DOCUMENT RESUME

ED 229 741 CS 007 116

AUTHOR Clark, Zende
TITLE Does the Ability or Inability to Comprehend Effect the Mathematics Problem Solving Ability of Seventh Grade Students.
PUB DATE May 83
NOTE 26p.; M.A. Thesis, Kean College of New Jersey.
PUB TYPE Reports - Research/Technical (143) -- Dissertations/Theses - Master Theses (042)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Content Area Reading; Grade 7; Junior High Schools; *Mathematical Concepts; Mathematics Instruction; *Problem Solving; *Reading Comprehension; *Reading Instruction; *Reading Research

ABSTRACT

A study was conducted to test the hypothesis that the ability to comprehend in reading has no effect on mathematical problem solving ability of seventh grade students. Two seventh grade classes were administered a standardized test of reading comprehension and knowledge of mathematical concepts and application at the beginning of a school year. They were then taught exactly the same way for 14 weeks, with the exception that the experimental class was given a special group lesson once a week that was designed to assist them in learning to solve problems through word meanings, problem solving strategies, and symbol meanings. The experimental class was also given vocabulary and symbol usage practice. At the end of 14 weeks, the classes were retested on the same measure. The results indicated that the experimental class students improved their scores on the reading comprehension test and on the knowledge of mathematical concepts test, but that the control class students achieved greater gains without the extra instruction. The results suggest that further research be done in this area with samples that are similar in intelligence and reading. (A summary of related research and tables of test score data are included.) (FL)

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Does the ability or inability to comprehend effect the mathematics problem solving ability of seventh grade students

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by
Zende Clark

May 1983

accepted 4/27/83

Presented in Partial Fulfillment of the Requirement for the Masters of Arts Degree at Kean College of New Jersey

May 1983

CS 007 116

Abstract

The purpose of this study was to examine ways to improve mathematics problem solving skills through the usage of symbols and their meanings, word meanings and problem solving strategies.

The subjects of the study consisted of nineteen seventh grade students in both the control and experimental samples. Both groups were evaluated by a pretest and a posttest, the California Achievement Test, Reading Comprehension and Mathematics Concepts and Applications. The results indicated a significant difference existed between the samples.

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Reading comprehension scores and quantitative math scores are steadily decreasing at the elementary level. As educators we are faced with the task of improving these vital skills. It is believed by some that in order to score highly in the area of quantitative mathematics, also referred to in this paper as problem solving, one must be able to comprehend when reading. Reasearch throughout the years has supported the fact that reading comprehension ability is not a determiner for failure or success in solving mathematic word problems.. Thorndike (1917) found similarities in the cognitive process necessary to understand mathematical problem solving and that of reading comprehension. He stated "..to understand a paragraph is like solving a problem in mathematics. It consists in selecting the right elements of the situation and putting them together in the right relations and also with the right amount of weight or influence or force for each.... all under the influence of the right mental set or purpose or demand." Even as early as 1917 it was noted that reading comprehension and solving a problem in mathematics were two autonomous skills comparable but independent of each other.

Data collected by Lyda and Duncan (1917) indicated that the direct study of quantitative vocabulary produced a significant growth in problem solving abilities.

Chase (1917) studied 15 variables which might effect the ability of a middle grader to problem-solve. He stated that skill in recognizing details in reading along with fundamental arithmetic concepts and the ability to compute were among three major predictors.

Stern and Keisler (1967) studied the effect of instruction in problem solving strategies upon third graders' abilities to interpret verbal problems. They found that children who were taught strategies for problem solving performed better with new, but similar problems than children who had not been given instruction.

Irish (1964 reported that fourth graders in her study spent ten percent of their study time in stating verbal generalizations appropiate to the topic under study. Irish found that the experimental children made significantly greater average growth than children who did not receive the training.

Reilly and Pachtman (1978) suggested specific guidance in solving word problems be given to students. They developed a three-level reading guide for use with word problems. This guide was created in an effort to support their belief that children must be ' taught how ' to solve word problems, not told how to solve them.

Hypothesis

To provide additional evidence to support the theory that mathematics problem skills are not dependent upon reading comprehension skills a study will be conducted. It is hypothesized that the ability or inability to comprehend in reading has no effect on mathematic problem solving ability of seventh grade students.

Assumptions

For the purpose of this study the researcher assumes the California Achievement Test is a reliable and valid instrument of measure. It is further assumed that the subjects will co-operate and will perform to the best of their ability on the given test.

Limitations

The brief period of time available for this study will place limitations upon it. The number of subjects used will be relatively small. This study will also be limited by the grade assignment of the students, their class assignment and the school of attendance.

Definitions

Ability. Potential or actual power to perform a responsive act.

Ability, reading. An individual's capacity to interpret printed symbols rapidly and accurately.

Procedure

In early October two seventh grade classes were administered the California Achievement Test. This test measures the achievement of students from kindergarten through twelfth grades. There are ten levels of the CAT/C (Levels 10-19). The California Achievement Test is a criterion-referenced achievement test. It provides information about the relative ranking of an individual student against a norm group. Level

17 was administered since it was recommended for students in grade seven. The only tests administered were Test 2, Reading Comprehension and Test 7, Mathematics Concepts and Application.

