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ABSTRACT

Two parallel studies were conducted to determine whether students' achievement in reading and/or mathematics would be affected by the use of Education Systems Corporation (ESC) Software for Chapter 1 students. Students in the experimental groups used the software twice a week during a period of one school year, with 561 Chapter 1 students in grades 2 through 6 taking part in the reading study, and 420 students in grades 4 through 6 participating in the mathematics study. Approximately one-half of the students included in the reading study also participated in the mathematics study. The Metropolitan Achievement Test (MAT) Mathematics and Reading Surveys were administered using a pretest posttest design to determine any differences between the control group and the experimental group in each study. An analysis of the MAT Reading Survey and MAT Mathematics Survey results showed statistically significant positive gains for the Chapter 1 students who worked with the ESC software, and that these gains were significantly greater than those of students in the control group. (12 references) (GL)

EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON READING AND MATHEMATICS ACHIEVEMENT OF CHAPTER 1 STUDENTS

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INTRODUCTION

This report is the second study evaluating the effectiveness of the Fayette County Public Schools elementary computer laboratories. The first study, Teacher Assessment of Elementary Schools' Computer Laboratories, was submitted to the Board of Education in September, 1988.

Fayette County Public Schools, Lexington, Kentucky, is a school district made up of 47 schools with approximately 31,000 students. The district's 32 elementary schools (K-6) with approximately 18,000 students, are involved in the district-wide computer instruction plan. This plan, begun in the 1984-85 school year, had three major goals:

1. Select quality computer software which includes an instructional management system. This software should offer instruction on higher-order thinking skills, not just drill and practice.

2. Purchase the number of computers per elementary school that equals the state mandated maximum class size (currently 29).

3. Minimize the teacher's burden, but insure the teacher's instructional responsibility (Computer Instruction Committee, 1985).

Beginning in the fall of 1986, four different pilot computer laboratories were established. From the experiences of the pilot sites, the Computer Instruction Committee, composed of teachers, principals, coordinators, and parents, recommended a comprehensive computer-assisted instruction program in a network laboratory setting to provide:

1. Individualized instruction in a consistent manner and of consistent quality.

2. Equal learning opportunities across the schools, grades, classrooms, and abilities.

3. Technology without negatively affecting an already overburdened teaching staff.

4. Comprehensive instruction that complements everyday classroom instruction.

5. Possible assistance and solutions to other district priority issues such as summer school, after-school and evening programs, as well as supplemental instruction (Computer Instruction Committee Report, 1987).

Currently, 23 Fayette County elementary schools have computer laboratories, using the Education Systems Corporation (ESC) system. The remaining nine labs will be installed prior to the opening of the 1989-90 school year. Each laboratory has a 40-megabyte host computer and CD-ROM disk with 29 student computer stations. A system attendant employed by ESC operates the laboratory. Each student is scheduled for a 20-minute mathematics and a 20-minute reading lesson per week on the computers. The classroom teacher brings the students to the laboratory and stays with them during the lesson, assisting students and monitoring their progress.

Funding for the computer laboratories primarily has been from increased revenues resulting from a payroll tax, approved by the Fayette County Public Schools Board of Education in 1986.

PURPOSE

The purpose of this study was to determine the achievement effects of computer-assisted instruction on elementary students classified as Chapter 1. Specifically, this research sought to determine if students' achievement in reading and/or mathematics is affected by the use of Education Systems Corporation (ESC) software for Chapter 1 students (grades 2 through 6 for

reading and grades 4 through 6 for mathematics) during a one school year time period.

Two null hypotheses were tested in the study:

1. No statistically significant differences exist in standardized reading gains between Chapter 1 elementary students who utilize ESC reading software during the school year (experimental group) and Chapter 1 elementary students who do not utilize ESC reading software (control group).

2. No statistically significant differences exist in standardized mathematics gains between Chapter 1 elementary students who utilize ESC mathematics software during the school year (experimental group) and Chapter 1 elementary students who do not utilize ESC mathematics software (control group).

DESIGN OF THE STUDY

A total of 561 Chapter 1 students took part in the reading study and 420 Chapter 1 students took part in the mathematics study. Approximately one-half of the students included in the reading study also participated in the mathematics study. Table 1 shows the distribution of the students per grade level and area of study.

