____ divided by 30 = .20

4. Mr. Kinney left his two small dogs and one large dog at the kennel for twelve days while he was on a trip. The kennel gave him a special rate of $6.00 a day for each small dog and $7.25 a day for the large dog. How much did he owe the kennel when he returned?

Facts (Literal Level)

____a. The kennel charges $6.00 a day for small dogs.

____b. The kennel's rates are based on the size of the dogs.

____c. The problem asks us to find the amount of money Mr. Kinney paid to the kennel.

Concepts (Interpretive Level)

____a. The amount Mr. Kinney spent each day on his dogs is needed.

____b. Mr. Kinney went away on a trip.

____c. Division is the opposite of multiplication.

Possible Numerical Depictions (Applied Level)

____a. 6 x 2 = ____

____b. (6 x 2) + 7.25 x 12 = ____

____c. 7.25 + (6 x 2) = ____

5. The Murphy family had chocolate cake for dessert two evenings. They ate 2/3 of the cake one night and 1/6 the next. How much cake was left after the two evenings?

Facts (Literal Level)

____a. The Murphy's ate cake for dessert.

____b. One-sixth of the cake was eaten the second night.

____c. One night 2/3 of the cake was eaten.

Concepts (Interpretive Level)

____a. Most of the cake was eaten in two evenings.

____b. The whole is equal to the sum of its parts.

____c. The words "how much left" often suggest subtraction.

Possible Numerical Depictions (Applied Level)

____a. $2/3 + 1/6 =$ ____

____b. $1 - (2/3 + 1/6) =$ ____

____c. $2/3 -$ ____ $= 1/6$

WORD PROBLEM COMPREHENSION TEST NAME_____

FORM B

Directions: Read over each problem quickly. Check those statements that are useful in understanding the problem. Refer to the problem and prior knowledge to verify your responses.

1. Mr. Kline keeps 12 pigs in each of his 8 pens. Each pig eats about 60 pounds of food per week. About how much food is eaten by the pigs in 10 weeks?

Facts (Literal Level)

____a. The problem asks us to find the amount of food eaten by pigs.

____b. Eight pens are each occupied by twelve pigs.

____c. Each pig eats around 60 pounds of food per week.

Concepts (Interpretive Level)

____a. There are seven days in a week.

____b. The word "each" often suggests multiplication.

____c. There are sixteen ounces in a pound.

Possible Numerical Depictions (Applied Level)

____a. (12 x 8) x 60 =_____

____b. (12 x 8) x ____ = 60

____c. (12 x 8) x (60 x 7) = ____

2. Susan purchased two boxes of cereal at 99¢ a box, a dozen cookies at $1.05 and a half pound of hamburger at $1.50 per pound. She gave the cashier four one dollar bills as payment. How much change did she receive?

Facts (Literal Level)

____a. The dozen cookies cost $1.05.

____b. Susan went to the grocery store.

____c. A pound of hamburger costs $1.50.

Concepts (Interpretive Level)

____a. There are twelve cookies in one dozen.

____b. The words "change received" often suggest subtraction.

____c. Addition is commutative. a + b = b + a

Possible Numerical Depictions (Applied Level)

____a. 99 + 105 + 150 = ____

____b. (2 x 99) + 105 + (150/2) = ____

____c. ____ = 4 - (2 x 99) + 105 + (150/2)

3. A sale offers 30% off. The sale price of a bicycle is $56. What is the original price?

Facts (Literal Level)

____a. Bicycles are discounted 30%.

____b. The sale price of the bicycle is $56.

____c. Bicycles are on sale.

Concepts (Interpretive Level)

____a. discount = original price x the percent of discount

____b. The sale price includes the discount.

____c. The customer pays 70% of the original price.

4. Mrs. Case left her two children with a babysitter while she went to Europe. The babysitter charged $20 a day for the first seven days and $25 a day for each day after that. She was gone for ten days. How much did Mrs. Case owe the babysitter when she returned?

Facts (Literal Level)

____a. The problem asks us how much Mrs. Case spent on babysitting.

____b. Mrs. Case went to Europe on her vacation.

____c. The babysitter charged $20 a day for the first week.

Interpretive Level (Concepts)

____a. The amount of money spent on babysitting is needed.

____b. Multiplication and division are opposite operations.

____c. You will need to find the total charge for ten days of babysitting.

Possible Numerical Depictions (Applied Level)

____a. $10 - 7 =$ ____

____b. $(20 \times 7) + 25(10 - 7) =$ ____

____c. ____ $+ 25(10 - 7) = (20 \times 7)$

5. The Smith family ate turkey as a main dish for two dinners. They ate 3/4 of the turkey one evening and 1/5 the next. How much was left after the two dinners?

Facts (Literal Level)

____a. One night 3/4 of the turkey was eaten.

____b. The Smith's ate turkey for dinner.

____c. The Smith's ate 1/5 of the meat on the second night.

Concepts (Interpretive Level)

____a. Most of the turkey was eaten in two dinners.

____b. The Smith's ate turkey for dinner.

____c. The Smith's ate 1/5 of the meat on the second night.

Possible Numerical Depictions (Applied Level)

____a. $3/4 + 1/5 =$ ____

____b. $3/4 -$ ____ $= 1/5$

____c. $1 - (3/4 + 1/5) =$ ____