The two classes were taught exactly the same with the exception that the experimental group was given a special group lesson once a week for fourteen weeks that assisted them in learning to solve problems through word meanings, problem solving strategies and symbol meanings and their usage.

The control group was taught using a structured approach following the curriculum guide. Symbol meaning and problem solving strategies were taught incidentally in conjunction with the mathematics computation process.

The experimental group was given vocabulary and practice in symbol usage. Isolated exercises were also given to help the students look at word problems logically and eliminate information that wasn't necessary to help them solve verbal problems.

At the end of the fourteen week period both groups were readministered the California Achievement Test.

Results

Table I illustrates the pretest results on the California Achivement Test in the areas of Reading Comprehension and Mathematics Concepts and Application as achieved by the experimental and control samples.

Table I

Comparison of Test Scores on the California Achivement Test in the Areas of Reading Comprehension and Mathematics Concepts and Application:

Subjects	Test	Raw Score Mean	Standard Deviation	t
Experimental 19 students	Pretest Reading Comprehension	19.47	7.35	14.92 s<.01
Control 19 students		14.63	6.21	
Experimental 19 students	Pretest Mathematics Concepts and Application	17.47	6.96	7.14 s<.01
Control		15.26	5.40	

As can be seen, the experimental sample mean at the outset of this study for the pretest on reading comprehension was significantly higher than the mean of the control sample. As can be further noted, the t for the difference between the means on the test of reading comprehension proved to be significant. The results indicate that the samples started with different levels of ability.

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The pretest mean for the experimental sample was also higher than the mean of the control sample on the mathematics concepts and application test. The t results indicated there was a significant statistical difference between the two samples.

To determine the affect of instruction as related to the hypothesis, a comparison of the mean gains of both samples was undertaken. The results are shown in the table.

Table II

Comparison of the Mean Gain of the Experimental Sample and Control Sample on the California Achievement Test in the area of Reading Comprehension and Mathematics Concepts and Application.

Subjects	Test	Raw Score Mean Gain	Standard Deviation	t
Experimental	Reading Comprehension	5.68	4.97	5.19 s<.01
Control		4	4.14	
Experimental	Mathematics Concepts and Application	5.26	3.73	11.51
Control		9	5.56	

Table II illustrates the mean gain between the experimental and control samples. In the area of reading comprehension the mean gain of both samples were relatively small but the gain by the experimental sample was greater. The t of 5.19 showed a significant gain between the mean gain of the control and experimental samples.

On the other hand, the mean gain on the mathematics concepts and application test was higher for the control sample than for the experimental sample. The t of 11.51 indicated there was a significant difference between the mean gain of the experimental and control samples.

Conclusions

The results revealed growth in the areas of reading comprehension and seeming, as a result of instruction in the area of mathematics concepts and application. It appears by an analysis of the data that the control group at the onset of the experiment was significantly different from the experimental group. The results of the data also indicates that the lessons given to the experimental group on problem solving, strategies and techniques, brought about a change in the mathematics concepts and application test scores on the California Achievement Test but the control sample achieved greater gain in the area of reading comprehension without the extra instruction on the mathematics concepts and application test. Since there was a significant gain in the reading comprehension skills of the control group it is suggested that further reasearch be done in this area with samples that are similar in intelligence and reading, to determine the true impact of teaching reasoning and its

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effect on reading comprehension.

The implications, suggested by the results, is that some other factor operated in this study to affect the comprehension of the control sample. Although no instruction was given to the sample, the students' significant growth may have been affected by a Hawthorne effect or by the teacher who may have striven to improve performance.

Comprehension and mathematics problem solving ability: Related Research

Reading comprehension scores and quantitative math scores are steadily declining at the elementary level. As educators we are faced with the task of improving these vital skills. It is believed by some that in order to score highly in the area of quantitative mathematics, also referred to in this paper as problem solving, one must be able to comprehend when reading. Reasearch throughout the years has supported the fact that reading comprehension ability is not a determiner for failure or success insolving mathematics word problems.

Thorndike (1917) found similarities in the cognitive process necessary to understand mathematical problem solving and that of reading comprehension. He stated " to understand a paragraph is like solving a problem in mathematics. It consists in selecting the right elements of the situation and putting them together in the right relations and also with the right amount of weight or influence or force for each... all under the influence of the right mental set or purpose or demand.."

Bye (1975) stated that reading difficulties in mathematics may stem more from the abstract and highly symbolic nature of the subject than form an inability to recognize or comprehend words. After reviewing Piaget's model of cognitive development Bye deduced that many seemingly simple mathematical terms assume the use of cognitive abilities which students might not possess. He suggested that teachers provide students with a broader set of experiences, centered on the difficult concepts, in order to generate deeper and more specific meanings for the words causing difficulty when problem solving.

Rosenthal and Resnick (1971) conducted a study which examined the effects of three variables on the difficulty of verbal arithmetic problems. The variables used in this study included problem form, sequence of information and problem verb. It was concluded that students need to distinguish sequence of information from sequence of events where they do not coincide and that reverse sequence causes the greatest difficulty in problem solving.

