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Solving Word Problems in the Classroom: Traditional Instruction vs. Computer Instruction

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by

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ABSTRACT

The intent of this study was to determine if there was a difference in student performance when word problems or mathematical problem-solving skills are taught the traditional way or when students are taught through Computer Assisted Instruction, CAI. Ninety students in grades 9 through 12 participated in this study. The Stanford Test of Academic Skills, TASK, was administered for pre- and posttesting. No significant difference in achievement were found.

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DEFINITION OF TERMS

Computer Assisted Instruction- Instruction and lessons which can be taught by or with the assistance of the computer. Students may utilize the computer on their own with appropriate software, or the teacher may instruct the lesson via a large television screen or overhead.

Higher-Order Thinking Skill- In Bloom's Taxonomy, ability to think beyond memorization of facts, i.e., functioning on the comprehension, application, analysis, synthesis, or evaluation levels.

Problem-Solving Skills- Thinking skills necessary to solve word problems in mathematics.

CHAPTER ONE: INTRODUCTION

The emphasis for computational skills in the mathematics curriculum has been a major thrust in education for decades. As comparisions are made of mathematical achievements of students around the world, educators in the United States are now realizing that our only strength is in the area of arithmetic and computational skills. According to Steen (1987), many standardized tests have emphasized computational skills, skills that can easily be solved by calculators, and have de-emphasized open-ended problem solving. As a result, educators in the United States has often avoid dealing with word problems and consequently students' problem-solving skills tend to be weak or undeveloped.

One current trend in education is to develop students' critical thinking skills. Solving word problems and the associated skills indeed involve logical and higher-order thinking which is part of the critical thinking process. Computers, as well, can facilitate the development of such thinking. Computers hold great promise as a tool for providing activities to develop higher-level problem-solving and thinking skills (Parker, 1986). Such activities can stimulate the best of minds in areas of creativity, ability to analyze, synthesize and evaluate.

By teaching a unit on problem-solving skills along with computer instruction, one could ask whether thinking skills might be enhanced compared with the students who are taught problem-solving skills without the aid of a computer. It is also possible that the computer's visual nature could affect student retention, as students in this generation are accustomed to television and entertainment. One may also find that by using the computer to aid in instruction, an increase in student motivation may result which in turn could lead to higher achievement. At this time there appears to be little research which has investigated these relationships.

The intent of this study is to determine if there is a difference in student performance when word problems or mathematical problem-solving skills are taught in the traditional way, i.e., with chalkboard, teacher lecture, question-answer sessions or when students are taught through Computer Assisted

Instruction. A study will be conducted at Middleburg High School in Middleburg, Florida. Two Consumer Mathematics classes and two General II Mathematics classes which are primarily tenth, eleventh and twelfth grade students will participate in this study. One Consumer Mathematics class and one General II Mathematics class will be taught by traditional methods, while the others will be instructed using Computer Assisted Instruction material.

CHAPTER TWO: REVIEW OF LITERATURE

Education in the United States is constantly changing. In the late 1960s and early 1970s emphasis was the implementation of the open classroom; children were encouraged to experience life and learning and the word "memorize" was not stressed in teachers' lesson plans. In the late 1970s and early 1980s the trend was back to basics---memorizing was again an acceptable practice. Now, in the middle 1980s, the emphasis is on thinking and problem solving. Computation is necessary, but there is a need for students to be able to think and solve problems.

Currently there is a limited amount of research in the area of computers in the classroom. Computers are being introduced into education slowly due to the high cost of the systems. Software development has recently seen considerable advancement.

According to Bennett (1986), math education lacks a relationship between computation and application to real world problems. There is a great deal of emphasis on rules and formulas as opposed to intuitive and exploratory problems. Bennett also notes that children in Japan and Europe by Grade 8 are involved in Algebra, Geometry and mathematical problem-solving, while in the United States the curriculum is primarily arithmetic computation.

Bennett (1986) and other educators claim that the focus on word problem skills is not being reflected in current math textbooks. The number of word problems and the amount of reading in math textbooks are both decreasing. McGintry (1986) compared the number of written words and word problems in math textbooks and reported the following.

	Written Words	Word Problems
1924	69,000	1,510
1944	47,000	1,620
1984	34,000	510

Compared to 1924, today's math textbooks have half the number of written words and one-third the word problems.

