THE MICROCOMPUTER MATHEMATICS PROGRAM: FACILITATING THE COUNSELOR'S CONSULTATIVE FUNCTION

A THESIS

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INTRODUCTION

In spite of a constant concern by both the public and private sector for improving mathematics education over the past few years, the tide of declining math ability has not been stemmed (Maffei, 1978). Educators continue to search for new ways to improve mathematics achievement scores. Computers entered the educational picture during the 60's, but their use was restricted for several reasons. The high cost of the first computer systems made them prohibitive to most educational institutions. There were also technical problems in keeping the computers functioning and in finding people trained to operate them.

With the continual progress being made in computer technology the medium is becoming less expensive, easier to operate, and more dependable. The microcomputer, small, portable, and self-contained, has been developed making it possible for more schools to utilize this relatively new teaching tool (Folk, 1978).

Today schools are using computers in their mathematics programs to present concepts, generate and score tests, keep records, provide individualized tutoring, drill students on new skills and help them practice these skills, diagnose learning problems, explore new concepts, learn algorithms, and provide motivation. Not only are computers being used to enhance mathematics teaching and learning, but their use is being carried out in a cost-effective manner (Bell, 1978).

Research conducted at Stanford University showed that students using computers for Computer Assisted Instruction (CAI) in mathematics gained a realistic attitude toward their mathematics ability. While giving the students a better self-evaluation of their abilities the computers were not dehumanizing and no across-the-board negative attitudes resulted from the program (Smith, 1973).

Taped programs for drill and practice of basic mathematics skills are being developed by many different groups. This study focused on one of those microcomputer cassette taped programs and its effectiveness with middle school students.

Statement of the Problem

This experimental research was designed to determine the effect of the Microcomputer Mathematics Program on the mathematics achievement scores of middle school students and to differentiate the effect on students with different beginning achievement levels. The Microcomputer Mathematics Program (MCMP) is a set of programmed tapes on basic computational skills for students in grades kindergarten through eight. This cassette tape program has been developed and copyrighted by the Dallas Independent School District for use on the TRS-80 microcomputer.

Statement of the Purpose

The MCMP is a new program and, in fact, is still in the developmental stage. Its use has been very limited and only informal research has been conducted. The only prior evaluation of the program has been observation of students using the tapes and informal interviews with these students. Research data was needed to determine the most effective use of the MCMP by math instructors throughout the district (Lester, Note 1).

This research tested the hypothesis that mathematics computational achievement scores of middle school students using the MCMP would show a greater increase than the scores of students whose math instruction was restricted to the traditional classroom setting regardless of beginning achievement levels of the students.

Significance of the Study

Counselors are constantly searching for methods and programs that are motivational and at the same time raise achievement scores. When a new teaching method is developed an evaluation of its effectiveness is essential.

The importance of planning, implementing, and evaluating computer use is vital to all educators (Microcomputers, 1979). Hopefully by enlisting the aid of the microcomputer for drill and practice exercises of the computational skills, the students will master this part of the mathematics curriculum. If the MCMP is shown to be a successful teaching tool in the computational skills area with this group of students, the possibility exists of expanding its use to more students and to other age groups to improve mathematics knowledge.

School counselors have as part of their responsibilities defining the needs of students and determining the best way to accomplish the defined objectives. Counselors are often consultants to administrators relative to curricular offerings to meet abilities, interests, and needs of pupils. This study can help counselors to fulfill their duty to provide appropriate placement for pupils with special abilities and disabilities (Administrative Regulations, 1975). If different results occurred among students because of different beginning achievement levels this research would be useful to counselors in deciding which students can benefit most from the program.

Limitations

1. Since the Microcomputer Mathematics Program is designed for students through the eighth grade, the 17 students in the sample who were working on or above eighth-grade level found little or nothing in the program that they had not previously mastered.

2. The microcomputers and the programmed tapes were received by the school about 10 school days before the research project began making it impossible for the teachers to become thoroughly familiar with the program. Perhaps after the teachers are more experienced with the medium the students will benefit more from its use.

3. The students in the control group who were left in the classroom may have received more than ordinary attention from the teacher because of the smaller class size resulting from the absence of those in the treatment group.

4. Some of the students were familiar with the typewriter keyboard, while most of them were not. Becoming acquainted with the keyborad is necessary for maximum use of the computers. Typing is taught to all eighth graders in this middle school for one quarter. No seventh grade students are enrolled in typing. No attempt was made to determine which students had completed one quarter of typing before entering the computer program.

5. The research fails to take into account the motivation resulting from the newness and novelty of the microcomputers. It also doesn't consider differences in maturity or age of the subjects. The program is strictly visual and no consideration was given to a student's ability or inability to learn visually.