Table 1

Number of Chapter 1 Students in Study

Experimental Reading Group		Control Reading Group	
Grade 2	36		105
Grade 3	60		128
Grade 4	21		55
Grade 5	27		43
Grade 6	26		60
	subtotal 170		subtotal 391

Experimental Mathematics Group		Control Mathematics Group	
Grade 4	72		106
Grade 5	41		95
Grade 6	33		73
	subtotal 146		subtotal 274

Only students from Chapter 1 schools were included in this study. Further, the schools in the experimental group must have had a computer laboratory utilizing ESC software during the one school year (1987-88) of the study. These schools in the experimental group were: Arlington, Cardinal Valley, Harrison, and Mary Todd elementary schools.

The schools in the control group must not have had access to a computer laboratory anytime during the one school year of the study. These schools were: Ashland, Breckinridge, Deep Springs, Dixie, Linlee, Meadowthorp, Millcreek, Northern, Picadome, Russell Cave, and Yates. The criterion for computer laboratory placement was the availability of space for the laboratory in the school.

Students identified as Chapter 1 students: (1) must be enrolled in an elementary school which has 25.99% or more of its students receiving free or reduced price lunch, and (2) scored at or below the 45th percentile on the previous year's Kentucky Essential Skills Test (KEST). By state regulations, elementary students must receive a minimum of 150 minutes of reading and language arts instruction per week and a minimum of 60 minutes of mathematics instruction per week. In the Chapter 1 compensatory reading program, students receive an additional 35 minutes per day of reading skills instruction from Chapter 1 teachers and tutors. In the Chapter 1 compensatory mathematics program, students receive an additional 25 minutes of mathematics tutoring per day (Chapter 1 Elementary School Mathematics Program, 1988).

Students in the control group must have been identified as Chapter 1 and remained at their school throughout the one year study. Students in the experimental group must have been identified as Chapter 1, remained at their school and utilized the ESC software throughout the one year study. Students in the experimental group worked with the ESC software in the computer laboratories 20 minutes per week on reading and 20 minutes per week on mathematics. The laboratory time was not required to be added to the regular reading and mathematics instruction time.

The Metropolitan Achievement Test, Sixth Edition, Survey Edition was the instrument used to determine if any differences in achievement occurred between the control group students and the experimental group students. In October, 1987, all Chapter 1 students in the reading study took the Metropolitan Achievement Test (MAT), Sixth Edition, Reading Survey for their grade level as a pretest. In April, 1988, all the students then took the same Metropolitan Achievement Test as a posttest. Similarly, the Chapter 1 students in the mathematics study took the Metropolitan Achievement Test, Sixth Edition,

Mathematics Survey for their grade level as a pretest in October, 1987, and as a posttest in April, 1988.

Scores on the MAT are reported in Normal Curve Equivalent (NCE) scores. NCE scores are the units typically employed in the evaluation of federal programs. The scores are equal to percentile scores at the 1st, 50th, and 99th percentiles. They have equal units with a mean of 50 and a standard deviation of 21. NCE are used in evaluating Chapter 1 programs due to this interval scaling making mathematical comparisons appropriate (MAT, 1986).

ANALYSIS OF DATA

An analysis of the MAT Reading Survey and of the MAT Mathematics Survey results show statistically significant positive gains for the Chapter 1 students who worked with the ESC software in the elementary computer laboratories during the 1987-88 school year. Test results were analyzed collectively for all students and separately per grade level. Table 2 displays the collective data for the reading and mathematics test score gains on the MAT. Chart 1 displays this information graphically. Since the students were homogeneous because of the Chapter 1 selection criteria, a one-way analysis of variance (ANOVA) test was used to determine statistical difference. Minitab data analysis software was used to interpret all statistics.