Muth (1986) argues that test results are low today because of the lack of problem-solving skills. Students cannot transfer their mathematical knowledge into real life situations which often contain extraneous information. Students often have difficulty selecting relevant information in a problem. Moursand (1986) reinforces this assertion since College Entrance Examination scores are falling due to the lack of higher-order thinking skills. Further, teachers and adults complain about the inability of students to think and solve problems confronted in daily living.

The ability to think mathematically does not occur overnight or in a few lessons. According to Burns (1985) mathematical thinking is a long-range goal that must be taught continuously. Teachers are the key in building math confidence, as well as the key in challenging and stimulating interest in mathematics. Burns suggests that the teacher must promote mathematical thinking and have students reflect on that thinking.

Bennett's (1986) report addresses the need not only for computational skills but also for strategies to solve word problems. Bennett concludes that schools in the United States face a major challenge in imparting crucial math skills and problem-solving strategies. Problem-solving should be a subject of daily study dealing with real-life issues, academic skill, patient thinking and creativity. Further, teachers need to remove the pressure associated with being right or wrong so that thinking skills can be enhanced. Slife and Cook (1986) suggest that if the pressures of failure were removed, half of our obstacles to teach problem-solving skills would be eliminated.

According to Davidson (1987) computers foster a postive feeling and response in students. Students are in control of learning and have the opportunity to be successful and the potential to build confidence. Learning often occurs at the student's own pace. Davidson also claims that computers not only provide for intellectual stimulation but also allow for active participation and thinking.

Pogrow (1986) reports that computers can assist secondary schools by providing high levels of problem-solving skills. Teachers can replace rote learning activities with problem-solving activities. The computer can graph an equation in seconds while the student can answer the question regarding what happens to the graph when x and y change. In a general math class students may simulate operating a business and may make decisions. These higher-order thinking skills--synthesis, integration and analysis of information--can be a direct result of reorienting the curriculum with more computer instruction.

To be a more successful teacher and to make teaching easier, Moursund (1987) suggests that educators take advantage of Computer Assisted Instruction. Moursand also suggests that the entire class participate in computer activities such as simulations as the latter add a new dimension to class instruction.

Lowd (1986) and Davidson (1987) agree that computers can aid in creating positive feelings by providing immediate feedback and by allowing for individualized learning. Lowd also comments that computers can mechanize teaching and ensure learning. Computers can challenge the best minds and teach logic as well as critical thinking. Students are encouraged to see that there are many solutions to real-world problems. Open-ended software allows children to think for themselves. It de-emphasizes memorizing facts and stresses students' abilities to analyze data, to develop solutions and to simulate complex problems in order to arrive at solutions. Students are encouraged to think independently and to make decisions.

Samson et al. (1986) reviewed 45 published studies on the effect of computer instruction on students learning in the secondary schools. Samson found that in 38 of the 45 studies greater gains in performance were made when computers were used in class instruction than when traditional methods of instruction were used. Samson states: "One result stands out: studies where the computer use was of short duration (two weeks or less) produced stronger positive differences compared to regular instruction, but this short-term advantage was not maintained when computers were used for approximately one semester."

A study by DeClercg and Gennaro (1986) included four ninth grade classes. The classes were taught a unit on volume displacement. At the completion of the unit, half the students spent 10 to 20 minutes in computer simulation. Fifty-five days later, and with no other class discussion, a posttest was administered. Students who worked with the computer simulation did significantly better than students who did not participate in the simulation. The study concluded that there is a long-term impact on student's learning when aided by a computer.

According to Rumage (1987), Eula, Texas conducted a study of elemetary students using computers in math classes. Results in the first year of operation showed a gain of 7.8 academic months following 75 ten-minute sessions. The gains by middle school students in this study were not impressive. Growth at the middle-school level was only 3.0 months to 5.3 months.

Douglas and Bryant (1985) conducted a study in Garland, Texas, which found positive results by using computers in instruction. The scores in mathematic concepts and computation of the Iowa Tests of Basic Skills were 6% to 7% higher than the scores of years prior to the implementation of computer-assisted instruction in the elementary schools. Two 20 minute sessions per week were spent on mathematics studies in the computer lab. Again, the performance of the middle schools, grades 6 to 8, were not as positive as the elementary results.

Roblyer's (1985) intense study included reviews of 12 research studies published from 1972 to 1985.