6. Although a stratified random sampling was used to select the subjects, scheduling in the school made it necessary to adjust sampling to accomodate 14 students during a class period. The 10 minute period for work on the microcomputers had to be taken from the subjects' regularly scheduled math class.

The Microcomputer Mathematics Program

The computers used for this research were TRS-80, Level II, microcomputers. The unit consists of a video display screen, a typewriter keyboard, and a cassette player. The lesson is loaded from the tape through the cassette player.

The Microcomputer Mathematics Program developed by Dallas Independent School District consists of 24 tapes containing 450 different lessons. Since the numbers are randomly generated, if a student needs to repeat a lesson the actual exercises encountered will differ while the skill level remains the same. The 10 strands in the program are horizontal addition, vertical addition, horizontal subtraction, vertical subtraction, multiplication, horizontal math, fractions, decimals, and numeration. Two digit numbers are used to identify the lessons, the first digit indicating the grade in which the skill is generally mastered. The program has been correlated with the Dallas Independent School District Baseline Curriculum and with all state adopted textbooks.

Computational skills are presented with a steady increase in difficulty to keep students challenged yet working at their own pace. A student receives immediate, private correction, assistance and review as needed, and positive reinforcement.

To complete the program, a sequence has been developed to lead the teacher to lessons needed as prerequisites and parallels for a particular skill. A printed form for keeping each individual student's daily record comes with the program.

CHAPTER II

REVIEW OF LITERATURE

Mathematics Achievement

Recent History

According to a recent Gallup (1979) poll to determine public opinion about subjects taught in public school, mathematics topped the list of essential subjects included in the public school curriculum. Of the people polled 97% rated mathematics essential. English grammar and composition followed, being considered essential by 94% of the people questioned. The question asked was "Public schools can teach many different things. Will you tell me in the case of each of these high school subjects, whether you regard it as essential for all students or not too essential?" (p. 40). Of the 3% that did not classify mathematics as essential, 1% said math is not too essential and 2% gave no answer.

Even though the importance of learning math is acknowledged, student achievement in the subject continues to decline. In a study conducted by the National Assessment of Educational Progress and reported in the Chronicle of Higher Education (Math Achievement Down, 1979) the mathematical achievement scores of 17-year-olds were 4% lower in 1978 than in 1973, and the scores of 13-year-olds had dropped 2% for the same period. The conclusion drawn from the test scores was that many students have difficulty solving everyday problems in mathematics and that their ability to do so is declining.

Results on the Comprehensive Test of Basic Skills given to students in an eighth-grade class, midway through the year before entering high school, showed 64% scoring below grade level in computation. Many could not perform the simplest problems with whole numbers and certainly not with fractions (Doggett, 1978). An analysis of the scores showed the students lacked accuracy in solving subtraction and addition problems; they did not know multiplication facts, nor could they solve multiplication and division problems; the use of fractions and decimals was beyond them.

When asked the reason for the decline in math ability, junior high school math teachers mentioned motivational problems with students, the new math and its lack of emphasis on basic computational skills, and the move toward individualization and the teacher's difficulty in making the transition to individualization (Hendrickson & Virant, 1978; Maffei, 1978; Newport, 1979). Secondary school teachers should not assume that students learned their computational skills in the lower grades, nor should they give up on a student's ability to learn such skills. One suggestion by

Doggett for attacking the problem was to give math drill and repetition in a variety of ways to keep up the interest of the students. Teachers expressed a need for innovations such as computers and other ways to individualize instruction as a means of improving motivation.

Predictors

Sex. Sex of students did not prove to be a significant predictor of general academic achievement among eighth graders in a study by Merrifield and Hummel-Rossi (1977). Mathematics achievement studies, however, reveal a different result. Males tend to out-achieve females in math, but attitude toward math is the only reason researchers can find for the difference. Male and female differences in attitudes toward math began as early as third grade and both sexes consider math a male subject. Student attitudes are due to cultural influences rather than intellectual ability (Boswell, 1979; Keys & Ormerod, 1977). Math achievement scores are affected by stereotyping at an early age, and by the time students reach high school female students avoid sciences because of perceived, rather than actual, subject difficulty.

Fennama and Sherman (1977) collected data that did not support either expectations that males are superior in math achievement or the idea that the differences between the sexes increase with age and/or mathematics difficulty. They concluded that socio-cultural factors have the greatest influence on patterns of differences in math achievement.