Table 2

One-Way ANOVA on Achievement Tests' Gains

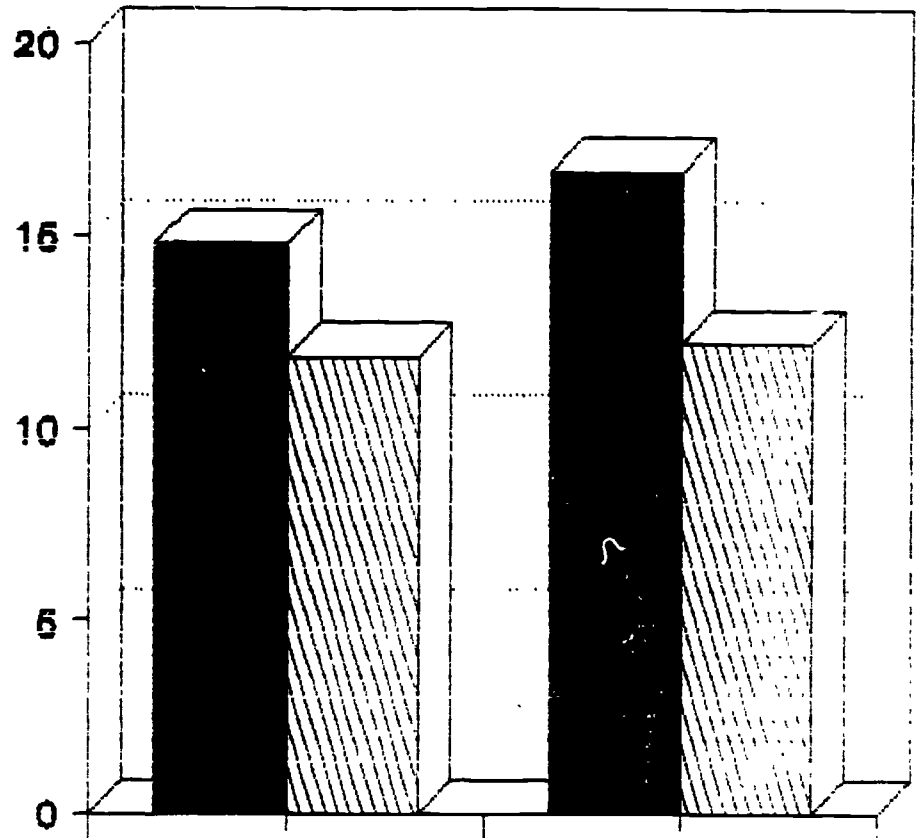
	N	Mean Gain	F	p ≤
Experimental Group Reading	170	14.77	7.53	.006
Control Group Reading	391	11.87		
Experimental Group Mathematics	146	16.68	14.12	.0001
Control Group Mathematics	274	12.23		

The data suggests a rejection of the null hypotheses of this study. Chapter 1 students who worked with the ESC software (experimental groups) demonstrated significantly greater increases in achievement both in reading and in mathematics than those Chapter 1 students who did not have access to computer laboratories (control groups). Students who worked with the ESC reading software gained an average of 14.77 Normal Curve Equivalents (NCE) on the MAT Reading Survey, a significant increase above the average of 11.87 NCE of those students that did not work with the software on the computers. An even stronger difference was found in mathematics. The experimental group students who worked with the ESC mathematics software gained an average of 16.68 NCE on the MAT Mathematics Survey, significantly above the average of 12.23 NCE of those students that did not work with the software.

CHART 1

ESC Software

Computer Assisted Instruction



	Reading	Mathematics
Computer	14.77	16.68
No Computer	11.87	12.23

NCE Gain

Computer No Computer

The reading data for each grade level are shown in Table 3. Chart 2 displays this information graphically.

Table 3

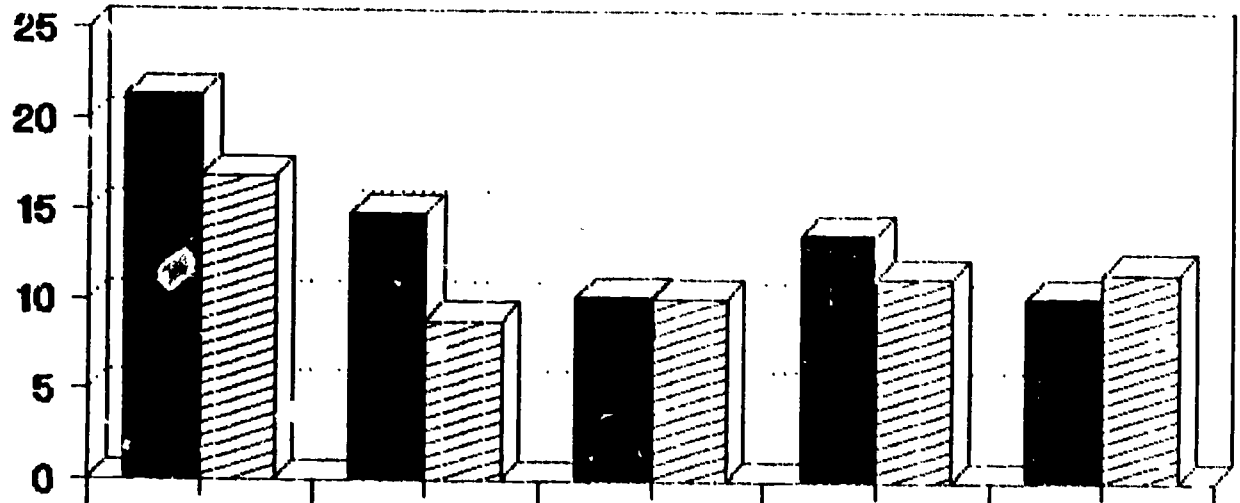
One-Way ANOVA on Reading Achievement Tests' Gains