Roblyer's conclusions were similar to the findings as mentioned in this chapter. Higher gains are generally made at the elementary level than at the middle or high school levels. Mathematics lessons taught with the computer tends to show greater success than reading or language arts programs. Lessons that are supplemented by computer instruction tend to have a greater effect on student's retention than concepts which are taught solely using the computer.

Roblyer's (1985) study also addressed problem solving. The study stated that teaching problem solving and higher-order thinking skills by computers is still in its infancy. There is still a critical need for further studies to determine the computers instructional power in the classroom. Arch (1986) supports Roblyer's position. He remarks that computers are seen as a great aid to students in allowing them to be more proficient problem-solvers. Computer programming as well as the software packages available today, is a tool to enhance learning and to allow students to make decisions. Arch, like Roblyer, concludes that further studies need to be done in this area.

To summarize, educators need to place more emphasis on word problem-solving skills in the classroom and less emphasis on computation since students' skills in the area of application tend to be weak or undeveloped. Computer instruction in the classroom has great potential however, more research needs to be conducted in this area.

CHAPTER THREE: DESIGN OF THE PROCEDURES

PURPOSE

The intent of this study was to compare student performance in solving word problems as a result of using two types of instruction. One group was taught by the traditional method: question-answer sessions, teacher lecture, chalkboard demonstrations, and practice with worksheets, while the other group's instructional method included: question-answer sessions, teacher lecture, practice with worksheets, as well as, visuals provided by a computer.

SETTING

The Middleburg High School community is predominantly white and middle class. Middleburg is a rapidly changing area. The change is from rural to surburban with large areas of each. In a 1982 survey of graduating seniors, 95% of them planned to continue some type of formal education after completing high-school. 15% of the population of high-school students qualify for free or reduced price lunches.

SUBJECTS

The study was conducted in two Consumer Mathematics classes and two General II Mathematics classes at Middleburg High School in Clay County, Florida during February, 1988. In the computer-instructed Consumer Mathematics group there were 8 white males, 1 hispanic and 14 white females. In the computer-instructed General II Mathematics class there were 13 white males and 11 white females. The traditionally instructed Consumer Mathematics class included 13 white males and 9 white females, while the General II Mathematics class had 10 white males and 11 white females. In all classes the students' mathematics backgrounds vary greatly. Some students have completed courses in General Mathematics, while others have had or are currently enrolled in Algebra classes. Both Consumer classes are similiar in their overall academic performance in mathematics as was the General classes.

MATERIALS

To determine the word problem solving achievement level of students at the beginning of instruction, the TASK, Stanford Test of Academic Skills, Form E, Level 1 Mathematics Test was administered as a pretest. To determine effects of the word problem solving unit the

TASK, Stanford Test of Academic Skills, Form E, Level 2 Mathematics Test was used as a posttest.

PROCEDURE

Pretesting. The pretesting of the students with the TASK was done in one class session to determine the achievement level and to acquire a raw score for each student.

A unit on word problem solving was taught in both Consumer Mathematics classes and both General II Mathematics classes. The classroom setting was the same for both classes with the exception that one Consumer class and one General II class was taught via computer instruction. The other factor that may influence the results was the time of day in which the classes met. The classes utilizing the computer instruction met early in the day, while the traditional method of instruction classes met the last two hours of the day. All classes were instructed 55 minutes per day, for 6 days.

The Polya mathematical method of instruction was utilized in all classes. Do you understand the problem? Do you know what the problem is asking? Draw a figure or chart. Do you know a related problem? Carry out your plan. Check your results. Work backwards if necessary.

The Apple computer attached to the liquid crystal display panel, LCD, projected the problem-solving programs. Three computer programs: The Microcomputer and Problem-Solving Project, Hayden's Quantitative Comparisons and Word Problems, and Peterson"s Math Skill Development Exercises were used in the lessons.

The other two classes were presented the identical word problems on the overhead projector and chalkboard.

Posttest. The posttest was administered using the TASK Mathematics Test, Form E, Level 2 in one class session to determine the effectiveness of the word problem solving unit. A raw score was assigned to each student as a way of scoring the test. The results of the pre and post test are compared and analyzed using the raw scores and derriving the mean, median and standard deviation.