Manzo (1975) examined the problem of mathematical illiteracy. He stated, " the math word problem possesses a barrier to learning because of the new words and notations and the complex language and terse sentences. " He suggested math teachers use an approach to the problems which would involve the teacher and the student and the math problem. Manzo developed a procedure entitled the R/Q procedure. The R/Q procedure involves the participation of both the teacher and the student in a questioning strategy, they both read each sentence of the problem and then ask each other questions until the student is ready to solve the problem.

Schell (1981) in a paper presented at the annual meeting of the Missouri State Council of the International Reading Association explored the underlying factors to students' problems in reading and completing mathematics problems. Among these factors were:

1. interest and motivational level
2. their readiness for reading of the material
3. the reading level of the material
4. the students understanding of the purpose for reading mathematics

She suggests students be able to restate problems in their own words before attempting to solve them.

Irish (1964) reported that fourth graders in her study spent ten percent of their arithmetic study time in stating verbal generalizations appropiate to the topic under study. Irish found that the experimental children made significantly greater average growth than children who did not receive the training.

When working with mathematic word problems, students must be able to read mathematical statements in symbolic form, use spatial cues to interpret arithmetic processes and self instrict in order of process. In an A.C.E.R. study (1976) conducted by Munro it was found that students encounter more difficulty in manipulating math statements written in normal language. Munro hypothesized " performance in many areas of human functioning is implicitly related to one's ability to use language skills. Mathematics performance in many areas of language." He further suggested that the students be trained to translate symbolic statements and word problems into a " set of temporarily sequenced actions or operations initially applied to concrete materials or represented in drawings." The students can describe a statement through a series of physical actions or overtly verbalize a written statement or problem before solving it. This will help the student code the information within his existing language structures, which may not assist him to process and use the coded information intellectually.

Watkins (1979) in a study conducted on college students concluded that students understand mathematics better when concepts are written with more common grammatical structures and without symbols. This suggests that the process of solving the problem is not the difficulty faced by students, it is the symbols used in mathematics that might be causing the most difficulty.

Pribnow (1969) in his article entitled 'Why Johnny Can't "Read" Word Problems' stated " the reason or reasons for the inability of students to master the solving of word problems appears to be an inability on the part of the student to organize and analyze the problem.

In some problems, the math process is not explicitly stated and the student must choose the correct process. Problems which require the student to manipulate the statement, cause great difficulty. Brunner makes some suggestions for teachers in an effort to prepare students for reading mathematical exposition. She suggests that the teacher point out to students that "mathematics be read at a slower rate in terms of the number of words read in a given interval of time since this rate is not slow in terms of information communicated in that time interval.... mathematical exposition communicates a great deal in a short statement. Because of the non-redundancy of mathematics, a reader must be aware of the possibility that he may overlook a key word or phrase." Earp, in an address before an IRA Convention, recognized at least three different kinds of reading adjustment required for mathematics:

1. slower rate than used for non-mathematical materials,
2. varied eye movements including types of regressive eye movements,
3. intentional rereading

Thomas and Robinson (1972) developed a mathematics study skill device called the PQ4R. This method, a variation of the SQ3R requires the student to preview, question, read, reflect, and rewrite the word problems. It provides math students with a systematic method of approaching word problems.

It was suggested by Maffei that the teacher provide the student with structure. He also feels that this method is most effective with average and below average students since bright students usually have their own method of solving problems that is already successful for them.

In conclusion, Reilly and Pachtman (1978) suggested specific guidance in solving word problems be given to students. They developed a three-level reading guide in an effort to support their belief that children must be 'taught how' to solve word problems, not told how.

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APPENDIX

TEST SCORES OF CONTROL SAMPLE

	Reading Comprehension		Mathematics Concepts and Application	
	Pretest	Posttest	Pretest	Posttest
1.	19	18	11	15
2.	14	15	14	21
3.	18	25	21	21
4.	22	36	15	33
5.	17	18	18	28
6.	15	19	13	22
7.	17	25	11	23
8.	6	19	9	14
9.	10	17	18	33
10.	13	13	22	26
11.	9	14	5	13
12.	29	36	26	42
13.	12	16	10	20
14.	27	34	18	32
15.	15	24	23	22
16.	8	14	19	30
17.	7	10	11	20
18.	10	14	13	16
19.	15	15	13	30

TEST SCORES FOR EXPERIMENTAL SAMPLES

	Reading Comprehension		Mathematics Concepts and Application	
	Pretest	Posttest	Pretest	Posttest
1.	29	32	27	37
2.	20	18	16	18
3.	29	30	19	19
4.	11	12	15	26
5.	27	34	28	36
6.	23	29	14	35
7.	12	16	14	21
8.	13	19	20	22
9.	16	10	18	10
10.	31	36	31	38
11.	13	18	14	18
12.	23	28	18	21
13.	11	14	14	12
14.	16	20	13	19
15.	10	15	8	15
16.	24	30	13	21
17.	13	24	9	11
18.	11	23	9	11
19.	33	36	32	36