	N	Mean Gain	F	p ≤
Experimental Grade 2 Reading	36	21.38	3.90	.050
Control Grade 2 Reading	105	16.88		
Experimental Grade 3 Reading	60	14.84	11.92	.001
Control Grade 3 Reading	128	8.84		
Experimental Grade 4 Reading	21	10.19	0.00	.978
Control Grade 4 Reading	55	10.11		
Experimental Grade 5 Reading	27	13.76	0.87	.354
Control Grade 5 Reading	43	11.32		
Experimental Grade 6 Reading	26	10.24	0.33	.565
Control Grade 6 Reading	60	11.62		

The grade level data shown give a better insight into the effects of the ESC reading software. A significant positive difference was found in grade 2, with students in the computer laboratories gaining and average 4.5 NCE more than the control students. A significant positive difference ($p \leq .001$) was found in grade 3, with the experimental students averaging a gain of 6 NCE more than students not using the software. However, no significant difference was found in grades 4, 5 or 6. This suggests that the significant difference shown in Table 2 solely is due to the impact of the software in grades 2 and 3.

CHART 2

ESC Reading
Computer Assisted Instruction



	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Computer	21.38	14.84	10.19	13.76	10.24
No Computer	16.88	8.84	10.11	11.32	11.62

NCE Gain

Computer No Computer

The mathematics data for each grade level is shown in Table 4. Chart 3 displays graphically the mathematics gains.

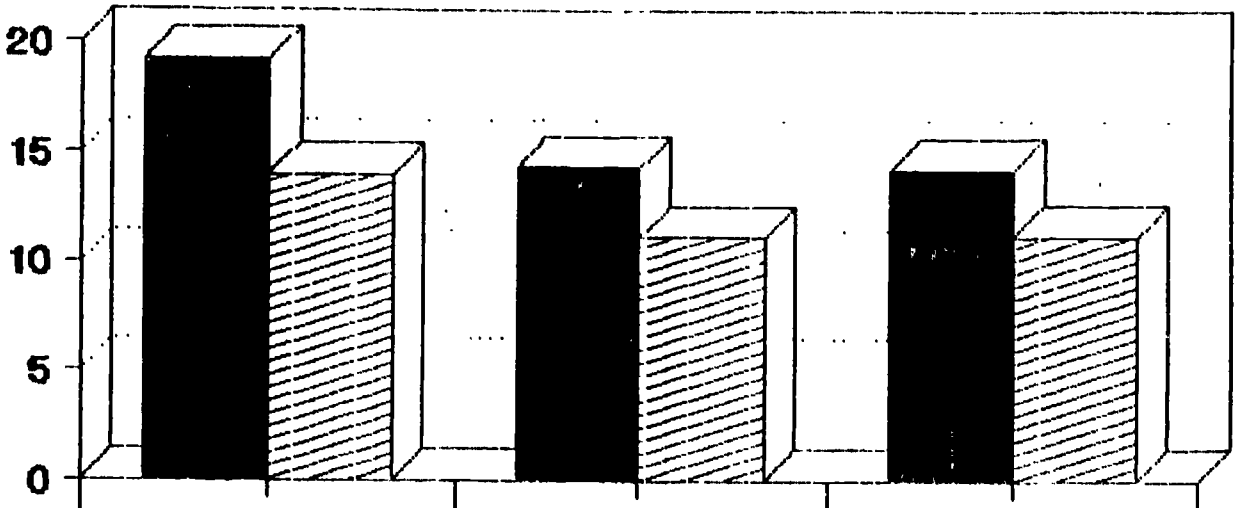
Table 4

One-Way ANOVA on Mathematics Achievement Tests' Gains

	N	Mean Gain	F	p ≤
Experimental Grade 4 Mathematics	72	19.20	8.87	.003
Control Grade 4 Mathematics	106	13.96		
Experimental Grade 5 Mathematics	41	14.29	2.17	.143
Control Grade 5 Mathematics	95	11.12		
Experimental Grade 6 Mathematics	33	14.15	1.59	.210
Control Grade 6 Mathematics	73	11.18		