CHAPTER FOUR: RESULTS

PURPOSE

The purpose of this project was to determine if a relationship exists between type of mathematical instruction and student performance. Would there be differences in student performance between students taught problem-solving skills with the aid of a computer and those taught by the traditional method of instruction?

SUBJECTS

Ninety students in grades 9 through 12 participated in this study. Forty-four males and forty-six females ages fifteen to twenty were involved in a six day word problem solving unit in their Consumer Mathematics or General II Mathematics class in February, 1988.

MATERIALS

The Stanford Test of Academic Skills, TASK, Form E, Level 1, Mathematics test was administered as a pretest to determine entrance level ability. To judge the effectiveness of this unit the TASK, Form E, Level 2, Mathematics Test was administered as a posttest.

Results

A comparison of the pre- and posttest scores of the TASK was done by using the raw scores and tallying the difference between the two tests. (Table 1).

Table 1

Student Number:	Consumer w/computer	Consumer w/out	General w/computer	General w/out
1	-6	-16	-9	-19
2	-17	-15	-7	-9
3	-12	-15	-5	-18
4	-16	0	-5	-13
5	-3	-12	-12	-11
6	-6	-7	-10	-14
7	-16	-23	-16	-11
8	-14	-11	-10	-13
9	-16	-3	-9	-13
10	-17	0	-1	-11
11	+4	-7	-8	-1
12	-8	-7	-10	-4
13	-9	-3	-9	-7
14	-3	-22	-18	-14
15	-10	-14	-5	-4
16	-3	-3	-14	-9
17	-14	-15	-3	-23
18	-8	+6	-10	-14
19	-17	+1	-8	-14
20	-7	-6	-9	-7
21	-8	-12	-3	-10
22	-6	-11	-23	
23	-7		-18	
24			-9	

Table 1 (continued)

	Consumer w/computer	Consumer w/out	General w/computer	General w/out
Number of Students	23	22	24	21
Mean	-9.52	-8.86	-9.63	-11.38
Median	-8.00	-9.00	-9.00	-11.00
StDeviation	5.67	7.52	5.21	5.20

In table 1, the first column refers to the number of students tested in a given class. These numbers were assigned to the students randomly. Columns two through four contain gain scores for students (pretest- posttest score). The posttest was much more difficult than the pretest which was reflected in the data and the differences.

DISCUSSION

The national mean for the pretest range from 30.8 to 35.1 depending on the grade level. The national mean score on the posttest range from 22.1 to 28.0 again depending on the grade level. National scores on these tests show a decrease from 7.1 to 8.7 on the posttest.

The mean results of the raw scores of these Middleburg High School classes are shown in table 2.

Table 2

	Pretest	Posttest	Change
Consumer without computer	34.1	25.1	-9
Consumer with computer	32.2	22.2	-10
General without computer	31.1	19.8	-11.3
General with computer	26.3	16.6	-9.7

The Consumer classes differed by only one point in favor of the traditonal instruction. The General II classes differed by 1.6 points in favor of the computer instruction. An analysis of variance procedure was used to analyze the results summarized in Tables 1 and 2. The results do not indicate a significant difference in the instructional method. In summary, although the Consumer class without the computer and the General class with computer did not drop as far as the Consumer class with the computer and the General class without the computer there was no significant difference.

CHAPTER FIVE: CONCLUSION

CONCLUSION

The problem-solving unit used two types of instruction, traditional instruction and computer aided instruction. The computer programs offered colorful diagrams and animated characters which the students enjoyed and which maintained their interest. The other groups were required to take a more active role as they were responsible for the drawings. Both groups developed a cooperative atmosphere. They were able to work as a group and achieve joint success. Students were never told they were wrong, rather they were pointed in another direction. This resulted in more participation than normal as students were encouraged to think, probe as well as guess. As there was no significant difference in the results of either group one could conclude that the teacher plays an important role in communicating and directing students in solving word problems.

DISCUSSION

The results on the National level as well as the results at Middleburg High School show a decline in scores from the pre- to the posttest. In comparing the results there appears to be no significant difference in the instructional methods. Several factors may have attributed to the overall drop in scores. First, senior skip day was the same day as the pretesting and many students missed a day of instruction while they were taking the test. Second, the first semester was over and many students throughout the week were having their schedules changed. Students were entering and leaving the classes daily and these disruptions distrubed the flow and structure of instruction. Third, some students felt that they were not receiving a grade so they were not fully interested in learning.