Race. In a search for a reason for Black students scoring lower on measures of academic achievement than Whites, Ruhland and Feld (1977) studied a group of elementary school children to see if there were racial differences in achievement motivation. Motivational differences have been blamed on cultural deprivation and educational deprivation. Cultural deprivation is the lack of home background; educational deprivation is the lower expectations of teachers and failure of the school to set standards of excellence. Ruhland and Felt tested for race differences in autonomous achievement motivation and social comparison achievement. They defined autonomous achievement as comparison between one's own performances which would be developed in a very young child before he or she enters the school educational setting. Low autonomous achievement motivation would then be associated with cultural deprivation. Social comparison achievement results from comparing oneself with the others and would be associated with educational deprivation. This study showed no significant difference in the autonomous achievement motivation of the races, but the social comparison achievement motivation was lower for

Blacks than Whites. The difference resulted between White and Black girls, with White females showing a strong approach motivation and Black girls showing a low approach motivation.

A project that acknowledged the differences for Black and White children on academic achievement, but delved into other variables including sex, social class, and grade in school, was reported by Touliatos, Lindhom, and Rich (1977). They found that Blacks did not do as well as Whites, although all scores increased progressively from the 3rd to the 6th grade, scores for Black children did not increase as rapidly as those for White children. Differences showed girls higher than boys and Whites higher than Blacks on overall scores. When the test was further analyzed the differences were found to be in language and reading but not in mathematics.

Perney, Hyde, and Machock (1977) in a study of Black intelligence found that "conclusions that Blacks perform dramatically different from Whites on tests of intelligence is premature" (p. 455). Their research findings on the intelligence of first graders in the predominantly Black, low socioeconomic area of East Cleveland showed the East Cleveland first graders' I.Q. scores were by no means inferior to, but were at least equal to the I.Q.'s obtained in the test's normative population.

Mathematics is acknowledged as a skill of importance for everyday living. Yet in the recent past students' ability to compute has been on a gradual decline. Different reasons have been cited for this decline, but the concern remains for a reversal of the trend. A search for ways to bring about the reversal gains momentum. Modern technologists and educators are developing teaching methods using the computer hoping to improve mathematics skills in a nonsexist, nonracist format.

Middle School Students

The middle years should be considered as crucial for establishing a student's attitude toward learning. From ages 12 to 14 students want to be actively involved and at the same time they want to become increasingly more independent. The student at this age must be challenged with new and interesting materials. It is imperative that middle school curricula focus on the individual and provide for the unique characteristics of this segment of the public school population. The growth spurts of this group are uneven in any one individual and vary greatly from individual to individual. Probably at no other time in the educational system is there such a tremendous range of social, physical, and intellectual development (Alexander, 1969; Stelle & Wallace, 1979).

Middle school students are vigorous, inquisitive individuals who need opportunities for trial and error in situations where mistakes are admittable. The middle school places emphasis on individual learners at an age when they are sometimes awkward and uncertain, sometimes facile and adept (Grooms, 1967).

DeVita, Pumerantz, and Wicklow (1970) stated that "individualization may be the very quintessence of our educational system. No longer may the tools of education be enumerated in a simple manner. Now a variety of tools is at hand: television, overhead projectors, teaching machines and computerized possibilities are a reality" (p. 31).

The computer may be one answer for meeting the various needs of middle school students. Computer programs present materials in a new and interesting way, allowing the student to progress from his or her own starting point at a pace compatible to the individual. The element of embarrassment of sensitive middle school students is minimized making the challenge of exploration and discovery possible for the student.

Computer Assisted Instruction

Suppes and Jerman (1970) listed as the most prominent educational requirements that "make CAI inevitable (a) current emphasis on individualizing instruction, (b) the increasing amount of new information to be learned, (c) the shortage of qualified teachers, (d) the growing need for periodic upgrading of one's education throughout life" (p. 27). Computer assisted instruction does not allow students to practice their mistakes but provides immediate reinforcement and correction as the student works through a lesson. Remedial work can be made much more attractive and efficient in a CAI context.

Instant feedback and positive reinforcement proved to produce large achievement gains in a study by Brown and Epstein (1977). Students in seventh and eighth grade mathematics classes were given 5-minute drills during each class period for five days. Large gains were made by low achievers in the group that received positive feedback for correct problems. Since a computer program gives instant positive feedback it might be expected to be most effective with the underachiever. The performance of high achievers in the positive feedback group was no better than high achievers in the no feedback condition.

A comparison of alternative instructional media was made by Jamison, Suppes, and Wells (1974). The media studied were traditional classroom instruction, instructional radio, instructional television, programmed instruction, and computer assisted instruction. Results showed that intensive drill by the teacher can be as effective as the computer, but the computer takes less time and does not require extra effort from the teacher. Their findings included the observation that "CAI drill and practice is more effective with students who start below grade level" (p. 43). Lysiak (1976) also found that low scorers on a pretest made greater gains in a CAI program while high ability students performed better in a regular math situation.