CHART 3

ESC Mathematics
Computer Assisted Instruction



	Grade 4	Grade 5	Grade 6
Computer	19.2	14.29	14.15
No Computer	13.96	11.12	11.18

NCE Gain

Computer No Computer

From Table 4, the various grade levels had differing increases in achievement between the computer and non-computer students. In grade 4, the Chapter 1 students using the software gained a significant average 5.24 NCE more than the control students. In grades 5 and 6, the experimental students also had gains of approximately 3 NCE, but this was not statistically significant at the .05 level. However, when these gains are collapsed, as in Table 2, an overall significant difference is obtained.

CONCLUSIONS

From the structure of this study, the data shows that utilizing the ESC software in the elementary computer laboratories twice a week significantly increased Chapter 1 students' achievements in reading and mathematics skills more than the control group students. These results coincide with numerous other research studies on the effectiveness of computer-assisted instruction and achievement (Capper, 1988; Capper & Copple, 1986; Vinsonhaler & Bass, 1972; Jamison, et al., 1975).

An interesting aspect of this study was the discrepancy between NCE gains per grade level. For both reading and mathematics, the statistical gains were at the lowest grade levels for the Chapter 1 students. What would cause this? Several explanations are possible. First, the tests used measure mostly reading and mathematics skills. The software lessons, especially at the higher grade levels, go beyond skill work. At the earlier grade levels the software is more in line with the tests used, therefore the tests could measure gains easier than at the higher grade levels. From this viewpoint, if an instrument (test) was used that was more sensitive to measuring such things as problem-solving skills or estimation, the gains would have been even more pronounced.

Second, Chapter 1 students at the higher grade levels may be more impious to school and learning than at the lower levels. It may take much more effort to significantly impact students at the higher levels.

For whatever reasons, the Chapter 1 students using the ESC software in the laboratory setting twice a week benefitted. The 2nd and 3rd graders in reading, and the 4th graders in mathematics had strong, significant achievement gains. It would seem that this is quite cost-effective since the Chapter 1 students used the laboratories only 40 minutes per 1800 minute academic school week.

The logical question is why does the laboratory time help these students? Perhaps, it is the fact that during the two 20-minute lab times, students are completely spending their time on task. Or it may be that the students respond better to the individual attention the computer gives them.

A final idea is that the computer does not know the Chapter 1 student is a Chapter 1 student. The computer is not programmed to respond to the Chapter 1 student differently than it does to other students. It has the same expectations and presents the material in the same manner to all students.

A final concern with respect to the ESC software and the elementary computer laboratories is how effective they are for all the students, not just the Chapter 1 students. This could not be measured because consistent, standardized instruments (tests) had to be used for the pretest and posttest. All Kentucky schools have administered the Kentucky Essential Skills Test (KEST)for the past four years. The KEST has been discontinued by the Kentucky Department of Education due to concerns about reliability and technical quality of the test. The Comprehensive Test of Basic Skills (CTBS) has been adopted beginning in the Spring of 1989. While the CTBS scores will be available in the future, two problems will be present. First, the CTBS will not be given in the pretest/posttest method during the regular school year. Second, the CTBS

emphasizes the basic skills in reading and mathematics. The ESC software emphasizes more higher-order processes than the CTBS may measure.

In conclusion, from the research on impact of technology, such systems as the ESC software used in a computer laboratory setting would seem to be effective (McDermott & Deaton, 1987; U.S. Congress Office of Technology Assessment, 1988). The first study of the Fayette County Public Schools computer laboratories, Teacher Assessment of Elementary Schools' Computer Laboratories, found that the teachers have very positive attitudes toward the computers, the laboratories, and the software. Teachers were very positive about the decision to set up the computer labs with the ESC mathematics and reading software. They felt that the computers do play a valuable role in the mathematics and reading instruction (Zollman & Wyrick, 1988). This second study has also identified successes using the same integrated learning system.

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