LIMITATIONS

Time was the most important factor in this study. The curriculum set by the state and county does not allow much time for enrichment activities.

The computer lessons were more time consuming than the traditional lessons due to the programs and demonstrations. This created a problem in planning the days activities so that both classes received equal instruction.

The computer and equipment had to be moved from room to room as the researcher was a floating teacher. This created problems not only because the equipment had to be moved and set up in time, but security of the equipment was also a factor.

SUGGESTIONS

Three recommendations are suggested for further studies.

First, the study should have been done on one day of the week for several weeks to keep the interest level high. For some students six intense days of problem-solving was too draining.

Second, each student should receive a copy of the word problems. In the computer lessons, once the program demonstrated helpful hints, the problem disappeared from the screen and students had to rely on memory for answering the question.

Finally, students need to be given a participation grade. When students are not being graded there tends to be a loss of interest.

APPENDIX A

CONSUMER MATHEMATICS CLASS TAUGHT WITH THE COMPUTER

STUDENT	GRADE	SEX	AGE	PRETEST	POSTTEST
1	9	F	16	16	11
2	10	F	17	32	15
3	10	F	16	35	23
4	10	F	17	37	21
5	10	M	16	18	15
6	11	F	16	41	35
7	11	F	17	42	26
8	11	F	18	22	08
9	11	F	16	40	24
10	11	F	17	34	17
11	11	F	17	29	33
12	11	F	17	30	22
13	11	M	17	32	23
14	11	F	17	31	28
15	12	M	18	34	24
16	12	F	18	21	18
17	12	M	17	38	24
18	12	F	18	41	33
19	12	M	17	35	18
20	12	F	18	30	23
21	12	M	19	34	26
22	12	M	18	24	18
23	12	M	18	44	37

CONSUMER MATHEMATICS CLASS TAUGHT WITHOUT THE COMPUTER

STUDENT	GRADE	SEX	AGE	PRETEST	POSTTEST
1	9	F	16	41	24
2	10	F	16	37	22
3	10	M	17	41	26
4	10	M	15	43	43
5	10	F	16	44	32
6	11	F	16	43	36
7	11	M	17	35	12
8	11	M	17	26	15
9	11	F	17	40	37
10	11	F	17	42	42
11	11	F	17	33	26
12	11	M	17	18	11
13	11	M	17	22	19
14	11	M	16	35	13
15	11	M	16	34	20
16	12	F	17	34	31
17	12	M	20	34	19
18	12	M	18	14	20
19	12	M	19	42	43
20	12	M	17	17	11
21	12	M	17	43	31
22	12	F	17	30	19

GENERAL MATHEMATICS II TAUGHT WITH THE COMPUTER

STUDENT	GRADE	SEX	AGE	PRETEST	POSTTEST
1	9	M	15	18	09
2	9	M	15	25	18
3	9	M	16	19	14
4	9	M	15	25	20
5	9	M	17	28	16
6	9	F	15	33	23
7	9	F	15	36	20
8	10	F	15	30	20
9	10	F	15	28	19
10	10	F	17	23	22
11	10	M	16	26	18
12	10	M	16	22	12
13	10	M	16	17	08
14	10	F	17	39	21
15	10	M	16	19	14
16	10	M	17	26	12
17	10	F	16	17	14
18	10	F	15	37	27
19	10	F	16	21	13
20	11	F	16	38	29
21	11	M	16	19	16
22	11	F	18	37	14
23	11	M	18	35	17
24	11	M	17	14	03

GENERAL II MATHEMATICS TAUGHT WITHOUT THE COMPUTER

STUDENT	GRADE	SEX	AGE	PRETEST	POSTTEST
1	9	F	15	30	11
2	9	F	16	38	29
3	9	M	15	39	21
4	9	F	15	39	26
5	9	F	17	23	12
6	9	F	15	33	19
7	9	F	15	35	24
8	9	F	15	29	16
9	10	M	17	46	33
10	10	M	16	36	25
11	10	F	16	24	23
12	10	M	15	18	14
13	10	M	15	24	17
14	10	F	16	35	21
15	10	F	16	25	21
16	10	M	15	22	13
17	10	M	16	31	08
18	10	M	15	40	26
19	10	F	15	37	23
20	11	M	18	28	21
21	11	M	18	23	13

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