An effective CAI program supplements and complements traditional instruction rather than replacing it (Magidson, 1978). The positive evaluations received throughout the country by drill and practice programs in elementary reading and math need to be kept in proper perspective. The computer cannot replace the teacher, but is a powerful extension of the teacher. It is a valuable resource that should be integrated into the regular flow of instruction rather than be considered as a separate entity (Grimes, 1977). Von Feldt (1977), however, found that CAI can be cost effective as a replacement for traditional education with college level students as well as a supplement to regular instruction for elementary students. These cost effective studies were made on regular computer terminals and do not reflect the current impact of low cost minicomputer and microcomputer technology.

Computers have been studied not only for achievement gains but for other areas of interest to educators (Brod, 1972; Fisher, Blackwell, Garcia, & Greene, 1975; Ghose, 1978; Sutter & Reid, 1969). Brod investigated student attitudes toward the computer and concluded that the computer actually replaced the teacher as an authority figure for some junior high school students. Ghose was interested in some critics' claims that computers reduce the learning process to mechanical and stereotype drill. He claimed that CAI can provide a constructive and creative approach to learning with the possibility of leading to more precise communication between learner and teacher.

The effects of allowing students to select their own problems from a CAI math program was the focus of research by Fisher et al. Their treatment group was allowed to select their work and determine the level of difficulty and how long they would stay with the task each day. The control group did not have a choice but followed the same patterns as their match. The control group actually showed greater achievement gains. The implications of this research are unclear but may suggest that the control group was more interested in what choice to make than in solving the arithmetic problems.

Sutter and Reid (1969) were concerned with the lack of interpersonal contact in learning from computers. The results showed that students with high sociability performed better when paired with another student on the computer, but students with low sociability achieved better working alone at the terminal. Sutter and Reid concluded that "CAI programming to allow for individual differences may indeed produce both greater learning and improved attitude toward learning for each individual student" (p. 157).

In a project that focused on CAI reading (Atkinson, 1968) there was no difference in rate of progress between boys and girls. These results are surprising because common findings are that girls generally acquire reading skills more rapidly than boys. Atkinson concluded that the results "suggest that in a CAI environment the sex difference is minimized in proportion to the emphasis on analysis rather than rote memorization in the learning task" (p. 236).

The answer to the question of whether Computer Assisted Instruction is effective was sought by Edwards, Norton, Taylor, Van Dusseldorp, and Weiss (1974). They found that most studies showed increased achievement results when CAI was used as a supplement to traditional instruction and that drill and practice is the most consistently effective mode of CAI. CAI was found to be more effective for low ability students than for middle or upper ability students.

CAI is popular with both students and teachers and seems to be cost effective. The effectiveness of any CAI program depends upon the quality and reliability of its components (Magidson, 1978). It is time to turn the focus to evaluation of specific curricula (Von Feldt, 1977).

As the cost of computers goes down and efficiency and availability go up, more and more schools are employing computers in hopes of making educational gains. A great deal of research has been done in an attempt to evaluate CAI. Research generally has confirmed that students who have lacked success in the regular classroom seem to benefit the most from this new approach to education (Edwards et al., 1974).

Advantages of the use of the computer in the classroom include instant feedback and positive reinforcement, time saving for both the student and the teacher, and the presentation of material in a consistent nonprejudicial mode. Drill and practice exercises as a follow-up to classroom instruction have produced favorable results. The computer has been most successful in the school as a supplement to the teacher rather than a replacement for the teacher.

Summary

Math achievement scores are declining and a continuous search is on to find ways to reverse the trend. Some possibilities for improving math scores are individualization to enable the student to work at his or her own pace, new and interesting ways of presenting material to improve motivation, instant feedback and positive reinforcement to provide encouragement particularly to the under achiever. Research has shown that CAI can help many of these things become a reality.

The early teens are years of special concern because of the varied stages of development in individuals and because of the importance of these years in forming educational attitudes and setting goals. CAI may help to meet needs on an individual basis, and keep students interested in education.

The microcomputer has not been the subject of research and differs from the computer programs researched in some ways. Because of the self-containment of the micro the wide range of programs available by terminal is not readily assessible. The small machines have the advantage of being portable and can be plugged into any electrical outlet in any classroom.

The program used in this report was the Microcomputer Mathematics Program, a cassette taped program for drill and practice of the basic computational skills. The purpose of the project was to find the effect of this CAI program (MCMP) on the achievement scores of middle school age students.

CHAPTER III

RESEARCH DESIGN

Subjects

The subjects of this research were students currently enrolled in the seventh and eighth grades of a large city middle school with an enrollment of about 950. The neighborhood has a middle to low socioeconomic status with additional Black students bussed from the inner city under a court ordered integration plan. The community has some natural integration, and the school population is about 48% Black, 45% White, and 7% Brown.

A stratified random sampling was used to select 80 students to be members of the treatment group. Two of these were dropped because of withdrawal from school, eight were left out of the research because of inability to find a match in the control group, and seven were absent when the posttest was given, resulting in 63 pairs of subjects completing the project. Although particular attention was not given to race and sex, the treatment group chosen by random sampling resulted in approximately the same number of males and females, 32 girls and 31 boys. The racial distribution was also balanced and reflective of the total school population with 30 Whites, 27 Blacks, and 6 Mexican-Americans.

Instrument

The computational skills section of the Iowa Test of Basic Skills (ITBS) was used as the pretest-posttest instrument. This strictly computational section was added to the ITBS in 1979, and the students had not seen it before the pretest date. Since the Microcomputer Mathematics Program (MCMP) is a drill and practice program on the computational skills the test was valid as to content.

Levels 12, 13, and 14 of Form 8 were used. These three levels of the ITBS computation section all have Kuder-Richardson Formula 29 reliability coefficients of .88.

Procedure

A total of 843 students were in attendance on a particular day and were administered the test instrument with strict controls on administration and timing. The tests were graded and divided into three groups according to pretest scores. The divisions were A (students whose grade equivalent was two or more years below grade placement), group B (from two years below to grade level) and group C (grade level or above). More specifically, seventh graders in group A scored below 5.5, group B from 5.5 through 7.4, and group C from 7.5 up. Eighth grade students in group A scored below 6.5, group B from 6.5 through 8.4, and group C from 8.5 up.

Level 12 of the ITBS (sixth grade) was administered to all students who were considered by previous evaluations to be in group A, Level 13 (seventh grade) was given to seventh graders in groups B and C, and Level 14 (eighth grade) to eighth graders in groups B and C. In the stratified random sample the number of students selected for each stratum reflected the percentage of the total school population which fell in that achievement group. For instance, since 38% of the total population fell in group A, 38% of the treatment group was from group A. The treatment group consisted of 27 students in group A, 25 students in group B, and 18 students in group C.

A control group was selected by matching each student with a student who receives regular classroom instruction from the same teacher. The groups were matched by pretest scores, grade level, sex and race.

Members of the treatment group were told that they had been selected by chance to be the first to use the microcomputers. They were brought to the math lab from their regularly scheduled math class for 10 minutes each day for a period of eight weeks. At the end of the eight week period the same instrument used for the pretest was administered as a posttest to the 126 students in both the treatment and control groups.

Hypotheses

A null hypothesis that the achievement scores between the experimental and control groups will not vary significantly is based on the fact that all students have spent the same amount of time on mathematics. All groups are expected to gain two months achievement from two months time spent on the task regardless of the type of instruction received or beginning achievement level. Therefore the following null hypotheses were tested:

1. There is no statistically significant difference in mathematics computational skills of low-level functioning students (group A) in a microcomputer mathematics program compared to students in a traditional mathematics program.

2. There is no statistically significant difference in mathematics computational skills of moderate-level functioning students (group B) in a microcomputer mathematics program compared to students in a traditional mathematics program.

3. There is no statistically significant difference in mathematics computational skills of high-level functioning students (group C) in a microcomputer mathematics program compared to students in a traditional mathematics program.

4. There is no statistically significant difference in mathematics computational skills of all the students in a microcomputer mathematics program (Group D) compared to students in a traditional mathematics program.

Research Design

This is a pretest-posttest control group design with four levels in each experimental condition:

	Ex	Cn
Pre	A-B-C-D	A-B-C-D
Post	A-B-C-D	A-B-C-D

A stratified random sampling was used to select subjects for the experimental group; the control group was established by matching on the pretest variable.

Statistics

Statistics were analyzed using a series of *t*-tests for independent means and a series of Wilcoxon matched-pairs signed-ranks tests. Both parametric and nonparametric procedures were used because of the irregular distribution of scores.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The effect of the Microcomputer Mathematics Program on the mathematics achievement scores of middle school students was sought with this research project. The purpose was to determine whether achievement scores would be affected and to distinguish differences on students with different beginning achievement levels. This research was designed to evaluate the use of the microcomputer in teaching mathematics and to help in planning its future use with different groups of students.

A stratified random sampling of the total school population placed 80 students in the treatment group to receive 10 minutes a day on the microcomputer for a period of eight weeks. They reported to the math lab for the first or last 10 minutes of their math class. The subjects included Blacks, Whites, and Mexican-Americans from low, moderate, and high achievement levels. A matched control group was selected from students who remained in the traditional classroom for the entire math period. The groups were matched not only on beginning achievement level and teacher, but also on race and sex.

The number of students who were selected, matched, completed the eight weeks, and took the posttest included 63 pairs for a total of 126 students. The average gain scores are given in grade equivalents in Table 1 (p. 29). Every group showed at least the two months expected gain with the experimental group in every case gaining more than the control group.

Grade equivalent scores were used for the statistical analysis because different levels of the ITBS were administered. Since more than one level of test was given in each achievement group the raw score values had different grade equivalent conversions.

The Wilcoxon matched pairs signed-ranks test was used to test the hypotheses. Table 2 (p. 30) shows the result of the Wilcoxon test for group A. The first null hypothesis stated that there is no statistically significant difference in mathematics computational skills of low-level functioning students (group A) in a microcomputer mathematics program compared to students in a traditional mathematics program. On the basis of these findings the null hypothesis cannot be rejected. A total _T_ for 17 subjects is statistically significant at 35 or less.

Null hypothesis 2 stated that there is no statistically significant difference in mathematics computational skills of moderate-level functioning students (group B) in a

Table 1

Mean Gain Scores In Grade Level Equivalents

Group	Treatment Condition	*N*	Pretest	Posttest	Differences
A	Experimental	23	4.7	5.4	.7
	Control	23	4.8	5.2	.4
B	Experimental	23	6.7	7.1	.4
	Control	23	6.7	6.9	.2
C	Experimental	17	8.9	9.5	.6
	Control	17	8.9	9.3	.4
D	Experimental	63	6.6	7.1	.5
	Control	63	6.6	6.9	.3

Table 2

Grade Equivalent Gains for Treatment and Control Groups
Of Low-Level Functioning Students (Group A)

Pair	Treatment	Control	d	Rank	Rank with less frequent sign
1	0	3	-3	-2.5	2.5
2	4	10	-6	-9	9
3	15	8	7	11.5	
4	6	3	3	2.5	
5	12	0	12	14	
6	18	-2	20	17.5	
7	13	13	0		
8	4	-3	7	11.5	
9	-5	0	-5	-6.5	6.5
10	9	3	6	9	
11	11	-3	14	15	
12	3	5	-2	-1	1
13	0	0	0		
14	24	20	4	4.5	
15	7	7	0		
16	8	26	18	-16	16
17	-8	0			
18	11	-9	20	17.5	
19	-2	8	6	9	
20	7	2	5	6.5	
21	4	8	-4	-4.5	4.5
22	8	17	-9	-13	13
23	8	8	0		

T = 52.5 (n.s.)

microcomputer mathematics program compared to students in a traditional mathematics program. Tabel 3 (p. 32) shows that the null hypothesis cannot be rejected.

The third null hypothesis stated that there is no statistically significant difference in mathematics computational skills of high-level functioning students (group C) in a microcomputer mathematics program compared to students in a traditional mathematics program. The Wilcoxon $\underline{T}$ in Table 4 (p. 33) shows no significant difference between treatment and control and the third null hypothesis cannot be rejected.

When the subjects are not divided into groups but are combined into one group the results are shown in Table 5 (p. 34-5). Null hypothesis 4 states that there is no statistically significant difference in mathematics computational skills of all the students in a microcomputer mathematics program (group D) compared to students in a traditional mathematics program. This null hypothesis is rejected because a statistical significance of $p < .028$ was obtained. The value of $\underline{T}$ is 563 as shown in Table 5 and N is 56 after dropping ties. Since $N > 25$ and the table shows significance of $\underline{T}$ through $n = 25$, the formula for converting $\underline{T}$ to $\underline{z}$ was used (Siegel, 1956, p. 179).

Table 3

Grade Equivalent Gains for Treatment and Control Groups Of Moderate-Level Functioning Students (Group B)

Pair	Treatment	Control	*d*	Rank	Rank with less frequent sign
1	-2	4	-6	-8.5	
2	12	-20	32	19	19
3	-2	-2	0		
4	-3	-4	1	1.5	1.5
5	2	16	-14	-16	
6	5	-7	12	15	15
7	-7	2	-9	-11	
8	10	6	4	5.5	5.5
9	-22	13	-35	-21	
10	14	-11	25	18	18
11	-1	0	-1	-1.5	
12	-2	0	-2	-3	
13	6	12	-6	-8.5	
14	7	-4	11	13.5	13.5
15	23	-10	33	20	20
16	22	6	16	17	17
17	19	10	9	11	11
18	4	7	-3	-4	
19	11	20	-9	-11	
20	-2	2	-4	-5.5	
21	5	5	0		
22	4	-7	11	13.5	13.5
23	-5	0	-5	-7	

T = 134 (n.s.)

Table 4

Grade Equivalent Gains for Treatment and Control Groups
Of High-Level Functioning Students (Group C)

Pair	Treatment	Control	*d*	Rank	Rank with less frequent sign
1	1	22	-21	-16	16
2	10	11	-1	-1.5	1.5
3	-1	6	-7	-9	9
4	4	1	3	4.5	
5	9	-2	11	13	
6	11	4	7	9	
7	5	0	5	6.5	
8	7	-5	12	14	
9	10	7	3	4.5	
10	8	13	-5	-6.5	6.5
11	13	6	7	9	
12	9	-8	17	15	
13	6	7	-1	-1.5	1.5
14	1	-1	2	3	
15	14	-9	23	17	
16	-1	7	-8	-11	11
17	13	4	9	12	

T = 45.5 (n.s.)

Table 5

Grade Equivalent Gains for Treatment and Control Groups Of All the Subjects (Group D)

Pair	Treatment	Control	d	Rank	Rank with less frequent sign
1	0	3	-3	-10	10
2	4	10	-6	-24	24
3	15	8	7	29	
4	6	3	3	10	
5	12	0	12	42	
6	18	-2	20	49.5	
7	13	13	0		
8	4	-3	7	29	
9	-5	0	-5	-19	19
10	9	3	6	24	
11	11	-3	14	44.5	
12	3	5	-2	-6	6
13	0	0	0		
14	24	20	4	14.5	
15	7	7	0		
16	8	26	-18	-48	48
17	-8	-8	0		
18	11	-9	20	49.5	
19	-2	-8	6	24	
20	7	2	5	19	
21	4	8	-4	-14.5	14.5
22	8	17	-9	-35	35
23	8	8	0		
24	-2	4	-6	-24	24
25	12	-20	32	54	
26	-2	-2	0		
27	-3	-4	1	2.5	
28	2	16	-14	-44.5	44.5
29	5	-7	12	42	
30	-7	2	-9	-35	35
31	10	6	4	14.5	
32	-22	13	-35	-56	56
33	14	-11	25	53	
34	-1	0	-1	-2.5	2.5
35	-2	0	-2	-6	6

Table 5 (Continued)

Grade Equivalent Gains for Treatment and Control Groups
Of All the Subjects (Group D)

Pair	Treatment	Control	*d*	Rank	Rank with less frequent sign
36	6	12	-6	-24	24
37	7	-4	11	39	
38	23	-10	33	55	
39	22	6	16	46	
40	19	10	9	35	
41	4	7	-3	-10	10
42	11	20	-9	-35	35
43	-2	2	-4	-14.5	14.5
44	5	5	0		
45	4	-7	11	39	
46	-5	0	-5	-19	19
47	1	22	-21	-51	51
48	10	11	-1	-2.5	2.5
49	13	4	9	35	
50	-1	6	-7	-29	29
51	4	1	3	10	
52	9	-2	11	39	
53	11	4	7	29	
54	5	0	5	19	
55	7	-5	12	43	
56	10	7	3	10	
57	8	13	-5	-19	19
58	13	6	7	29	
59	9	-8	17	47	
60	6	7	-1	-2.5	2.5
61	1	-1	2	6	
62	14	-9	23	52	
63	-1	7	-8	-32	32

$T = 563$; $z = 1.91$; $p = .028$

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

This experimental research was undertaken to evaluate the use of the Microcomputer Mathematics Program as a tool for raising the mathematical computational skills of middle school students. The subjects were seventh and eighth grade students enrolled in a large city middle school that is integrated by court ordered bussing. The population comes from moderate to low income families and the racial mixture of Blacks and Whites is about equal. A few Mexican-Americans are included in the enrollment.

The subjects in the treatment group were selected by stratified random sampling. The stratification was based on beginning achievement level determined by pretest scores on the computational skills section of the ITBS. The control group was selected by matching students of the same sex, race, beginning achievement level, and teacher with the experimental group. Matched pairs of 63 students completed the project.

The students in the treatment group used the microcomputers for 10 minutes a day for a period of eight weeks for drill on the computational skills. This 10 minute period was taken from their regularly scheduled mathematics class period each day. The members of the control group remained in the classroom while the members of the treatment group reported to the mathematics lab to use the microcomputers.

The null hypotheses tested by this research included three null hypotheses based on the strata divisions and a fourth including all the pairs of subjects combined.

Null hypothesis 1. There is no statistically significant difference in mathematics computational skills of low-level functioning students (group A) in a microcomputer mathematics program compared to students in a traditional mathematics program. This null hypothesis was not rejected.

Null hypothesis 2. There is no statistically significant difference in mathematics computational skills of moderate-level functioning students (group B) in a microcomputer mathematics program compared to students in a traditional mathematics program. This null hypothesis was not rejected.

Null hypothesis 3. There is no statistically significant difference in mathematics computational skills of high-level functioning students (group C) in a microcomputer mathematics program compared to students in a traditional mathematics program. This null hypothesis was not rejected.

Null hypothesis 4. There is no statistically significant difference in mathematics computational skills of all the students in a microcomputer mathematics program (group D) compared to students in a traditional mathematics program. This null hypothesis was rejected.

Discussion

The original hypothesis stated that mathematics computational achievement scores of middle school students using the Microcomputer Mathematics Program would show a greater increase than the scores of students whose math instruction was restricted to the traditional classroom setting regardless of beginning achievement levels of the students. The Wilcoxon test on the scores of all the groups combined supports this hypothesis.

Although the mean scores showed much greater gains for the treatment group than for the control group in each case these gains did not appear to be statistically significant using parametric analyzation methods. Graphs of the data resulting from this research showed a wide range of differences in the scores and some non-normal curves. For this reason and because of the necessity of using grade equivalent rather than raw scores an analyzation was made using nonparametric statistical methods.

A statistically significant difference was found when the total treatment group was compared to the total control group. When the groups were analyzed separately the level of statistical significance was not reached probably because of the size of the sample and the wide range of differences in the gains.

The mean gain scores of all students regardless of treatment condition or beginning level rose the expected two months for two months spent on the task. However, all but one of the groups exceeded the two months gain. Considering that the majority of these students are functioning below grade level the gains for all groups of students were above their usual performance. The low-level functioning group showed the highest mean gain of seven months in the two month period.

Conclusions and Implications

The microcomputer like so many tools used in education seems to have a different effect on different students. This study divided the students by beginning achievement level to see if previous academic gains would be a factor in the gains made in this program. The variation in the gains was large regardless of the students' beginning levels. Although statistical significance was found when the total treatment group was compared to the total control group, that difference could not be assigned to a beginning achievement level.

Mathematics drill and practice on the microcomputer seems to be an efficient way to help students sharpen math skills. The immediate evaluation of the student's work in the form of instant correction of mistakes, positive reinforcement of correct answers, and a grade at the end of the assigned time is a time saver for both students and teacher. Although some of the students felt that the computer "talked" to them through the written messages, at least one student was disturbed by the quietness of the machines. The strictly visual presentation of material could prove to be a handicap for some students.

The length of time spent on the computer, both in number of days and number of minutes per day, was necessarily short because of the limited number of computers available and the limited amount of time that students could be taken from their regular mathematics class. If time spent on the computer could be set up as additional mathematics practice time instead of time taken from regular instruction, gains might be further positively affected. The regular daily instruction was interrupted to send the students to use the microcomputer at their allotted time.

All students seemed to enjoy using the microcomputers. The attention given to the display screen even by the slowest students indicated an interest and concentration that is often hard to get with middle school students. Several students who had not learned their multiplication facts were motivated to study them when a lesson could not be mastered without instant recall of those facts.

The results of this study can be helpful to counselors because it shows that teaching by computer can benefit some students. The search continues for a more definitive group of students to be assigned to computer learning, although the mean gains indicate that the low-level functioning students are the group best served by MCMP. In assigning students to this program as in any educational program counselors and teachers should endeavor to meet the needs of individual students.

Further Research

Suggestions for further research resulting from this project follow.

1. A research project of the same framework but continuing for longer than the eight week period is needed. The eight week period included two holidays, days of district-wide testing, quarter final exams, and the usual student absences. The average number of days spent on the computers by the subjects was 27 with a range of from 9 to 35 days in attendance.

2. More research is needed on the 10 minute a day time frame. Students at the middle school age might benefit more with a longer time period spent on the task. Some students showed disappointment by the shortness of the time period.

3. A comparison of students' abilities to learn visually with their progress made on a microcomputer could help educators determine which students should use this medium.

4. Research is needed to determine how middle school students' attitudes and motivation toward math are affected by microcomputers.

5. The use of the MCMP as additional math instruction instead of the time being taken from the students' traditional classroom time should be evaluated.

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